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Notes.

Mersey and W. Lancs. Electricity District

The draft schemes for the constitution of three Joint Electricity Authorities have been issued, viz., those for the West of England, North Wales and Chester and the Mersey and West Lancashire areas. We have already given some particulars of the two first named, and we are now able to give an outline of the third, which is in some respects the most complete and most interesting of the three. The area is that provisionally defined by the Electricity Commissioners, but a rival scheme for the constitution of an authority for the Wirral district has also been submitted. The present scheme contains provisions for the constitution and organisation of the Joint Authority, a technical scheme for the reorganisation of electricity supply in the district, and financial details for its operation and development. Like the other two, the Mersey and West Lancaashire Joint Authority will consist of 30 members, 10 of whom form a quorum. Twelve members are to be appointed by the local authorities specified in the first part of the second schedule to the scheme, six members by local authorities supplying (or entitled to supply) electricity within the district; two members by local authorities having a population of over 5,000 not supplying electricity; four members to be appointed by 11 companies supplying electricity in the area; one member by the Mersey Docks & Harbour Board; two members to be elected by nine railway companies using electricity, and three members by large consumers of electricity. Though the local authorities who supply electricity in the area will have two-thirds of the representation on the authority, the railway companies, the Docks & Harbour Board and the large consumers (those whose annual consumption exceeds 100,000 units) will be entitled to elect six members, or one-fifth of the total. The fact that there are 23 local authorities whose population is over 5,000 indicates that there is still plenty of room for the development of electricity supply in the district.

Technical Details.

On the technical side it is proposed to develop the scheme in stages, the first being the interlinking of the generating stations at Bootle, Birkenhead, Liverpool, St. Helens, Wallasey and Warrington. From this combination extensions will be carried out for the supply of other parts of the district. At a later stage it is proposed to link up the Joint Authority's undertaking with the United Alkali Company, the Mersey Power Company, and, through the area of the latter, with Ellesmere Port and thence through Birkenhead to a junction with the mains running from Liverpool to the Cheshire side of the River Mersey. The system of supply will be 3 phase, alternating current, 50 periods. The main transmission pressure suggested is 33,000 volts, stepped up from the generating pressure, which at present is, in the majority of the stations, 6,600 volts. Details of the proposed main transmission mains and the transformers required are included. The main generating stations in the area will be linked up with 33,000-volt transmission mains, and, as the load develops, extensions will be made to other areas. It is proposed to erect a new capital station on the riverside at Liverpool, and until this station is running all the existing stations will be required, but eventually certain of them will be shut down. The estimated maximum load for the year 1925 for the main generating stations (at Bootle, Birkenhead, Liverpool, Prescot, St. Helens, Wallasey and Warrington) is 155,000 kw., and the maximum load that can be provided for in that year by the individual undertakings, with the extensions at present sanctioned, will be 87,000 kw., or a deficit of 68,000 kw. At the new capital station there will be four 25,000-kw. turbo-alternator sets, one of which will be a spare. It is proposed to apply for authority to proceed forthwith with the equipment of the first section of this capital station. The scheme of the proposed Joint Authority will also be capable of providing for all the railway and tramway requirements in the district.

Financial Proposals.

The details of the financial side of the scheme are elaborate, and provision is made for establishing capital and revenue accounts, the creation and application of reserve and sinking funds, &c. Power is sought to borrow money for the purchase of generating stations and main transmission lines, and to issue stock, bills or bonds, but the total of the outstanding bills is not to exceed £1,000,000. The authority may also obtain advances by way of temporary loans to the extent of £1,000,000, or £2,000,000 with the sanction of the Electricity Commissioners. Any constituent body and any authorised undertaker, and any authority or company receiving or intending to receive a supply of electricity from the Joint Authority shall have power to raise money for lending to the Joint Authority, or for subscribing for any of its securities, &c.

The New Electricity Bill.

Many of the powers sought in this part of the scheme will be seen to be similar to those proposed to be conferred by the new Electricity (Supply) No. 2 Bill which was introduced and read a first time in the House of Commons last week. It is, therefore, clear that the provisions of the Electricity (Supply) Act, of 1919, are inadequate for the requirements of a Joint Electricity Authority, and it is to be regretted that the Ministry of Transport did not deal seriously with this important question earlier in the session. No doubt the officials of the Ministry have been so deeply immersed in the details of the Severn Barrage and other grandiose schemes that they were not able to pay attention to the requirements of electricity undertakings. It is true they introduced a Bill early in 1920, but they must have known that it would encounter serious opposition and that it had little chance of passing. Then, in the last days of a crowded session, when there was no time for dealing even with a non-contentious measure, the actual situation seems to have been realised, and a modified Bill was brought in. This looks like playing with the legislative requirements of a key industry, and it is to be hoped that the Bill, which is mainly permissive in character and should not be seriously opposed, will be reintroduced early in the next session and passed into law without delay.

A New Theory of Electric Resistivity.

Prof. E. Denville Campbell, of Ann Arbor University, Michigan, is one of those scientific workers who has had the courage publicly to recant convictions which he once held, such recantation being caused, not by the arguments of others, but by the results of his own work. For while in 1917 Prof. Campbell sought to explain the peculiarities of certain iron alloys under heat treatment by regarding them as solid solutions, in which chemical reaction only takes place between the ions carrying electric charges, now he considers this theory quite untenable for metallic solutions, and proposes to substitute for it the "force-field" theory of Prof. E. C. C. Baly. As pointed out by Prof. Campbell in a Paper read at a recent meeting of the Faraday Society, according to this theory, each atom possesses an electromagnetic "field-force" which is closed when the atoms combine, but opens more or less under the action of solvents. Reactivity is not due to ions, but to the presence of these force fields, and molecules not in solutions may also possess this property of reacting with certain forms of energy—*e.g.*, pure metals would react with electrical energy and would possess electric resistivity. The resultant of reactivity in metallic solutions is resistance, while in aqueous solutions it is conductance. These theories open up a wide speculation, which, though not altogether accepted by other workers in the same field, should certainly repay investigation.

Telephone Charges.

The recommendations made in the report of the Select Committee on Telephone Charges, which has just been issued, do not differ materially from those made by the Departmental Committee on the same subject to whose report we referred in July of this year. The flat rate, which is now in use throughout the country, and the measured service rate, which is only in use in the provinces, are both to go and the message rate, which is really made up of a fixed charge per annum plus a charge for each message initiated, will reign supreme. Thus the telephone rate known to certain station engineers will become what it has not been before, a universal fact in the telephone service. As will be seen from a detailed account of the report which we give on another page of this issue, the rates generally are to be raised, but the war surcharge is to be done away with, a reform which will mean that new subscribers will be able, other things being equal, to obtain a telephone for a less sum than they can at present. This, however, is the only thing they will be able to get for less.

Telephone Economics.

But very much more interesting than these sordid financial details are the sections of the report in which the Committee let themselves go on economic questions. We are interested to see, for instance, the Post Office authorities striking out a new line for themselves in face of the manifold complaints of the operation of the telephone system which have recently been made. They do to some extent admit that the present system does not give the service that it might, and they implicitly realise that higher rates should in equity be accompanied by improved working and more businesslike methods of administration. During the past few years we have been accustomed to increased charges in plenty, but there are very few cases where those increased charges have not been followed by worse service, so that the Post Office are to be congratulated on what we hope will soon be a universal policy. The interests of the subscribers and of the administration too are also considered in the recommendation that meters for checking calls should be installed at the subscriber's end, while we are glad to see that the call office fee is to remain at 3d. in London, and not to be raised to 5d., as was at one time suggested. We consider, however, that these increases should only be temporary and that with proper management and development it should not be impossible to reduce the charges even below the pre-war level.

The Third Burnham Committee.

We understand that the third Burnham Committee has commenced its deliberations. This Committee seeks to recommend a national scale of salaries for technical teachers—a body which, it will be agreed, has always been badly treated in the past. We therefore trust that this Burnham Committee will not make any mistake in the interpretation of the word economy. The cry for economy is going up from everybody, but we fear that the general interpretation of the word is reduction of expenditure, whatever the consequences may be. Indeed, it would be something more than epigrammatic to say that in many minds the cry for economy means reduction of expenditure, whatever the cost! We trust that the Burnham Committee will not make any such interpretation, and that it will bear in mind the position of scientific and technical education in the economic and industrial development of the nation. We are sorry to see that the Committee has no direct representatives of industry to aid it in its deliberations and to assist it in assessing the value of technical teachers from the industrial point of view. We trust, however, that the Committee as a whole will be able to take the larger view—the view that seemed to be universally accepted during the years of war—that without adequate scientific and technical knowledge no nation can successfully compete in the market places of the world. And we wonder whether those people who merely think of economy as ruthless reduction of expenditure realise that technical education means the application of scientific knowledge to the general benefit of mankind.

Progress in Lighting.

In a paper recently read before the National Association of Supervising Electricians, Mr. W. E. Bush remarked on the change that had taken place during recent years in the way lighting is regarded. Formerly the sole criterion by which artificial lighting was judged was the efficiency of the lamp. Nowadays we look beyond this to the actual illumination produced at the point where work is needed, and it is also recognised that the mere provision of this illumination is not alone sufficient unless other essential principles, such as avoidance of glare, uniformity of illumination, &c., are complied with. The latter part of the paper was devoted to an analysis of various practical problems, such as the lighting of churches, offices, shops, &c., and an example was worked out to show what a small fraction the cost of lighting forms in comparison with the wages bill (in this instance about 0·7 per cent.). Mr. Bush remarked that while engineers concerned with lighting are becoming familiar with technical terms and scientific methods, light has been treated for centuries in such a casual manner that the general public still do not appreciate sufficiently the need for care in its use. We fear that this is in the main true, but it seems evident that in this matter education must begin at the top. It is at least something to congratulate ourselves upon that by engineers, experts, and authorities lighting is regarded in a much more scientific manner than a few years ago.

Troubles of a Municipal Supply Authority.

Those who talk glibly about scrapping existing electricity works and erecting super-stations and transmission lines for supplying "rivers of electricity" throughout the country might well learn a lesson from the recent experiences of Kirkcaldy Corporation. Faced with a refusal on the part of the Electricity Commissioners to allow an extension of their generating station, the Council were left in April last with the option of either selling the undertaking or taking a supply in bulk from the Fife Electric Power Company. At first it was thought better to effect a sale, and negotiations with the company were entered upon. It is now, however, reported that a bulk supply will be dearer, and not cheaper, than the present cost of generation and supply, and the Council are advised by their Town Clerk that it would be wise to retain the generating station in the hope that conditions may change. This seems to be so extraordinary as to be incredible, but it is explained by the statement that the cost of laying the distributing mains is about equal to the cost of building a generating station. It is also contended that the generation and distribution of electricity should be in the same hands, and that it is not worth while for the Council to act as distributors and collectors of rates for electricity produced by some one else. This is very much open to argument, and sounds rather like pique. Following the advice of their Town Clerk, the Electricity Committee has now suspended negotiations with the Fife Company in respect of the transfer of the undertaking, but the company has been asked to state what bulk supply they are in a position to give the Corporation, what supply they will be in a position to give in the near future, and on what conditions. We await their reply with some interest, as we feel that the matter is of greater importance than it seems at first sight.

Tramway Conductors' Duties.

Many actions are brought against tramway undertakings on account of accidents to passengers when leaving or entering tramcars at "stop if required" points. These cases frequently entail an elaborate investigation of the duties of conductors towards the public. An interesting case of this nature recently came before a Divisional Court on appeal from a decision of the County Court Judge at Bow. It appeared that a woman, who was in the act of mounting a car (she had one foot on the step), was seriously injured owing to the sudden starting of the car. There was no direct evidence on the point, but the inference was that the starting-bell was rung by someone other than the conductor. The Judge gave judgment for the defendants, the West Ham Corporation, on the ground that there was no evidence of negligence on the part of their servants. For the woman it was argued on appeal that the conductor was responsible for the control of the car, and it was his duty so to adjust the performance of his duties that he could prevent the car from being improperly started or stopped, and that if he failed to prevent the car from being so started his employers were responsible. The court was invited to adopt the principle of a judgment in an Irish case in which it was laid down that the conductor "should adjust the performance of his functions in such a way that the safety of the travelling public should not be prejudiced by his absence collecting fares or otherwise." Fortunately, the Court did not adopt this stringent view.

Conductors and Conducting.

In dismissing the appeal Mr. Justice Rowlatt pointed out that the argument really amounted to an effort to make the defendants take the risk of a third person's starting the car in the absence of the conductor, whatever the circumstances. He did not think that could be so, unless it was shown in each case that the conductor was negligent. Mr. Justice McCardie, who concurred, went further and said, "It is the duty of a conductor to conduct, to be on the platform at compulsory stopping-places, to assist passengers to alight and enter, and control the bell, and I conceive a like duty may arise in respect to optional stopping places. But a conductor has the other, if somewhat less important duties, of collecting fares and giving information to passengers whether on top or inside, which may necessitate his absence from the platform, even at a stopping-place, optional or compulsory." We are afraid that if this test were generally applied very many undertakings would be discovered not to comply with it. We have found that conductors are mainly engaged on the "necessary, though less important," duty of collecting fares in over-crowded cars, and it is physically impossible for them to comply with the Judge's ideal code of conduct under present conditions. As, however, passengers can apparently expect no redress in law they must assume the "important and necessary duty" of looking after themselves.

The Colour of Light from Searchlight Carbons.

So much interest was taken during the war in the greater intensity derivable from special forms of searchlights and its effect on range and the visibility of distant objects, that the progressive change in the colour of the light appears to have been somewhat overlooked. Some interesting data on this point are furnished in a recent technological paper issued by the Bureau of Standards, Washington. The photometric methods are described in great detail, and curves illustrating the distribution of energy throughout the spectra of various forms of carbons are presented. These researches confirm the impression that in these "super-searchlights" an exceptionally blue light is obtained. It appears, indeed, from the results for some types of carbons that the quality of light approaches very closely to that of the noon sun at Washington, although relatively more intense in the blue-violet portion of the spectrum. It appears that the richness in rays of this description is due largely to the presence of rare earth elements (including cerium, thorium, lanthanum and yttrium), a combination of which yields a practically continuous spectrum. What one would also like to know is the effect of this bluer light on the sharpness of distant illuminated objects. Where the brightness is relatively low, this blue element would be, in one sense, an advantage, but it has been argued by some that there is a difficulty in focussing distant blue light, and that the absorption of such rays by a suitable yellow screen would improve the definition. This, however, seems to be a matter that has not yet been finally determined.

Iron Conductors for Overhead Networks.

The suggestion to employ iron instead of copper or aluminium conductors for overhead networks has often been made and as often been commented upon without much practical result. For it is another of those cases where attractiveness at first sight soon fades into doubt and disillusion. This is amply confirmed by an example of the use of iron under the stress of war conditions given in a recent issue of the "Annales des Travaux Publiques de Belgique." The article describes how extensions to certain of the German supply networks were made by these means. When conductors up to 6 mm. in diameter were required wires were used and above that diameter cables were employed to avoid undesirable stiffness. Kinks were found to be troublesome, and great care had to be taken to avoid damaging the galvanising, making joints and generally in carrying out the work of erection. From the point of view of cost the arrangement was not a success, irong being 20 per cent. more expensive than copper, with the latter at 4 marks per kilogramme, against 0·71 marks for the former. It is therefore not surprising to learn that the use of copper is being resumed as quickly as possible.

Machinery or Labour.

This week's issue of The Electrician is the fourth that we have specially devoted to a consideration of the problems connected with the handling of materials. In former issues dealing with this important question we have perhaps not unnaturally looked at the subject almost solely from the electrical point of view. It is a widespreading view and leaves plenty of scope for the exercise both of imagination and the more mundane qualities. In this way we have described the design of electrical equipment for driving and controlling the movement of such machines as cranes, hoists, conveyors, telphers and transporters; we have pointed out that these machines can be more efficiently and easily operated by electrical means than by any other, and we have deduced from the examples of modern electrical engineering so published that our methods of conducting our lives and our businesses can be improved to a greater extent in this way than in any other.

A New View Point.

In this issue we deal with the subject of material handling from a different, but not less important, standpoint. Electricity is not placed so obtrusively in the foreground. First principles are neglected. Comparative economies are only referred to incidentally. Instead a number of authors describe in a series of special articles what is being done in a general way in handling of materials by mechanical (we use the word in the broadest sense) rather than by human means. Thus there are articles on coal-handling and storage, on grain elevating, on ore transport by ropeways, on distributing machinery, on cranes for all sorts of purposes, and on the important allied questions of storage which such methods of handling make desirable and even necessary. The one important branch of this important and varied subject that is not dealt with is traction whether it be on railways or on roads, and that we feel is so wide a question as to require separate consideration. To deal with it would indeed go rather outside the scope of this issue, whose object we may say is to illustrate the principles which have been enunciated in former issues. The application of electricity and electrical engineering to the carrying out of this programme is so obvious and clear in the perusal of the articles as to require no further comment here.

The Need for Mechanical Handling.

When writing on this subject in our Materials Handling Number twelve months ago we said that the application of machinery to the handling of materials, a process which is found to be more and more necessary as our civilisation widens and becomes more complicated as that widening takes place, was being forced upon us by two factors: the necessity for increasing production and the need for eliminating the human element from such operations to as great an extent as possible. This statement is not the less true now than it was twelve months ago. Indeed, these two factors in the conduct of modern industry keep cropping up again and again at every turn like a twin representation of King Charles' famous head. As regards the first the high hopes with which we started the year have been to a large extent disappointed for a variety of reasons well known to our readers, with the result that nothing like so great a step forward either in reconstruction or in industrial peace as had been hoped has been made.

The Replacement of the Human Element.

That this should be so is most unfortunate. For we feel that the more machinery takes the place of the human element the nearer shall we be to reaching that new world which is, not only the catchword of the politicians but the dream of us all. The arguments in favour of this change become the more profound, the more it becomes clear that we are using the human machine, which is not only inefficient, unreliable and expensive, but temperamental as well, to do something which the non-human machine can do very much better. Indeed, the only thing that seems to stand in the way of the universal replacement of the one by the other is the need for large capital expenditure at the time when money is hard to come by. We would go further and say that such operations as coal handling are work which a human being should never be called upon to perform, if even by his aid they could be performed more cheaply, quickly and efficiently than in any other way.

Precept and Practice.

We quite expect that these arguments will be met by two different kinds of reply. The one that all that we have said is already common knowledge and that capitalists and employers of labour would only be too glad to do everything by machinery if they could. But working conditions at the present day go to contradict the statement that it is known already or that if it is known something that we are not able to visualise prevents the simple precepts we have enunciated being put into practice. For there is not one of us who, after a moment's thought, could not recall some operation either in works, factory, warehouse, shop, office, street or house which is now being done by manual labour, and which could not be better performed by some machine or where the cost of such machine would not be saved many times over in the course of a year. The other reply is that the wholesale adoption of machinery in the way we have suggested would lead to equal wholesale unemployment. This is incorrect. Were the change to take place suddenly we agree there would be some dislocation, but even that might not be so great as is sometimes supposed. But as the change must be gradual nothing is to be feared on that score.

There is, therefore, we hope, this lesson to be learnt from the articles in our fourth Materials Handling Issue. That by the greater and greater use of machinery we can ensure greater production of the necessaries of life, improved conditions of existence and more abundant health. Electricity will, of course, play a greater and greater part in ensuring progress towards this state of things, which is not ideal but an actual fact if we would only realise it.

Elementary Electrical Text Books.

It is something of a novelty to find ourselves levelling a charge of over-production at workers in any sphere of activity. Nevertheless, in spite of the general axiom that over-production is an impossibility, we have arrived at the conclusion that in the matter of the publication of elementary or rudimentary textbooks on electrical engineering there is need for some drastic measure of regulation of output. New books seem to pour out of the publishers' presses daily; each one being strongly reminiscent of what was published yesterday and wonderfully prescient of what will be published to-morrow.

It was once said by a senior inspector of the Board of Education that every teacher should write his own text book. This advice—and it was excellent advice—appears to have been taken; but there is a distinction between writing and publishing which has been overlooked. That inspector owes it to the rising generation that his dictum should be re-issued with an appropriate epilogue.

Three Types of Textbook.

There are three distinct types of elementary textbook: the "syllabus" book, the book which aims at laying foundations, and the book which pretends that foundations may be done without. The syllabus book can never arouse our enthusiasm. It exudes the musty odour of the examination-room from its pages; it cramps the style of its author and distorts the perspective of its reader. Generally speaking, it frankly admits that it is written in order to cover some examination syllabus, and the admission is claimed as a sufficient justification for its existence. Perhaps the admission may also be regarded as an apology for its existence. It may not be fair to condemn syllabus books; it is the system that begets them which must be condemned. But this is the type of book that repeats itself above all others—book after book covering the same old ground in the same old way, and, only too often, illustrated by the same old illustrations. One can only presume that they dare not differ too much from one another lest they be charged with deviation from the strict and narrow path of scholastic rectitude known as "the syllabus." It must also be presumed that the reason for the multiplicity of these books is not entirely dissociated from commerce. There is a demand for books to cover the school-leaving syllabuses, and it is only natural that each and every publisher should wish to benefit by it. But is it not time that the reviewer was exempt from further service in the reviewing of such books? Let the publishers give a guarantee with each book that it does cover the syllabus in question in conformity with long-established tradition, and is illustrated by reproductions of well-known "old masters" in the textbook world of art. This would reassure any nervous and prospective buyer that the "new" publication was only new in so far as the paper, ink and binding were concerned.

The Laying of Foundations.

The second type, which seeks to lay foundations and disregards examinations, is a *rara avis*. Your publisher will ask who is going to buy such a book, and in asking that question he is suggesting that nobody is going to read a book merely in order to gain fundamental knowledge. Is such an estimate correct? We think not, and to support our view we point to the thousands of young men in electrical classes of the evening technical institutions up and down the country. They are attending those classes in order to learn fundamentals. They are not actuated by the examination motive, if only because of the fact that there are no longer any examinations for which they can sit. They want foundation books—real "live" books which seek, not only to impart information, but also to stimulate the enquiring mind.

The Practical Book for the Practical Man.

The third type is rather baffling. We praise it and condemn it in the same breath. Its foreword generally assures the intending reader that he need not be afraid. It tells him that he need not have any knowledge of mathematics or calculations, or other branches of science: that it is essentially a practical book for practical men, and that he who runs a dynamo or motor may read and profit. We are suspicious of this appeal. We do not think highly of the practicality of that man who does not endeavour to understand why he does a thing in a particular way. There is a type of man who habitually attempts to excuse his ignorance by the plea that he is "practical." If he were he would not be ignorant.

These books for practical men generally amount to a collection of glorified sets of "instructions for use," and are intended, it is to be presumed, for those who have some small degree of responsibility in the running of electrical plant. This in itself is not a bad object, and we realise that many men have been spurred on to further training and higher education from such beginnings. But we feel that authors should be more frank in the foreword—or they might even write an afterword—and indicate clearly and emphatically that such books can only improve the manipulative skill of the electrician in charge of some installation, and that progress in electrical engineering can only come through a knowledge of essential fundamentals. There is no "short cut," and no pretence should be made to the contrary. Unless this is recognised there is always the danger—and it is very great—that those who have become familiar with phrases and with the simpler manipulative processes may imagine themselves to be fully equipped electrical engineers. There have been, in the past, too many men of this type, either for the credit or progress of electrical engineering.

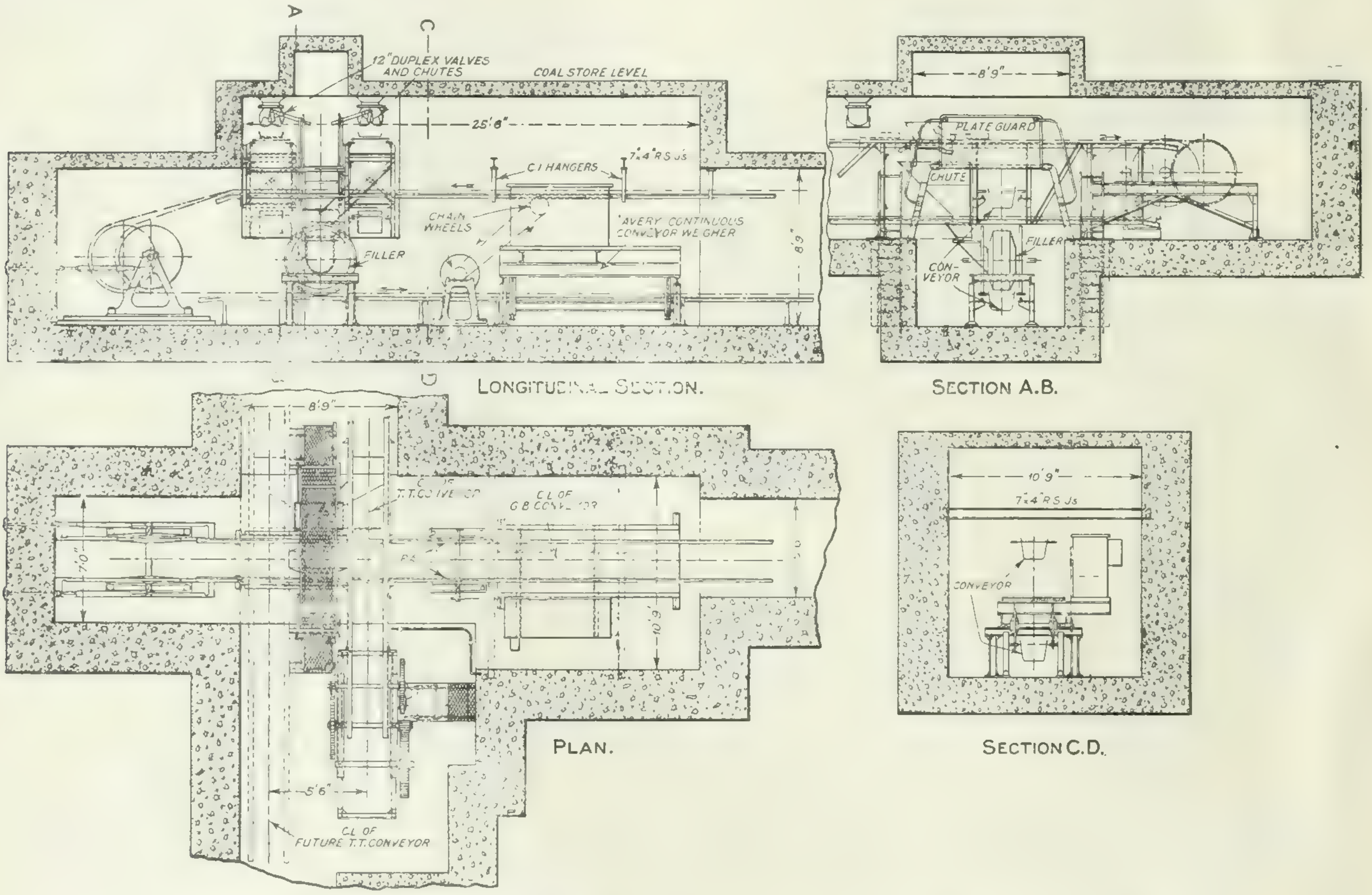
It will be seen, therefore, that it becomes a fine point to decide whether the good qualities of books of this type are not overweighed by the possible consequences that their readers may be deluded into the belief that therein lies the equipment of the complete electrical engineer. Is progress compatible with the attitude of the Scotsman who, upon his son complaining to him that he could not understand what he was reading, retorted, "Wha's asking you to understand it? *Larn* it"?

Coal Handling in the Power House.

The Equipment of the British Cellulose and Chemical Manufacturing Company.

By GEORGE FREDERICK ZIMMER, A.M.Inst.C.E.

COAL handling and storage installations for power houses, in which one conveyor of the gravity bucket type answers all or a number of handling purposes, are well known, and the type which Messrs. Babcock & Wilcox have adopted as their standard has been almost universally installed. The variety of purposes for which in such cases one conveyor is used, includes accumulation of the coal on to a stock pile; its withdrawal from this to the active store bunker of the boiler house and incidentally, if required, the disposing of the ashes and clinkers from the boilers. Generally, the lay-out of such installations is in one vertical plane, that is, the reserve storage pile and the boiler house are placed tandem-fashion, on the same centre line.



LONGITUDINAL SECTION. SECTION A.B. PLAN. SECTION C.D.

Fig. 1.—Part Arrangement of Conveyors under Coal Store. (The British Cellulose & Chemical Company, Ltd.)

Some Unique Requirements.

A distinctive new feature has arisen from the unique requirements of Messrs. The British Cellulose and Chemical Manufacturing Company for their new boiler house. When completed, this will consist of three distinct boiler houses with one common reserve coal store in the form of a large bing, extending the whole width of the boiler houses (a distance of 220 ft.) and parallel with them. This bing is 50 ft. wide and provides storage for 2,000 tons of coal.

In the plant under consideration the topographical conditions are favourable in so far that the coal arrives by rail at a sufficient elevation for it to be brought right over the coal storage space on an overhead rail track and gantry. It is thus discharged to stock by gravity, no conveyors being needed for its accumulation, under these favourable conditions. A coal pile, lodged upon a concrete platform raised about 4 ft. above the ground level, has a two-fold advantage. Firstly, the coal is deposited in a high and dry position; secondly, the excavation for the tunnel by which the coal is withdrawn to the three boiler houses has not to be so deep; incidentally, the excavated ground could be disposed of by being utilised for the formation of the platform.

Tipping Tray Conveyors.

Beneath the central portion of the coal bing and in the same vertical plane is a culvert, in which is installed one of Messrs. Babcock & Wilcox's tipping tray conveyors, having a capacity of 40 tons per hour. The arrangements allow for a second conveyor of this type being installed at a later date as the plant is extended. One of these conveyors travels to the right and the other to the left. The coal is withdrawn from this coal heap by gravity, through duplex valves pitched about 8 ft. apart, through openings communicating between the pile and the culvert. With this arrangement it is possible to reclaim coal for use in any, or in all, of the three boiler houses, from any point on the coal heap; and about two-thirds of the coal can be withdrawn by gravity from this reserve stock without resorting to any trimming. The remainder, which lies too remote from the openings and duplex valves, has to be trimmed, but it is the general practice to let this coal lie undisturbed, as an "iron ration," only to be used in cases of emergency.

Gravity Bucket Conveyor Essential.

Since now the coal bing lies parallel to the three boiler houses and at right angles to the three firing aisles, a distance of 114 ft.

between the boiler-house wall and the centre of the coal bing it is necessary for the coal for each boiler house to be conveyed by a separate conveyor which takes its feed from either one or other of the two tip-tray conveyors under the reserve coal-store. Since this same conveyor has also to elevate the coal and distribute it, in each case along a horizontal run over a series of bunkers extending over the whole length of the boiler house, the gravity bucket conveyor was the only suitable device (the capacity being also 40 tons per hour), and the most satisfactory solution, as it is more immune from breakdowns than most other types of conveyors, has a longer life and requires next to no attention, the upkeep also is trifling.

Fig. 2 is a general ground plan of the installation, the boiler houses being on the right hand side and for the ultimate capacity of the station. The lay-out is arranged for three boiler houses, No. 1 having been completed and containing six Babcock & Wilcox boilers. The other two boiler houses will contain the same number of boilers. At the right hand side of the plan is also shown a series of overhead bunkers, with 12 hoppered outlets, one over each of the 12 stoker hoppers. At the left hand side of the plan is the coal bing, shown dotted, and the two tip-tray conveyors side by side in the culvert, which latter is shown in sections. Here are also the three culverts which bring the coal from any part of the bing to any one of the three boiler houses. Fig. 5 is a cross section on A-A, through No. 1 boiler-house, with the active coal bunkers over, the capacity of which is approximately 600 tons. The twelve outlets of these bunkers, already mentioned, are provided with simplex valves operated by chains from the firing floor. These valves are accessible by two gantries running along the buckstays of the boiler setting at each side of the firing aisle. In this cross section (Fig. 5) may also be seen the upper run of the gravity bucket conveyor in the monitor of the roof, with the gangway at each side from which six standard dumpers can be thrown in or out for the distribution of the coal over the bunkers. A section through the culvert in which the gravity bucket conveyor runs to the boiler-house is also shown.

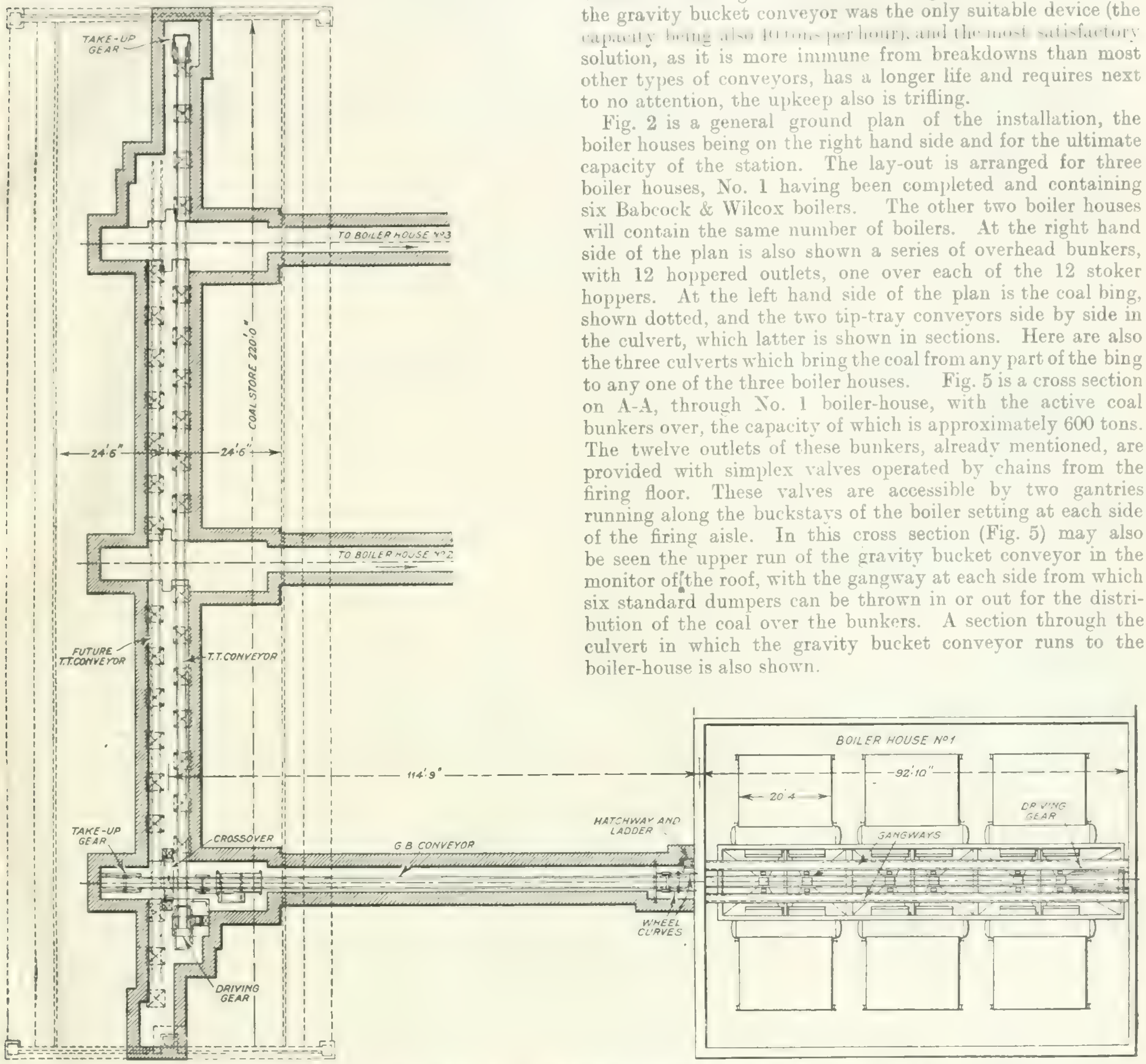


FIG. 2.—PLAN OF COAL HANDLING PLANT. (The British Cellulose & Chemical Company, Ltd.)

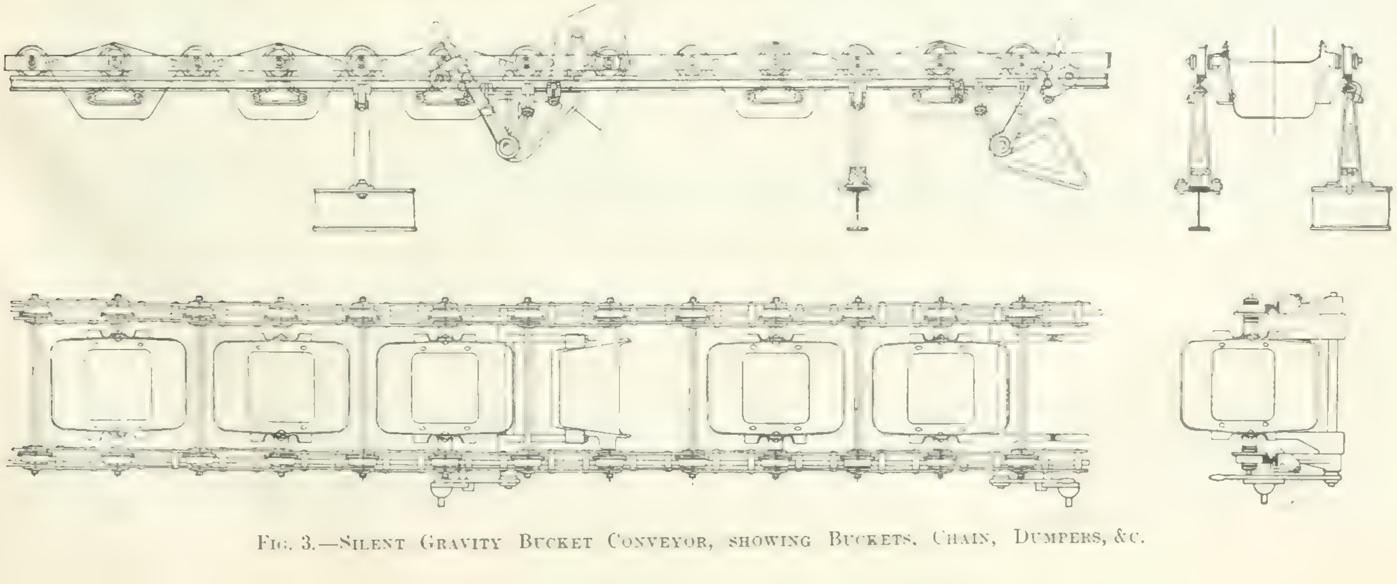
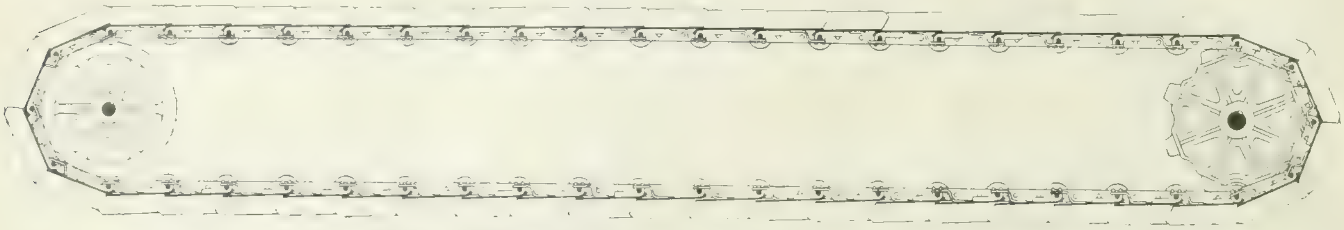


FIG. 3.—SILENT GRAVITY BUCKET CONVEYOR, SHOWING BUCKETS, CHAIN, DUMPERS, &C.

Path of the Gravity Bucket Conveyor.

The cross section B—B illustrates the two tip-tray conveyors in their culvert, and the openings through which the coal enters the duplex valves. The lower longitudinal elevation is a section through the main culvert which houses the two tip-tray conveyors and shows one row of 17 duplex valves, by which the coal is withdrawn. The upper view is a longitudinal section through one of the boiler houses, showing the complete path of one of the gravity-bucket conveyors from the receiving terminal under the reserve coal store to the front wall of the boiler-house where it ascends to the level of the monitor in the roof, traverses horizontally over the active coal store in the boiler-house to the other terminal, where, also, the electric motor for driving the conveyor is situated. It will be seen from this longitudinal section that the upper run of each gravity-bucket conveyor passes between the upper and the lower runs of the two tip-tray conveyors, so that it can take its feed from either through the standard revolving fillers.



Improved Tray Conveyor for Over End Delivery only.

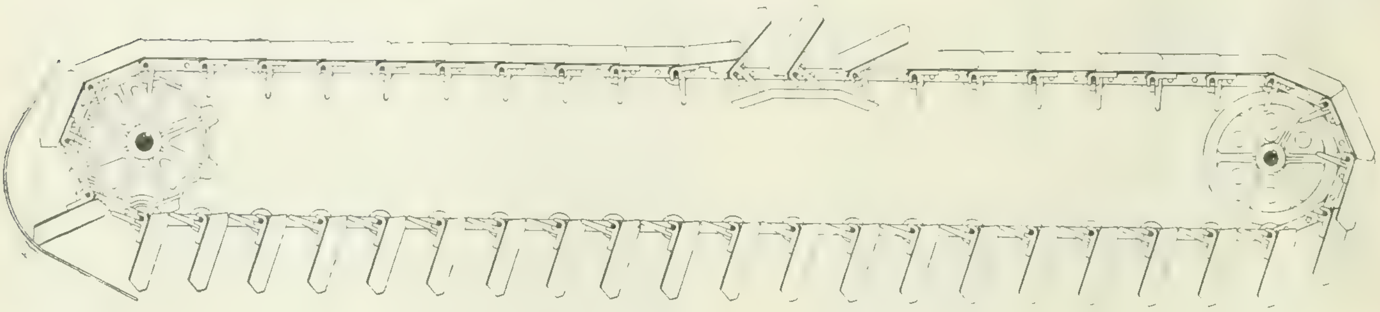


Fig. 4.—Tipping Tray Conveyor.

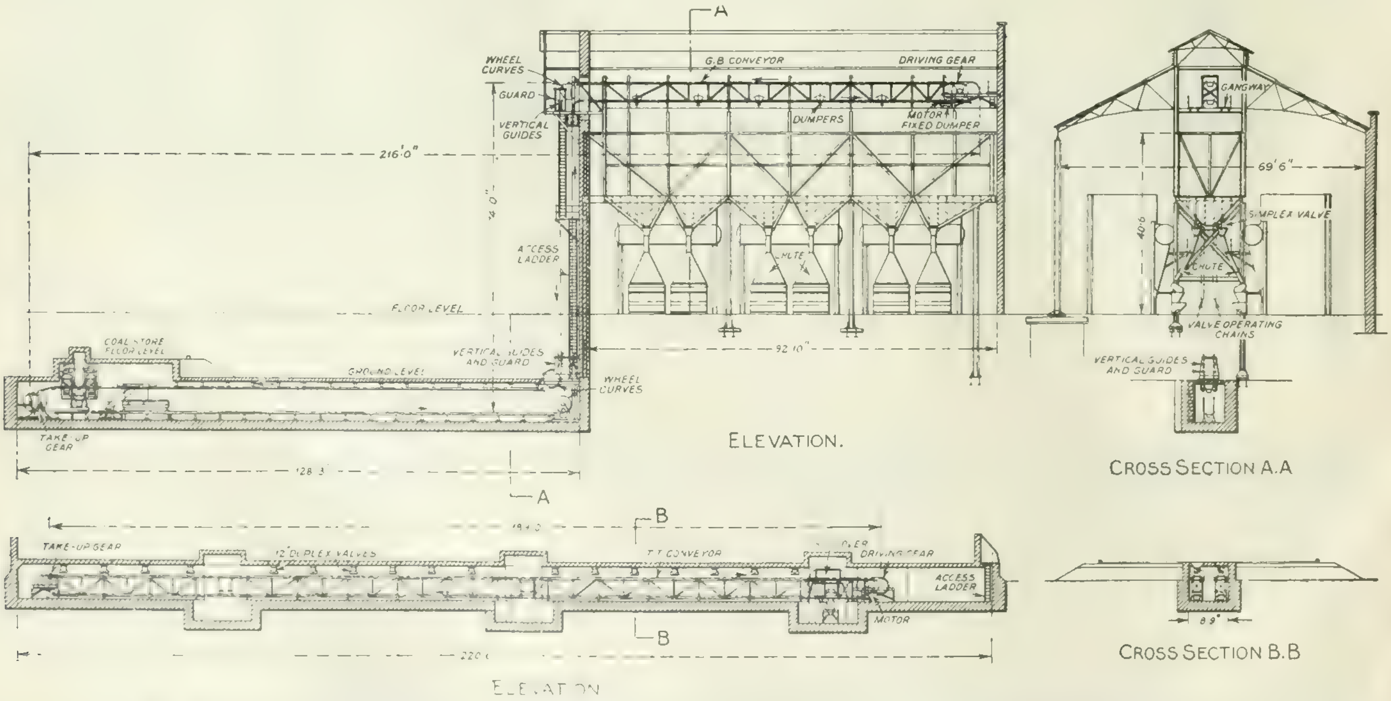


Fig. 5. General Arrangement of Coal Handling Plant. (The British Cellulose & Chemical Company, Ltd.)

In order to emphasise the more important and somewhat complex portion of this installation, which can scarcely be followed from the small scale drawing, the illustration (Fig. 1), is given, which will elucidate this particular portion. The plan view shows the driving terminal of one of the tip-tray conveyors, together with its driving motor, countershaft and gearing. The second tip-tray conveyor—which is only indicated in dotted lines—is not yet installed, as has been already mentioned. At the extreme left of the plan view the tension end of the gravity-bucket conveyor which feeds boiler-house No. 1 is shown. Immediately after leaving the tip-tray conveyor with its load, the gravity-bucket conveyor passes over an Avery continuous-weigher conveyor, which automatically records the amount of coal passed over it.

In the longitudinal elevation above the plan may be seen, in cross section, the two tip-tray conveyors with the duplex valves over by which they are fed from any part of the coal bing. The coal slides down from these conveyors into a stationary filler which delivers the coal on to the lower run of the gravity-bucket conveyor. The upper and lower runs are 5 ft. 8½ in. apart, in order that the upper run can have a clear path through between the upper and lower runs of the tip-tray conveyors. Sections A—B of this drawing clearly show the points at which the tip-tray conveyors discharge into the shoot which communicates with the filler. The steps and gangway over the gravity conveyor may also be seen. In section C—D a view of the gravity-bucket conveyor is represented, and the method by which the small driving power for the weighing machine is taken from this conveyor is also shown.

Construction of the Conveyors.

The gravity-bucket conveyors (*see* Fig. 3, which gives four views of these) consist, as is well known, of an endless train of tipping buckets linked together, and so arranged that whether the conveyor is being led horizontally, vertically or at any intermediate angle, the buckets always remain normal to the horizontal plane until they encounter the tripping gear, when they are forcibly tipped and emptied. Immediately after this process they assume their normal position once again, being supported on pivots well above their centre of gravity. The endless moving chain of these conveyors is always in balance, and when empty will stop at any position; the driving power required is therefore merely what is necessary in order to overcome frictional resistance, plus that in actual foot-pounds necessary to lift the weight of the coal from the receiving hopper to just above the bunkers. The chain links are bushed and the supporting rollers are carried on the bushes, and not only are the parts interchangeable, but the axles and bucket studs also. In practice it has been found that where lubrication is thoroughly attended to during the earlier stages of the installation, fine smooth surfaces are obtained in all the various parts of the chain. Each individual bucket is stamped out of one sheet of mild steel. The driver and wheel curve bearings are made self-aligning, with large bearing surfaces, thus avoiding binding and extra friction in the driving gear and shafting.

Tip-Tray Conveyors.

With the tip-tray conveyors (Fig. 4), the discharge is independent of the track, and each pair of rollers keeps to the normal rails, the tipping being effected by a lever attached to the forward end of each unit. The adjustable tripping gear is raised into position, and as the lever engages with the tripper the buckets are discharged. At the driving end the units are guided round the terminal by an attachment, and when leaving this the units of the tray hang down in a vertical direction in order not to impede the fall of the material conveyed, in the event of no delivery shoot being found desirable. The chains with their guide rollers, in these conveyors, are the same as those used in the gravity-bucket conveyors.

The Advantages of Mechanical Handling.

Lenin on the Taylor System.

By E. REED.

WE in this country have not hitherto regarded Messrs. Lenin, Trotsky & Company as exactly pioneers of efficient industrial organisation, but if reports of recent speeches are to be taken as accurate, it would appear that the advantages of capitalistic production and distribution are rapidly forcing themselves into the minds of the present rulers of Russia. According to one report Lenin is stated to have told an audience of workers that "we must introduce piece-work, the Taylor system and so on. We must compare the pay-roll with the general total of production. We must use the most valuable scientific attainments in the analysis of mechanical motions during work, in dismissing superfluous and useless motions, in determining the most correct methods of work, the best systems of accounting and control. We must introduce in Russia, the study and the teaching of the Taylor system in its systematic trial and adaptation."

The Elimination of Useless Motion.

If this is indeed the case, we can only say that M. Lenin is wise in his generation, for the future trade of the world undoubtedly belongs to the nation that can best and most quickly adapt itself to supplying the needs of the world at the highest rate of efficiency and with the least expenditure of physical energy, and one of the chief elements—perhaps the chief element—in both these factors is the elimination of "superfluous and useless motions," that is to say, by stringent economy of man-power, now, more than ever, necessary to those nations whose man-power has been so vastly depleted by the toll of war.

At the back of every problem of industrial organisation lies the question of the most effective distribution of human energy, mental as well as physical, though it is only the latter activity which can be compared with the work of a machine, and we all know that for the same capital cost a machine will perform an immeasurably greater amount of work than a man. When labour was cheap, the cost of handling was looked upon without much concern. It was often cheaper to take on an extra man or two than to put in a conveying plant, but with labour at its present price, no manufacturer can afford to neglect the possibility of being able to reduce the cost of handling, either by substituting machine labour for manual labour or reducing the time occupied in the handling processes. The particular system employed will, of course, vary with the size and lay-out of the factory and the nature and quantity of material to be handled.

The Unreliability of Man Power.

Not only is the labour of a man trifling in comparison with the performance of a machine of the same capital cost as a man's life-time, but the supersession of man-power by motive power is further necessitated by its unreliability. Machines do, of course, break down, accidents occur, repairs and renewals are constantly necessary. These disabilities a machine shares, though not to the same extent with a man. Where the superiority of a machine as an item of energy expenditure is triumphantly vindicated is in the sphere of what we may call "temperamental unreliability." It has no worries, domestic or pecuniary, to brood over and so lower its interest in the task in hand, it is immune to all alluring counter attractions; it smokes not, neither does it drink (using those terms in their popular significance and not in relation to fuel combustion and lubrication). It is impervious alike to cajolery and threats; it carries no "ticket" and is not subject to Trade Union rules. Once properly going, it will continue to do its work without pause for rest or refreshment, and in some cases at least a mechanical handling appliance will go on, like Tennyson's brook, practically for ever.

The Shoot and Runway.

For instance, the apparatus shown in Fig. 1 illustrates a spiral chute handling tea chests in a large warehouse, and has, once installed, a practically unlimited capacity, and apart, of course, from repairs or renewals, the initial cost of the installation is the whole expense, since no power whatever is required to drive it. In this case the shoot serves a gravity conveyor at its starting point. Such shoots may be either straight or spiral, as circumstances may require, and they may be with or without rollers. Generally, their gradients are sufficiently steep not only to render rollers superfluous, but also to require some brake action to reduce the speed of the packages. Such brakes are usually fitted at the sides; but, if without rollers, the shutes have sometimes to be so steep that the goods are subject to considerable impact and concussion. In such cases, runway shoots with more moderate gradients may be substituted with advantage. The gravity runway is now a familiar sight and is too well known for detailed description. It was enormously popularised during the war for handling munitions and stores, whilst the use of the "humper" has greatly increased the utility of this conveyor by enabling the gradient to be renewed as often as required to complete the conveyance to any distance. Humpers can be either fixed or portable and are worked by light petrol or electric motors. The gravity runway has a special advantage in the handling of material of a fragile or breakable nature, owing to its gentleness of motion. Shoots, which, of course, work by gravity, and usually have a fairly steep incline, cannot be used for very heavy articles or goods easily liable to breakage unless fitted with rollers and brakes, but for loose, dry material or for such things as forgings, castings, packages, papers, metal blanks, and, if not too steep, wooden boxes, tea chests, &c., shoots, with or without rollers, are a very useful device for saving labour besides being very convenient and taking up little room.

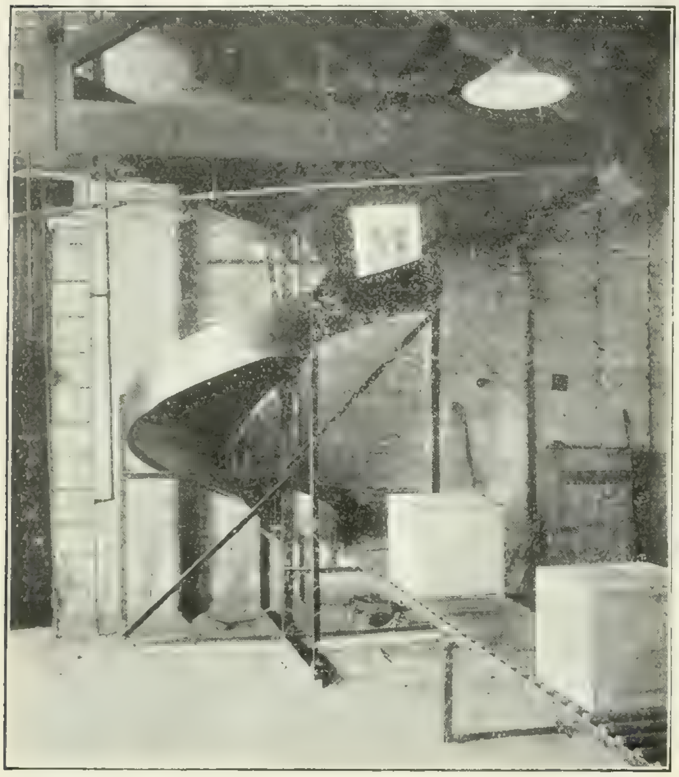


Fig. 1.—Spiral Chute feeding a Gravity Runway with Tea Chests. (Messrs. Rownson, Drew & Clydesdale, Ltd.)

Mechanical Appliances and Cost of Distribution.

The adoption of such methods of handling material is bound to take place in all large stores, warehouses and big distributing centres in a manner similar to the development of mechanical handling in manufacturing processes, whilst, where the use of gravity power is impossible, the greatly extended use of steam and electric power enormously simplifies the handling problem. How far mechanical inventions may be applied to increase the facility and cheapen the cost of distribution it is difficult to say. As Mr. J. A. Hobson has pointed out, the automatic machine for distributing matches and sweetmeats is adapted to most forms of routine consumption. In the larger stores many kinds of labour-saving machinery are already employed. As steam or electric power is adopted more widely in the local transport services, the retail distribution of goods from a large single centre is likely to proceed apace, and a displacement of human labour by machinery similar to that which is taking place in manufacture will take place in distribution. So far as the wants of large classes of the public become regular and their consumption reasonable in quantity, machinery will unquestionably take over the labour of distribution, especially in the large towns, which are absorbing in a way convenient for mechanical distribution a larger proportion of the consuming public. With each new encroachment of machinery into the domain of the distributing trades, the characteristics of machine industry, enlarged mass of the business, increased area of the market, increased inter-dependence and increased specialisation will be clearly discernible.

Bucket Elevators.

Elevators of the bucket type have been in existence in some form or another for many centuries, their longevity being an eloquent testimony to their simplicity and convenience. The earliest known forms usually consisted of earthenware gourds, or pots, chiefly used for drawing water, and operated by man or animal power. Their modern development had to wait for the advent of steam and electric power. They are now extensively used for many different purposes, the buckets being almost invariably of the gravity type, to allow the material to be carried horizontally, vertically, or at any requisite angle, without the equilibrium of the buckets being disturbed. A bucket elevator (Fig. 2) is shown carrying sand in a Glasgow iron foundry from a bunker below ground level up to a 50 ton hopper. The hopper is provided with four sliding doors, operated by a rack and pinion, whence the sand

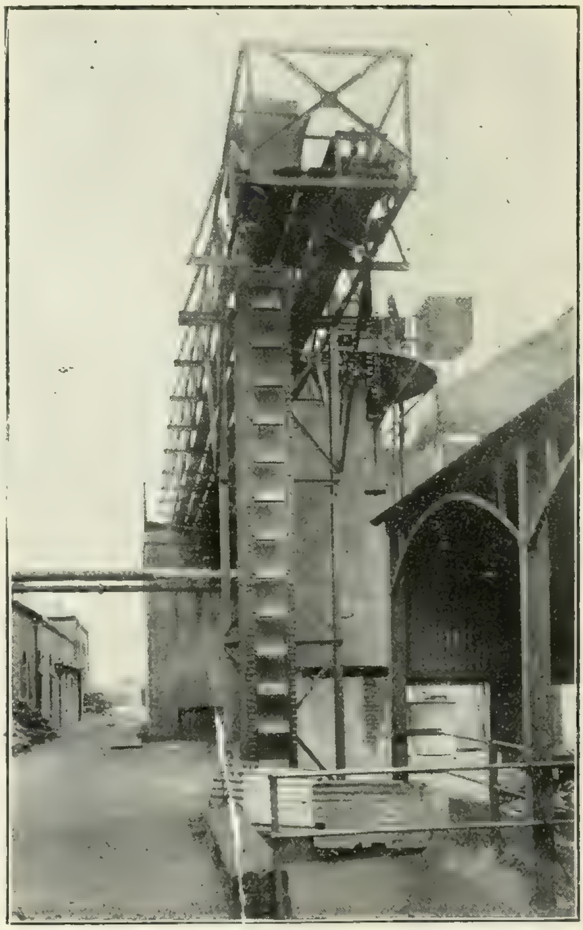


Fig. 2—Bucket Elevator Handling Sand in an Iron Foundry. (Messrs. Rownson, Drew & Clydesdale, Ltd.)

is discharged through shoots into the moulding boxes. The capacity of the plant is 30 tons per hour. The independent type of bucket elevator possesses distinct advantages in cases where boiler houses are small, or are so arranged that a coal elevating and conveying plant cannot conveniently be put down. In such cases a single elevator can be fitted to each boiler or one to every two boilers. A large number of such plants have been erected by Messrs. Ed. Bennis & Company, Ltd., and they are usually fitted with a patent self-starter and stopper (Fig. 3).

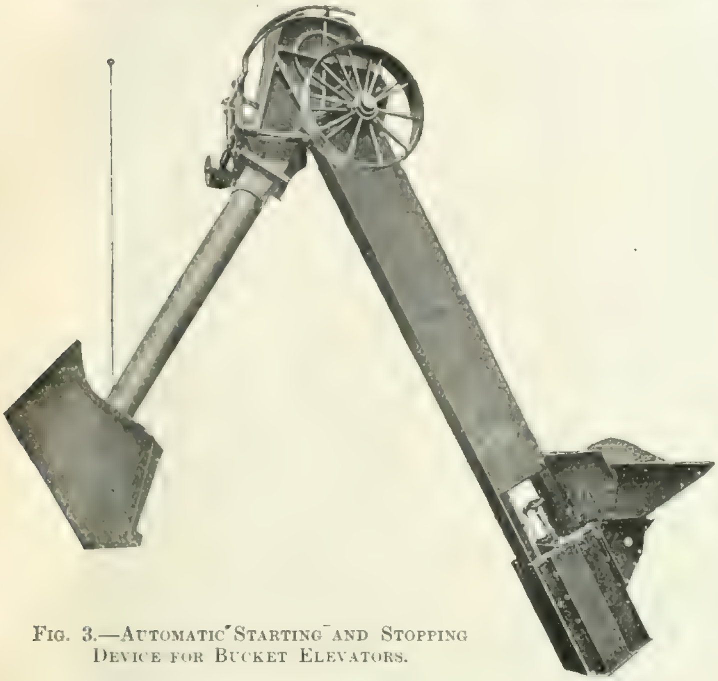


Fig. 3.—Automatic Starting and Stopping Device for Bucket Elevators.

Automatic Control.

This automatic appliance greatly enhances the value and adds to the convenience of the elevator. The shoots which feed the fuel from the elevator head to the hopper or store are swung on a balanced lever supported by the elevator head; the tail end of the shoot being supported by means of a chain, rod, or wire rope, as may be most convenient. The elevator feeds the coal into a small hopper forming the upper end of the shoot. When the shoot is empty, the weight on the balance lever draws the belt on to the driving pulley through a parallel-link motion, so that the elevator is running. When the shoot fills, it overbalances the balance lever and pushes the strap fork on to the loose pulley, and the elevator is brought to a stop.

When the shoots are about half empty the balance lever comes into operation again, and the elevator starts up. By this means there is always a sufficient supply of coal to keep the hoppers full, but the elevator is never allowed to overflow. The rate of revolution of the rotary feed can be altered by the raising or lowering of a handle. The device can be applied to any existing elevator. By its use the elevator is prevented from overfeeding the stoker hoppers, and dribbling of fuel down the back of the elevator through over-feeding is eliminated. Return shoots to the coal are rendered unnecessary. When the hoppers are full the elevator stops running, thereby greatly reducing wear and tear; the automatic action of the elevator enables close attention to be dispensed with; the operation is smooth and noiseless, the mechanism simple in design and strong in construction.

The Problems of Ash Removal.

Neither the bucket elevator, however, nor the ordinary steel-link conveyor is specially adapted for removing ashes—though the former is still largely used on account of its simplicity—the wear-and-tear costs being usually in excess of the best economic practice. With the employment of larger and more numerous boiler units per installation the problem of ash removal assumes serious proportions. The pneumatic-suction system justifies itself for large plants, but its employment on economical grounds is not to be recommended in small boiler-houses. For the latter, preference is given to a simple steam-jet conveyor. In both cases it is desirable to avoid long bends, as the ashes always tend to travel in a direct line, and bends interfere with their progress by deflecting the air current and considerably increasing the wear and tear, whereas a sharp-angled bend can be arranged so as to have the wearing parts much thicker and easily removed and replaced, whilst if the steam nozzle is placed at the bend it will help to keep the ash and clinker from the sides of the liners. A typical steam-jet conveyor serving two water-tube boilers and delivering the ashes into an overhead storage tank is shown in Fig. 4.

The Handling of Raw Cotton.

The suction system of conveying is also used for handling raw cotton, whilst it is now generally recognised as superior to any other method for transporting grain. The bucket elevator, with canvas slings as buckets, is still largely used, and is both serviceable as well as cheaper in construction and operation, but it suffers from the very great drawback of requiring much additional hand-labour in feeding the grain to the elevator. The pneumatic system, on the other hand, dispenses altogether with manual feeding, the flexible pipe can be taken to any part of the ship, and it is quite independent of restrictions imposed by variations in freeboard and depth of hold, which hinder and in some cases render impossible, the use of a bucket elevator. It is also a healthier process, as there is no dust to interfere with the breathing or irritate the eyes of the men employed, whilst the grain itself undergoes an improvement by aeration.

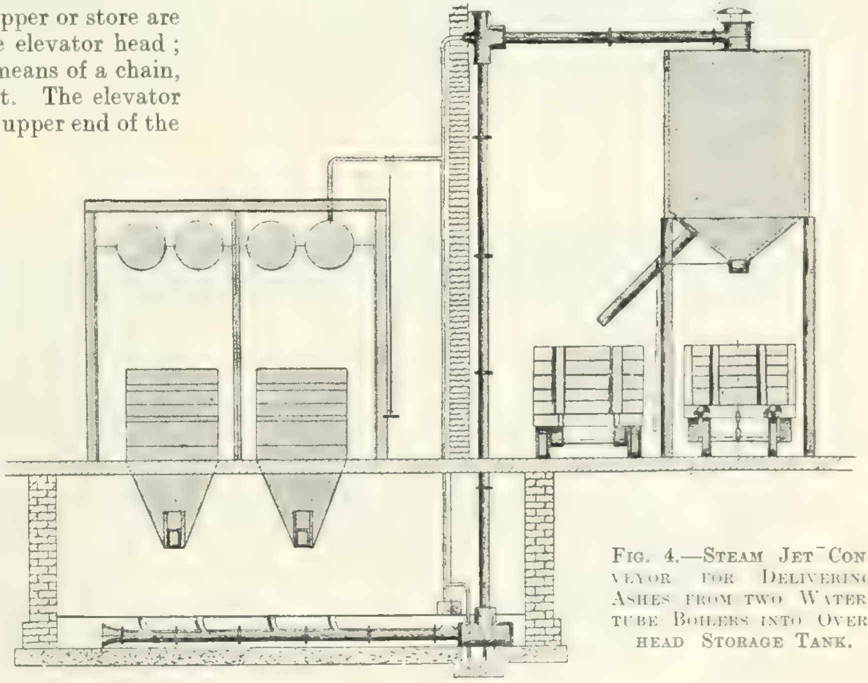


Fig. 4.—Steam Jet Conveyor for Delivering Ashes from two Water-tube Boilers into Overhead Storage Tank.

The Belt Conveyor.

It is a truism to say that it is desirable to handle material as little as possible. Money spent on moving material from one place to another adds no value to the material handled, and for that reason the economy of conveying plant is an all-important consideration. Given favourable conditions, the belt conveyor is undoubtedly the best general utility conveyor, and usually the most economical, but in large works, particularly in power stations, it is not at all unusual to find two or three types of conveyor, each doing the work it is best adapted for, while many notable installations have been completed during the last year or two in which hand labour is completely eliminated except for manipulative and supervisory purposes. Messrs. Babcock & Wilcox, Ltd., and Messrs. Fraser & Chalmers, Ltd., have achieved several highly successful results during the past months, where the coal, brought to the boiler house by barge or truck is discharged by crane and grab or lifting magnets in the one case or by rotary end truck tippers in the other, carried by steel link conveyors to bucket elevators, and passed on to tray conveyors which tip the coal automatically into the hoppers of mechanical stokers, or elsewhere as the case may be.

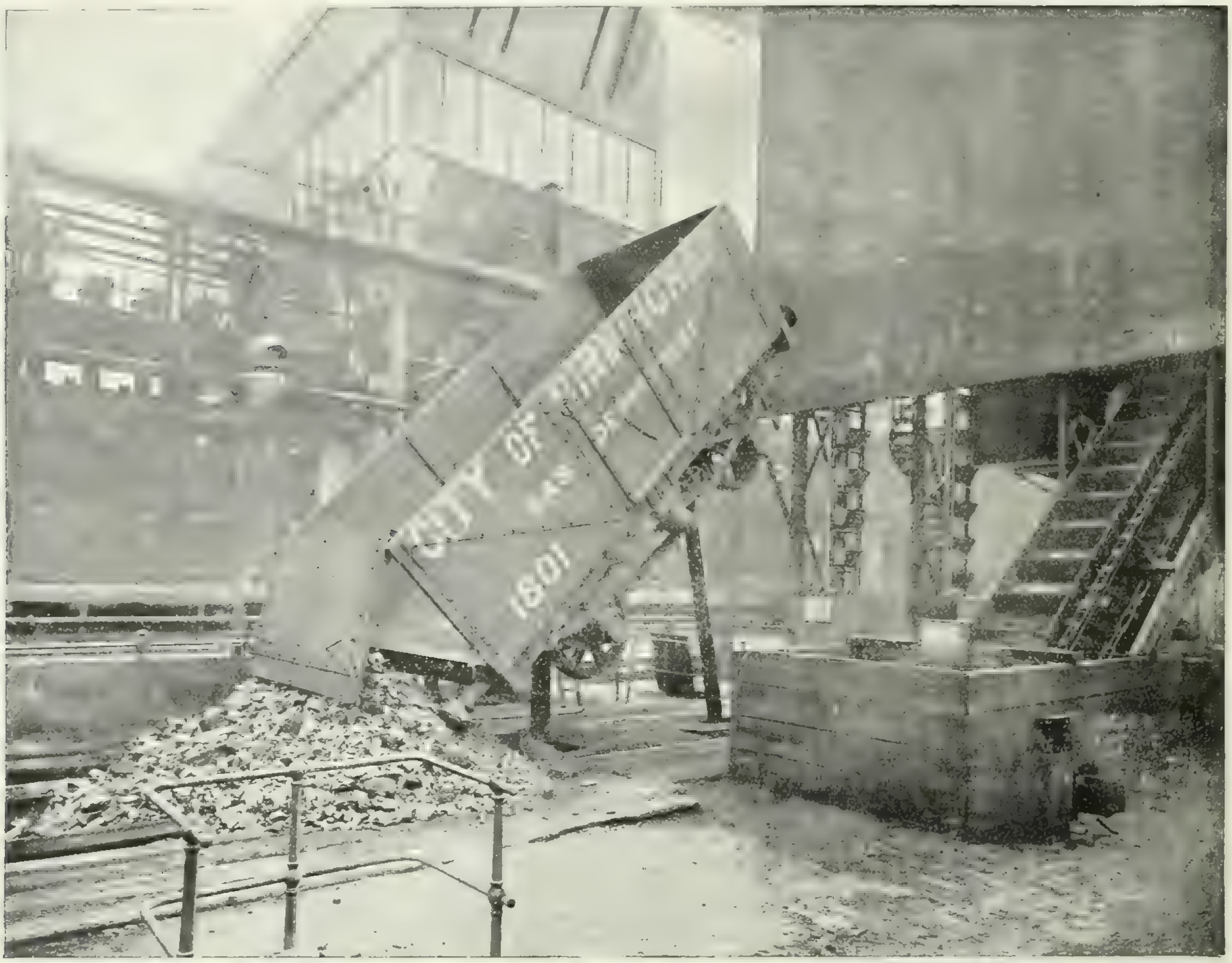


Fig. 5.—End Truck Tipper Delivering Coal Tubs to Underground Hopper.

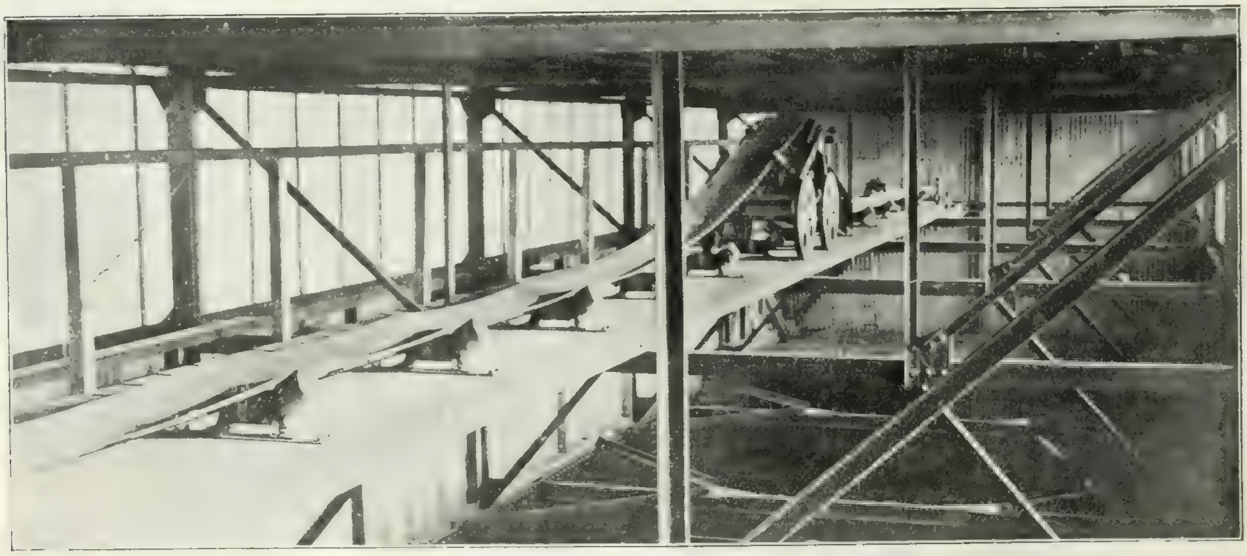


Fig. 6.—Boiler House Conveyor with Automatic Tipping Device.

A Gas Works Installation.

Fig. 5 shows a coal-tipping device over a track hopper installed in a gas works. The coal is received on a tray-conveyor, taken to a coal-breaker, and thence to the disintegrators, and finally carried by a gravity bucket-conveyor into the overhead bunkers. In this case end-door wagons are employed to bring the coal to the works, and they arrive on the same line of rails for both plants, as it is not intended that both units should be in operation simultaneously at any time. A turntable has been installed on the incoming line in order that any truck which may arrive otherwise than with the end door foremost can be turned round before proceeding to the discharging point. The track hopper will hold 15 tons. The coal is delivered through an adjustable valve

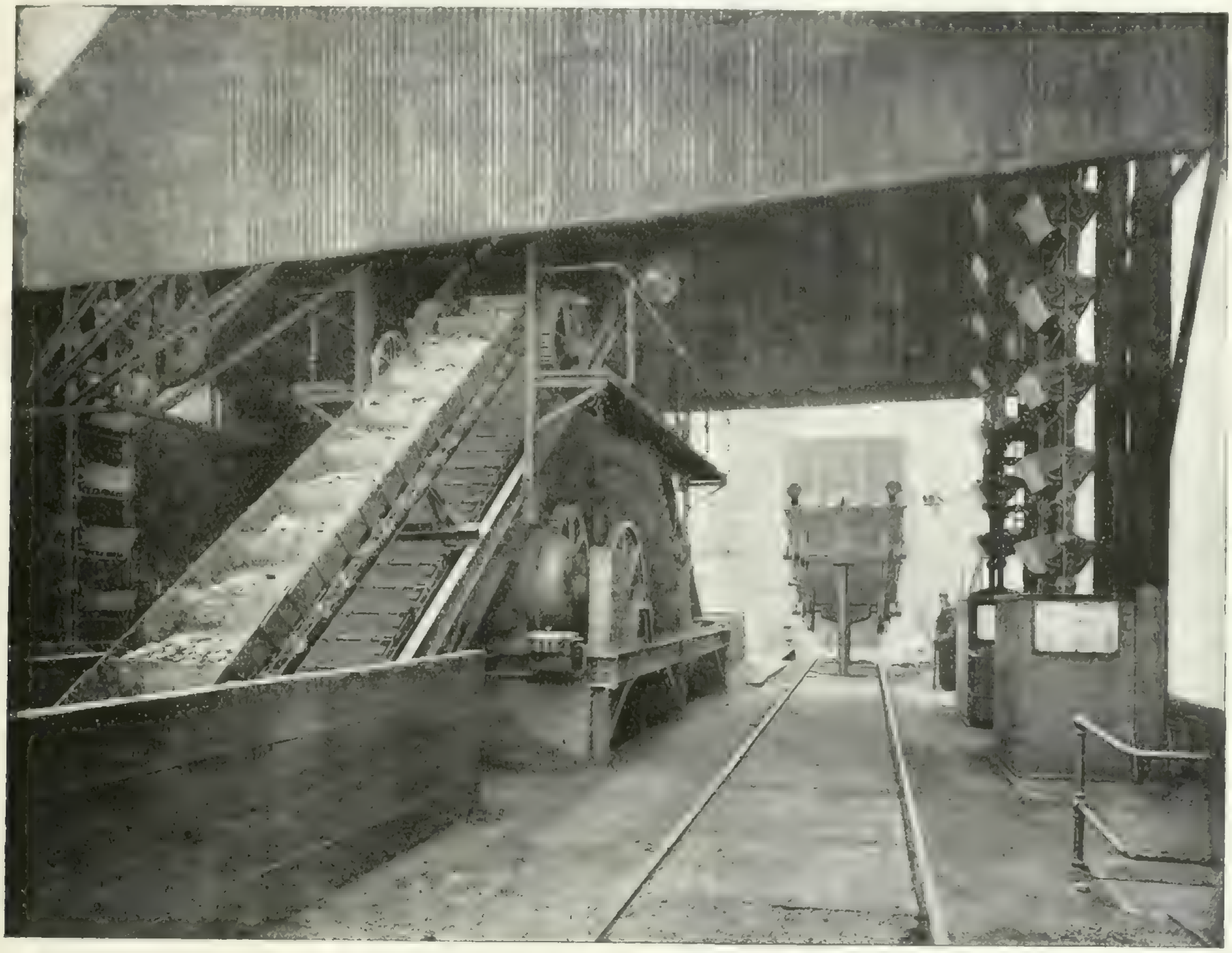


Fig. 7.—Conveying Arrangement Using Conveyor and Bucket Elevators.

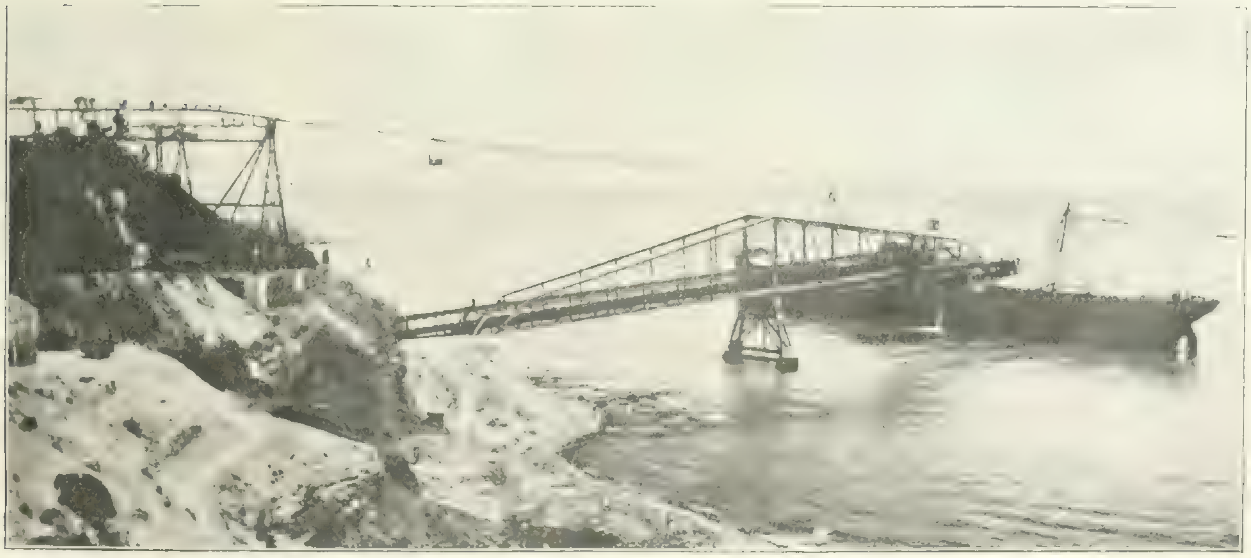


Fig. 8.—Shipping Conveyor Loading Large Vessel with Iron Ore.

at the base of the receiving or track hopper on to a jigging feed supplying the coal in a uniform stream to the receiving terminal of the tray-conveyor. An electric capstan is provided for hauling the wagons from the line to the tipping point, and for conveying the empties to the siding for the returning trucks. A view of the ascending and descending tray conveyors is shown in Fig. 7. A boiler house belt conveyor over bunkers equipped with travelling tripper for evenly distributing to all parts of the bunkers is illustrated in Fig. 6. It is fitted with dirt-tight decking protecting the return belt and ball-bearing idlers.

The subject of mechanical handling seems inexhaustible, but a brief reference may be made to shipping plants, of which Messrs. Fraser & Chalmers have a number of successes to their credit. The cost of loading by belt conveyor shipping plants shows an enormous saving over most other means of shipping.

In many cases no preparation of the site has been necessary. A spot is selected where deep water can be obtained fairly near the shore, and the plant erected to load the boat standing in this deep water. Buoys are provided to moor the ship to for the few hours that loading takes, but no further preparation is required. This effects an enormous saving when compared with the piers, breakwaters, &c., that have to be erected for most forms of loading.

Another point in favour of this method is the high rate of discharge obtained which often reaches 1,500 tons per hour. Loading can be commenced directly the hatch covers are off—there are no cumbersome shoots to place in position—no wagons to be shunted, tipplers worked, or large gangs of men to be organised. One man opens the hopper valve feeding the material to the belt, the belt carries its load to the hold, and the boat is easily loaded and away in one tide—besides the low cost of loading it enables much better freight rates to be obtained, discounts any chance of demurrage, and cannot be affected by labour troubles as the one or two men required can be permanent, reliable men. The method of loading for these belts necessarily varies according to conditions and materials to be shipped. In Fig. 8 is shown a bucket conveyor ore shipping plant, designed for loading 2,400 tons per hour. A large cantilever bridge carries the main conveyor with a telescopic structure at the extreme end for discharging direct over centre of steamers' holds. The feed end of the conveyor extends into a tunnel underneath the store heaps, and is fed through suitable openings at different points.

Large handling at most of our ports shows a range of labour-saving devices so great and of so many adaptations to an infinite variety of purposes that it would be impossible to describe them in one short article, but in general they will be found to follow the principles of those already described. Without them the multifarious articles required by modern civilisation could never be distributed with such wonderful rapidity as they are and without hopeless confusion and congestion.

THE AERIAL ROPEWAY.

Other forms of mechanical handling there is no need to mention here, and the use of the aerial ropeway for carrying human freight, an interesting development of which the writer recently saw in Switzerland, does not come within the scope of this article.

Man, we are told, was in the beginning cursed with labour for his sins, and if the measure of his perfection is the amount by which he can shift the curse of labour from his shoulders, humanity is greatly in the debt of modern manufacturers of labour-saving plant for having lightened its load by no inconsiderable amount, and if " the race is to the swift " then whoever succeeds in handling his goods most quickly and with the least employment of costly labour is bound to come out a winner. It is greatly to be hoped that the efforts now being made, as in this number of THE ELECTRICIAN, to explain and popularise the mechanical handling of materials will help to ensure to this country the position of pre-eminence which it has always held in the comity of nations, and which the genius of the race demands.

Electrical Grab Transporters for Han-Yeh-Ping.

Grabbing Ore from Steamers Cheaper than Chinese Hand Labour.

By H. J. SMITH, M.I.Mech.E.
(Member of the Engineering Society of China).

THE Han-Yeh-Ping Iron and Coal Corporation is the largest industrial undertaking in China, having a capital of over 60 million dollars, and finding direct employment for about 23,000 persons. The shareholders and management are entirely Chinese, although the Japanese have lent financial assistance on terms exceedingly advantageous to themselves. The writer joined the staff temporarily whilst installing the transporters described below.

The properties owned by the Company are situated along the valley of the Yangtsze Kiang, and they contain all the raw products necessary for the production of iron and steel. The iron and manganese mines—and also the limestone and dolomite quarries—are situated in the Tayeh district of the province of Hupeh ; the principal deposits of iron being in the Lion, Shark and Elephant Hills, all adjacent and connected to the river bank at Sz-hui-yai by 19 miles of standard gauge railway, also the property of the Company. These iron mines are worked on the open cast system, the total ore in the three deposits being estimated at seven hundred million tons. The writer thinks it possible that the three bodies mentioned may be huge outcrops of an enormous deposit at greater depth.

COAL MINES AND COKE MAKING PLANT.

The coal mines and coke-making plant are at Pinghsiang in the province of Kiang-si. The seventy miles of railway from the collieries to Chu-chow on the Siang-Kiang—a tributary of the Yangtze—where the wharves are situated for shipping coal and coke to the ironworks, was also built by the Han Yeh Ping Company. Part of the line has since been sold to the Government, and now forms a section of the future Hankow and Canton Railway, the completion of which will bring Hongkong within nineteen days post of London.

The original estimate of 500,000,000 tons of coal in the Pinghsiang district may be modified by later figures ; but the present output of 600,000 tons per annum could easily be increased by the introduction of more modern machinery and local management. The blast furnaces, the steel making plant and the rolling mills are situated at Hanyang on the confluence of the Yangtsze and Han rivers, which place, speaking approximately, is about midway between the deposits of coal and iron. These iron and steel works are under the superintendence of Mr. Z. T. K. Woo, Doctor of Science and Master of Metallurgy, Sheffield University, a man of marked executive ability. He is ably assisted by his engineer, Mr. Kwauk, also trained at Sheffield and a graduate of the same University.

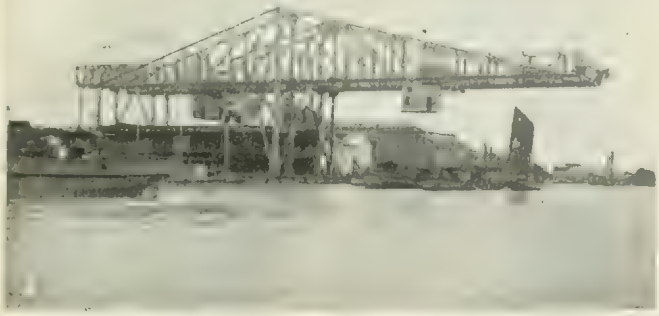
STEEL WORKS EQUIPMENT.

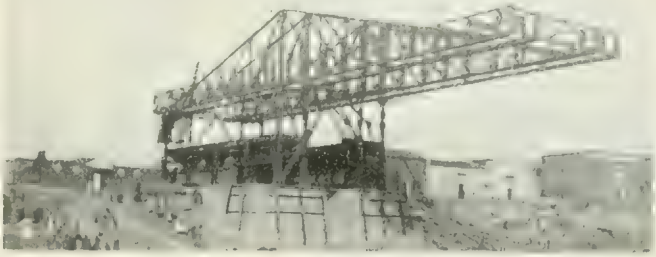
The works possess a fairly modern plant, consisting of four blast furnaces, seven Siemens-Martin steel furnaces, and a rolling mill which turns out plates suitable for shipbuilding and sections of all sorts up to 12 in. Rails are also rolled in fairly large quantities for the various railways in China. The older portion of the works is equipped with two blast furnaces each capable of producing 100 tons of pig iron per day. The newer extension has two 250-ton units, with turbo-blowers, turbo-alternators, and other details equally up to date. The steel is made practically from the raw material, as the only scrap available is the shearings from the output of the rolling mills.

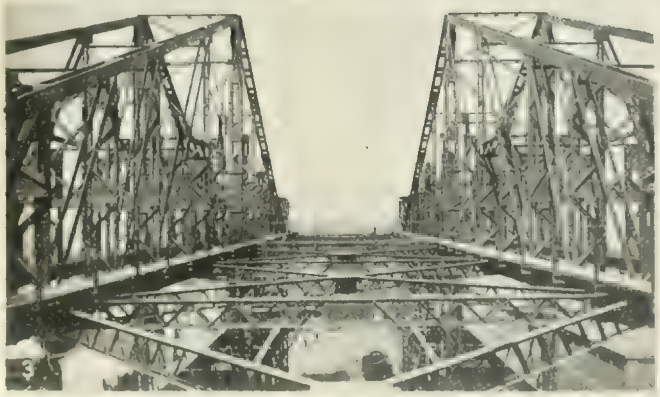
The Ton-tsu-pao Iron Works.

The new ironworks now being built at Ton-tsu-pao, on the Yangtzse close to the iron mines, are planned on a most ambitious scale. No less than eight 450-ton blast furnace units are projected, the first two of which are now being erected. The furnaces are of American manufacture, but the turbo-blowers for the furnaces and the turbo-generators for power purposes are being supplied and erected by the Fraser & Chalmers Engineering Works of London. The boiler installation is also of British manufacture (Babcock & Willcox). The mechanical appliances for unloading and loading the raw materials and finished products are being built in England.

All the ore, limestone, coal and coke for the Hanyang Works is carried from the Pinghsiang and Tayeh Wharves by the company's own tow boats and lighters, the total numbering 21 steam tugs and 180 lighters. The present output of iron and steel requires the unloading at the Hanyang Wharves of about 3,000 tons of raw material per day. Until recently this work was done by Chinese coolies, but the great rise and fall of the Yangtzse river*—over 45 ft.—was the cause of considerable trouble to these manual operations, especially in wet and wintry weather, and it was considered advisable by the Chinese management, in spite of the abundance of cheap labour, that it would be more economical to do this work by mechanical means.







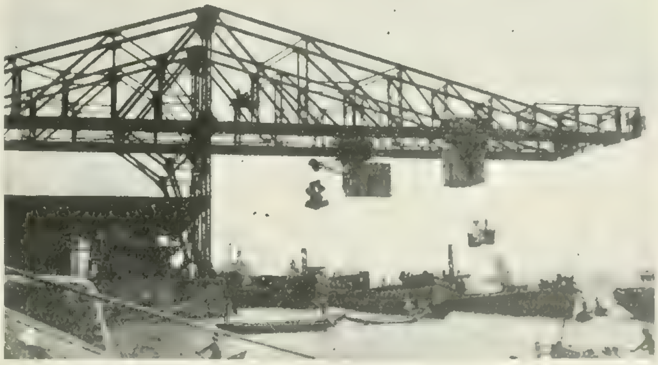


Fig. 1.—Plant at Work, River in Flood.
Fig. 3.—Showing Wind Bracing between Bridges.

Fig. 2.—Plant during Erection showing River Banks at Low Water. River to Cantilever, 100 feet.
Fig. 4.—Showing Grabs at Work.

Yangtzse Difficulties.

The decision entailed a plant of some magnitude to cope with the exceptional circumstances. When the river is in flood there is 25 ft. of water alongside the wharf (*see* Fig. 1), but at low water about 100 ft. of foreshore is disclosed (Fig. 2), and lighters can tie up no nearer than 130 ft. from the wall. This necessitated the building of cantilevers of considerable size and strength, capable of bearing large grabs at work 150 ft. from the face of the wall. The moving load is nearly 100 tons, and the stresses due to the operation of the grabs is severe, especially when the machinery happens to pick up the two 11-ton grabs simultaneously at full speed, whilst working at the extreme end of the cantilevers.

The cantilevers and anchor arms, together with the columns and bunkers have a weight of 530 tons. The total weight of the plant, including the grabs and machinery, is 680 tons. The four main bridge girders are 281 ft. in length, and 37 ft. in depth at the centre, each girder weighing approximately 100 tons. The bottom chord of the cantilever arms are 100 ft. above low-water mark.

When the grabs are working on the extreme end of the cantilevers there is an upward pull of 120 tons on the rear columns supporting the anchor arms, this being equal to 30 tons per column. The over-turning moment is safely counteracted by a continuous block of reinforced concrete, weighing 500 tons, which is laid under the four columns to act as foundation or loading as required. The six holding-down bolts to each column base are carried down and anchored to a grillage which embraces the loading in such a manner that no fracturing of the concrete could endanger the safety of the plant. Actually there is rarely any overturning effect, because the nest of bunkers, which are firmly fixed to the main and rear columns under each transporter, are seldom all emptied of ore at the same time. The total capacity of these bunkers is 1,000 tons of iron ore. They serve to prevent any stoppage of the grabbing operations due to the shunting of wagons, but need not be used necessarily as the grabs can discharge their load direct to the 30-tons bottom dump steel wagons when the latter are available.

The maximum load on the four main columns is approximately 800 tons, or 200 tons per column. This weight is supported by a substantial concrete and stone-faced wall founded on the mud banks of the Yangtzse. Considerable piling and grillage work was, of course, necessary to ensure stability, and the bank was afterwards well pitched with an apron of slag to prevent erosion. The writer made a careful examination of the work after the annual flood had subsided, and, so far as could be seen, the precautions taken were all that was necessary. The levels of the column bases were also checked without finding any settlement, unequal or otherwise

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* The rise and fall of the river is not tidal, but is caused by the melting of the snow in the Himalaya mountains.

Details of the Unloader.

The unloader consists essentially of two transporters 50 ft. between centres apart, braced together to act as one unit of great stability against wind pressure (*see* Fig. 3). Each transporter is fitted with a travelling carriage from which is suspended a crane capable of revolving 360 deg., whilst operating a grab weighing 7 tons when empty and 11 tons when full (Fig. 5). The total weight of each grab and its attendant machinery is nearly 43 tons, so that the total moving load on the twin transporters, when the grabs are full, is almost 100 tons. The jibs which carry the rope sheaves for the grab ropes form part of the crane structure. Each grab is operated by four ropes, i.e., two closing and two dumping ropes, each pair being capable of acting as sustaining ropes (Fig. 6). The under-hung portion with its grab and load is suspended from the centre of the travelling carriage by a large ball-bearing mounted on trunnions designed to ensure the weight being equally distributed on the four wheels of the traveller under all conditions of grabbing. As each grab is capable of travelling and turning a complete circle, the two working in co-operation can drop into any part of a ship's hatchway 90 ft. in length without moving the vessel. Or, when working separately, they can grab from two holds on smaller craft.

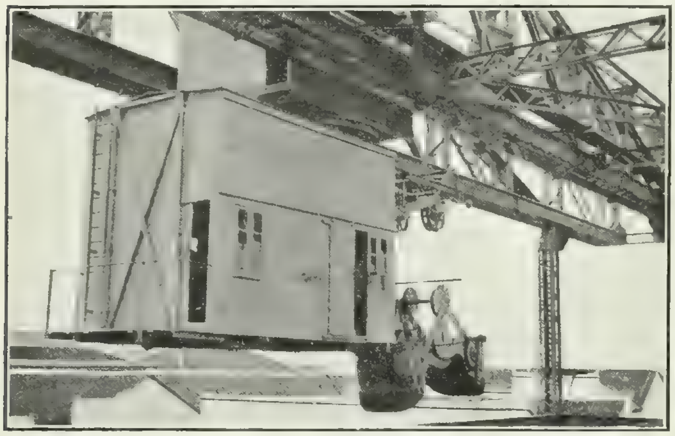


Fig. 5.—Showing Travelling Cabin and Grab.

The Electrical Equipment.

The hoisting, travelling and slewing machinery is driven by separate electric motors, each set being controlled by one man, who travels in the machinery cabin with the grab, so that he has always a complete view of the operations.

The total power called for by the motors on the transporter is equal to 500 B.H.P. This is drawn from a turbo-alternator working close to the blast furnaces, where the boilers generate steam by burning the waste gases from the furnaces, and a small coal fire for auxiliary and ignition purposes. The high tension current from the alternator is converted by a rotary converter, fixed near the transporter, to 440 volts direct current, and is transmitted to the collectors on the travelling carriages by copper mains suspended the full length of the bridges by ears fixed to the underside of the cross-bracing.

The 170 B.H.P. hoisting motors are of the series-wound interpolar semi-enclosed type running at 600 revs. per min., which gives a rope speed on the drums of 190 ft. per minute. The automatic circuit-breakers were set to 318 amperes, and in all cases where they came into action on peak loads, the grabs were held instantly by the powerful solenoid brakes provided for the purpose. Even when the maximum load ran full-speed into the hoisting limit switches the result was the same, the motor being disengaged from the gearing just a fraction of a second before the brakes gripped. The travelling motors are of similar type 65 B.H.P. (115 amperes), and are geared to move the travelling carriage at a maximum speed of 740 ft. per minute.

The 15 B.H.P. slewing motors can turn the grab through 360 deg. in 36 seconds, this being equal to a speed of 200 ft. per minute when measured at the maximum radius. The electrical control and brake gear supplied with the slewing motors was altogether too fierce in its action of starting up and shutting down for the work which had to be done by the mechanical portion and it was necessary to rearrange this on the site until the results became satisfactory.

Details of the Switchgear.

The switchboards are placed in the lower cabin close to the controls so that the driver has command of all the instruments without moving from the footplate. Besides the usual power and lighting switches, hand-guard fuses and meter dials, the panels are fitted with automatic overload and limiting circuit-breakers, which bring all operations to a standstill without damage to the plant in the event of sudden incapacity befalling the driver. The difficulty of connecting the main leads from the trolley wire collectors on the travelling carriage to the rotating switchboard in the machinery cabin underneath was overcome by fitting revolving contactors over the centre of the ball-bearing races, and passing the internal wires down the hollow centre designed for that purpose.

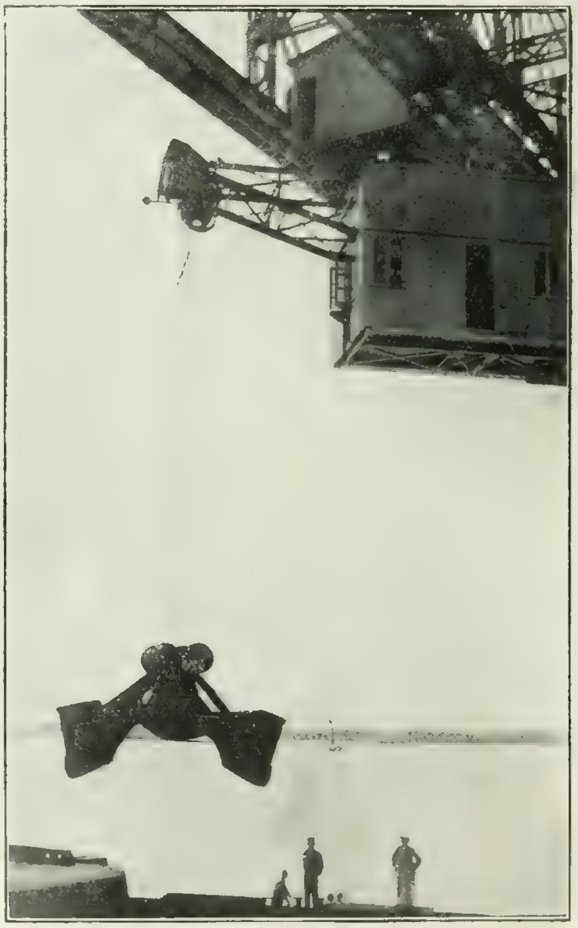


Fig. 6.—Lowering Grab, 75 feet at Low Water.

The whole of the erection work and foundations was carried out by Chinese labour, the writer being the only European on the site.

DIFFICULTIES OF ERECTION.

The erection of the structure presented several unforeseen difficulties, because the material was shipped from England at the time when the Minister of Munitions prohibited the export of steel. The contractors (The Fraser & Chalmers Engineering Works) made every effort to complete the plant, but a number of the smaller details and all the tools for erection had to be short-shipped. Making the tackle in China entailed a lot of work, the biggest job being the construction of two travelling derricks with 50 ft. jibs, capable of handling 5 tons each, so that the corbelling of the two cantilevers could proceed simultaneously. A lattice steel mast, capable of lifting 5 tons to a height of 65 ft., together with all the purchase tackle necessary and three double-geared hand winches, were also made on the site. These tools were built whilst work on the foundations was in progress, and the tackle required first was completed in good time to commence work on the superstructure.

After the columns and bunkers had been erected the timber falsework was built up from the latter to carry the bottom booms of the anchor arms. No special timber could be purchased for the falsework on account of the war shortage, but fortunately the sleepers required for the trackwork round the plant and lines leading to the furnaces arrived, and were utilised for the purpose with good and economical results. The work of driving 75,000 ⅞ in. steel rivets on the site by Chinese labour was completed without difficulty, although a larger percentage failed to pass inspection, and had to be cut out, than is usual at home. But the final work was creditably done.

DEFLECTION TESTS.

Finally, the bridge work was put through exhaustive tests for deflection, &c. The test load was moved along the bridge and readings taken at each vertical until the load reached the extreme end of the cantilever, where it was allowed to remain 40 hours before the final readings were taken at the verticals as the load was returned to the end of the anchor arm. By this means each panel and the nose of the cantilever showed 24 readings under varying conditions, with a like number at the centre of the anchor arms.

The building of the plant was completed without accident to men or material. This immunity was accounted for, in the native mind, by a liberal sprinkling of the water under the cantilever with rice purchased by general subscription of the gang to appease the water gods. This unusual method of insurance on one occasion led to fighting, because the man in charge of the pontoon—who was deputed to do the sprinkling—was too liberal with the rice around his own craft. The plant went to work without a hitch after the Chinese chosen as drivers had learned how to manipulate the controls, which they did rapidly.

Owing to the grabs having to be hoisted 75 ft. at each lift when the river is low (*see* Fig. 6), and then travel from the end of the cantilevers to the bunkers and back, a total movement of 650 ft. for each grabbing without reckoning the slewing movements and the smallness of the craft necessary to suit the river conditions, the rate of unloading is not so rapid as would otherwise be the case. The machinery is designed to unload 100 tons of iron ore per hour with each grab when working on ocean-going steamers, or craft of equal capacity; but the best results obtained by the Chinese drivers when unloading the small lighters was 700 tons with one grab in a working day of 10 hours.

When the writer left China the plant had unloaded 270,000 tons of ore, coke, coal and limestone without an accident of any kind, and travellers from England to Central China were somewhat astonished to find unloading appliances there equal to anything that could be matched against them by any similar undertaking in Great Britain.

In conclusion, the writer would like to make a point of the fact that an important undertaking under Chinese management and in China, where labour is plentiful and cheap, have found it worth while, after a lengthy trial of manual labour, to replace the coolie by a mechanical contrivance for unloading material in bulk.

"Toplis" Horizontal Luffing Cranes for the Royal Albert Dock Extensions.

By C. T. PEARCE, B.Sc.(Leeds).

THE crane described below is one of 26 which are being constructed by Messrs. Stothert & Pitt, Ltd., Bath, for the Port of London Authority. The cranes are to be erected on reinforced concrete jetties and quays at the Royal Albert Dock Extension (South), and are to be used for handling all kinds of general merchandise. The maximum load is 3 tons, which can be lifted at any radius from 60 ft. to the minimum radius of 20 ft.; the jibs may also be luffed out to 65 ft. radius, at which radius loads up to 2 tons may be dealt with. The height of lift above the quay level at 60 ft. radius is 70 ft., and the hook can descend a further 45 ft. below this level, giving a total lift of 115 ft.

The revolving portion of the crane is carried on a high gantry, which has a portal opening between the legs to clear railway rolling stock running on rails laid between the crane track rails. The cranes are electrically operated, the supply being direct current at 440 volts, and is taken from ground plug boxes placed at intervals inside the crane track at the ground level. The gantries are built up from rolled steel sections and are fitted with power travelling gear. The revolving superstructure which carries the jib, tail ballast jib balance weights, hoisting gear, luffing gear, slewing gear and machinery house is constructed from steel plates, angles and channels, and is of the "mast" type.

The mast is of square pyramidical form tapering towards a footstep bearing at its lower end and has four cast steel rollers attached to it (one roller on each side of the square) which bear against and revolve on a horizontal machined circular steel path built into the top portion of the gantry; the lower end of the mast is fitted with a mild steel pin capped with a bronze hemisphere revolving in oil inside a hardened steel cup which rests in a footstep casting. The footstep bearing is bolted to and spigoted in a Warren girder which is an integral part of the gantry, and is placed over the portal opening. The rollers are fitted with eccentric pins which are easily adjustable in case of wear and any slight inaccuracies of workmanship.

THE MAST TYPE OF CRANE.

In the mast type of crane the moment about the centre line of the crane caused by the load suspended on the hook and the complete revolving portion is balanced by an opposing couple whose arm is equal to the length of the mast between the centres of the rollers and the footstep bearing, and the horizontal forces which are transmitted to the gantry at these two points are equal to the moment divided by the length of the arm. It will therefore be obvious that with a long arm such as that in this case the horizontal forces produced will be comparatively small, and will permit a light construction of the upper portion of the gantry.

The vertical loading, which is equal to the weight of the revolving portion and the load on the hook, is taken direct to the lower part of the gantry through the Warren girder; the centre of this girder adjacent to the footstep bearing is connected to the four corners of the gantry by a horizontal plane of bracing built up of angles arranged as a cruciform section; this bracing transmits the lower horizontal reaction from the footstep bearing to the corners of the gantry.

The rollers at the front and back of the crane take the greater loads, the side rollers being only required to take any forces produced by the wind blowing sideways on the superstructure and to centre the mast in its circular path when slewing.

Ballast Arrangements.

The ballast is so proportioned that the horizontal force produced on the front roller with the jib at 60 ft. radius and 3 tons load suspended on the hook is equal to the load on the back roller with the jib at 20 ft. radius without a load on the hook; this allows of the most economical distribution of the material in the construction of the mast and the gantry as the same amount of tension and compression is produced in members in which the nature of the stress changes. All rope pulleys used on these cranes are built up of steel plates riveted together and fitted with patented self-lubricating bushes fed from an oil reservoir of sufficient capacity to last several months without refilling. The machinery house is built up from red deal framing, and is completely covered with 1 in. thick matchboarding, the floor boards being of red pine. All the woodwork is covered with fireproof paint and the house is completely lined inside with fireproof asbestos sheeting.

The Control Equipment.

The control cabin is a part of the machinery house, but is separated from the latter by a wood partition. A door fitted in this partition provides the means of access to the control cabin from the machinery house. The control cabin is placed on the left-hand side of the crane and is built forward of the jib foot pin, thereby enabling the driver to get a clear view of the load under all conditions of working. The four controllers, the hoist foot brake lever, the hoist clutch lever and the slew brake lever are so arranged in the control cabin that the operator may easily reach any of them without changing his position.

The switchgear comprises a double pole main switch and fuses combined with a crane protective panel arranged for wall mounting. The protective panel consists of two 150 amp. single pole contactor type circuit breakers operating in the main circuit, and a time limit overload relay is arranged in each of the motor circuits. The contactors and relays are mounted on a slate base and are totally enclosed in a sheet steel case, fitted with a removable wire embedded glass front. The contactors of the protective panel are automatically operated by an auxiliary control panel placed in the driver's cabin. The auxiliary panel operates in the shunt circuit and controls the shunt operating coil of the circuit breakers, so that when the switch of the auxiliary control panel is closed current is given to the operating coils of the circuit breakers which are closed through the pull exerted by these coils.

New Type of Hoisting Controller.

The hoisting controller is of the contactor type and is controlled by a miniature master controller. This type of controller is used in order to avoid the manual effort required to operate an ordinary type drum controller of a suitable size for controlling a 55 B.H.P. motor.

The hoisting contactor panel has double pole reversing contactors which are mounted on mica insulated steel bars, and are totally enclosed in a sheet steel case arranged for floor mounting. All the controllers are of the reversing drum tramway type with crank handles and are fitted with interlocking rings for electrically locking with the crane protective panel.

The function of the interlocking rings is as follows:—In the event of any controller being left in the "on" position after the circuit breakers have been opened either by an overload or a no volt trip or through opening the hoisting or luffing limit switches, it is impossible to pass any current through the shunt operating coils of the circuit breakers. All controller handles must, therefore, be returned to the "off" position before it is possible to energise the operating coils and so close the circuit breakers.

The current is collected from plug boxes by a flexible cable with a cab tyre sheathing. The other end of this cable is attached to a cable drum of the balanced type. Sufficient cable is allowed for the crane to travel 50 ft. either side of the ground box to which the cable is connected. When the crane travels towards the particular ground box to which the plug at the end of the cable is attached, the cable is wound on the cable drum through the power derived from a falling weight. When the crane is travelling away from the ground box the cable is uncoiled from the drum and the weight is raised.

A hand pulley block attached to a crab running in channel guides over the machinery is placed in each machinery house. This pulley block is of sufficient capacity to enable the heaviest part of the machinery to be lifted when repairs or renewals are required.

Hoisting Gear.

The hoisting unit consists of a 55 B.H.P. series-wound motor running at 400 revs. per min., driving a rope barrel through a single reduction of double helical machine-cut gear. The double helical pinion is supported on either side by a ring lubricated bushed bearing, and is cut from the solid on a forged steel shaft, which is placed vertically over the hoisting barrel; to the other end of this shaft the hoisting motor is connected through a pair of flanged half couplings, on one of which a brake drum is mounted. By this means a long shaft is obtained between the motor and the driving pinion, thus ensuring a "cushioning" effect and reducing the shock on the motor when raising or lowering the load.

The brake drum on the motor spindle is fitted with a Ferodo-lined brake of the post type, which is capable of sustaining and arresting the full load on the crane hook. The cast-steel double-helical hoisting wheel is about 44 in. diameter, and has a supporting gunmetal bearing on each side of it; this wheel is keyed to one end of the barrel shaft. The barrel may run loose on its shaft or may be rigidly connected to it by a friction coil clutch controlled by a hand lever. The barrel has spiral grooves machined to suit the 3 in. circumference hoisting rope, and has a large brake drum cast on one end of it; this brake drum is of sufficiently large diameter to sustain or to lower the load by means of a Ferodo-lined brake strap operated by the driver through a foot pedal.

The coil clutch is normally held in grip by the action of a weight, and is so interlocked with the foot brake pedal that the clutch cannot be released until the barrel is under the control of the brake. When the clutch is out of gear, the barrel is disconnected from the motor and gearing, and the load is controlled on the barrel brake by the foot pedal. Coil clutches of this type have been fitted by the makers on some 500 cranes of all types and sizes, and have given entire satisfaction in use.

Advantages of Free Barrel Working.

The chief advantages claimed for the free barrel are that loads and the light hook may be lowered with great rapidity and with complete absence of noise and vibration, thus effecting saving of time, and that when the load has been raised to the desired height it can be lowered immediately under the control of the foot brake without waiting for the motor and its train of gear to come to rest. Further advantages are (1) the empty hook can be lowered without giving current to the motor, whereas in fixed barrel cranes it is necessary to supply current; (2) there is no danger of the motor running at an excessive speed however great the lowering speed, as the motor is disconnected from the barrel.

Potentiometer Control.

The crane is also fitted with alternative electrical lowering, arranged on the so-called "potentiometer" system. When using this system the barrel is always rigidly connected to the motor and gearing through the coil clutch. This electrical braking system has been developed in the last few years, and is an improvement on the previous type, which was fitted with rheostatic brake and power notches on the lowering side of the controller. When lowering, the motor is always connected with the line circuit, but the field and armature are connected in parallel, and the braking effort is controlled by inserting the hoisting resistances in the field circuit. The speed of lowering is fixed for a definite load on a particular controller notch, and although on the same notch a somewhat higher speed may be obtained with a heavier load, the resistances are so arranged that the lowering speed is kept within safe limits when lowering the maximum load on the last notch.

The lowering speeds for the crane illustrated when tested at the makers' works were as follows :

Table I.

Controller Notch.	Lowering speed in feet per minute with	
	No load on the hook.	3 tons load suspended on the hook.
1	Crawling speed	Crawling speed
2	Crawling speed	64
3	50	115
4	90	176
5	150	260
6	175	274
7	300	460

This system gives a very safe and easy control, and eliminates all dangerous and deleterious sparking, but has the disadvantage of being somewhat wasteful in power consumption, particularly when lowering light loads or the empty hook. In a crane fitted with the two lowering systems, the "free" barrel may be used when lowering light loads or the empty hook, and the potentiometer control when lowering loads near the full capacity of the crane, thus obtaining an ideal combination for rapid and safe working. A limit switch is fitted to this motion to prevent the load being lifted too high, and is so arranged that when the switch is opened the main current is broken, and the load is prevented from falling by the solenoid brake.

During test the average hoisting speed was 200 ft. per minute with 3 tons load, with the motor developing only 50 B.H.P., giving a mechanical efficiency of the hoisting gear, including the pulleys, of over 80 per cent. The hoisting speed with 1½ tons load was 250 ft. per minute, with the motor developing 35 B.H.P. ; this increase in speed is due to the series characteristic of the motor. With lighter loads the speed increases still more, until with an empty hook the hoisting speed rose to 400 ft. per minute.

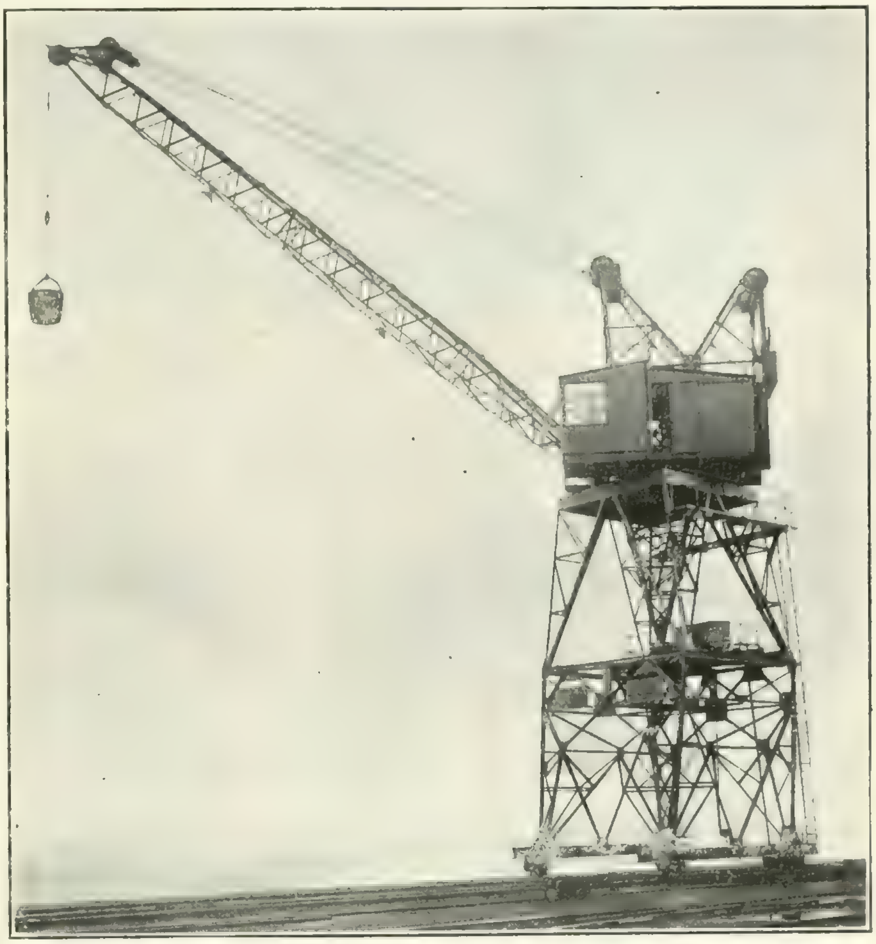
Luffing Gear.

The luffing gear is of the type patented by Mr. C. M. Toplis and constructed solely by Messrs. Stothert & Pitt, Ltd., and enables the load to maintain a horizontal path when varying the radius of the jib. The horizontal path is obtained by so arranging the reeving of the hoisting rope (which leads from the hoisting barrel over pulleys at the mast apex and the jib head) in conjunction with the position of the pulleys at the mast apex that the amount of hoisting rope paid out when luffing in is exactly equal to the vertical rise of the jib head. When luffing out, the amount of hoisting rope taken up is exactly equal to the vertical amount the jib head is lowered. This compensation for the rise and fall of the jib head causes the hook to travel in a horizontal path over the whole of the luffing range.

The gear consists of a 4 B.H.P. motor running at 450 revs. per min., driving a rope barrel through a double-reduction of spur gearing. The first pair of gears have double-helical machine-cut teeth, and the pinion is supported on the outside by a ring lubricated bearing. A solenoid operated brake of the post type lined with ferodo is placed between the pinion and the motor. The average horizontal luffing speed with a 3-tons load suspended on the hook from maximum to minimum radius, and vice versa, is 120 ft. per minute.

Two ropes are anchored on the spirally-grooved barrel, one of which proceeds from the barrel over a pulley at the apex of the mast around a pulley attached to the jib head and back to an anchor fixed on the pin at the apex of the mast; the other rope is led over a pulley on the luffing barrel side of the crane situated at the top of the back channel of the superstructure and thence around two pulleys on the sliding balance weight to an anchor attached to the channel remote from the barrel side of the crane. The jib is completely balanced at any radius by the rising and falling balance weights ; these weights are guided by the vertical channels at the back of the superstructure.

Because the jib is balanced and the load moves in a horizontal path, no actual work against gravity has to be performed during the operation of luffing, therefore the only energy is that required for overcoming the friction of the moving parts. It is, therefore, possible with this type of gear to work at a high speed with a very small power consumption. Limit switches of the shunt type are provided for preventing the jib being luffed out beyond 65 ft. radius or being luffed in to less than 20 ft. radius



View of New Crane at the Royal Albert Docks.

Slewing Gear.

The slewing motion is operated by a 10 B.H.P. motor running at 600 revs. per min. driving through a worm gear, a machine-cut pinion meshing into a fixed pin rack. The pin rack consists of a number of circular steel pins placed in holes drilled to receive them in a channel bent to a circular shape, this channel is securely riveted to the top plate of the gantry. The worm gear has a forged steel worm driving a phosphor-bronze machine-cut worm wheel running in an oil bath. The slewing gear is fitted with a safety slipping device for the purpose of protecting the motor and the gear from heavy overloads and sudden shocks such as may be caused by speeding up the slewing motor at too great a rate, by revolving the slewing controller handle too quickly, or if the driver endeavours to stop the slewing of the superstructure too suddenly by application of the hand brake too fiercely.

The rated slewing speed of the crane was $1\frac{1}{2}$ revs. per min. with the full load hung on the hook, but in actual test on a calm day $2\frac{1}{4}$ revs. per min. were obtained with the motor taking only $12\frac{1}{2}$ amperes instead of its full load of 21 amperes.

Travelling Gear.

The train of travelling gear is operated by a 20 B.H.P. motor running at 600 revs. per min. and consists of four reductions of spur and bevel gearing with the necessary shafts driving two of the four travelling wheels. On each side of the portal one travelling wheel is connected to the gearing, the other two run free when the crane travels. All the pinions have teeth cut from mild steel blanks, the wheel teeth being cut from machined steel castings and the first reduction gear has double helical teeth. The travelling wheels consist of double-flanged rolled steel tyres shrunk on cast-iron centres which are gun-metal bushed and rotate on pins fixed in dead eyes bolted to the crane sills.

The motor is placed over the portal and the power is transmitted to the driven travelling wheels through the gearing by a horizontal shaft and two vertical shafts. The first motion gear is arranged on the centre line of the crane and at each end of the horizontal shaft a bevel pinion is fixed which gears into a bevel wheel at the top of each vertical shaft; at the lower end of each vertical shaft another bevel pinion gears with a bevel wheel keyed to a shaft running in bushed dead eyes attached to the sills; to this shaft and inside the sills a pinion is keyed which mates with a wheel bolted to the centre of a driven travelling wheel. All the gear at the ground level is placed inside the sills, and men working on the quays are not endangered by projecting gearing.

The speed of travelling the crane with the full load on the hook with the jib in any position or at any radius is 100 ft. per minute.

A rail jack and a rail clip is fitted to each end of the sills, the former for the purpose of taking the loading off the travelling wheels when working and the latter for preventing the crane being moved along the track or from blowing over in the event of exceptional wind pressure on the crane. A brake drum with ferodo-lined post type brake shoes operated by a shunt solenoid is connected to the motor spindle. Expanded metal platforms are placed on three sides of the top of the gantry for the purpose of obtaining access to the machinery house when the jib is slewed to any position; these platforms are reached by a ladder from the ground level.

Erection.

Each crane is being erected complete with the exception of the jib at a convenient site at one end of the dry dock. By means of specially designed lifting tackle secured to the four corners of the truck top, the whole crane is bodily conveyed to its final position on the jetty or quay by a steam floating crane of 50 tons capacity.

At the present time Messrs. Stothert & Pitt, Ltd., are manufacturing eight further cranes of similar design but of 2 tons capacity for the Port of London Authority. These cranes will be erected at the River Jetty at Tilbury Docks.

Ferro-Concrete Silos and Storage Bunkers.

By W. NOBLE TWELVETREES, M.I.Mech.E., M.Soc.C.E. (France).

RECEPTACLES for the storage of dry materials, such as grain, flour and other vegetable products, coal, coke, stone, ore and other mineral products, are variously designated, sometimes appropriately and sometimes inappropriately. While the generic term *granary* denotes any kind of repository or building for the storage of grain, any closed receptacle for the same purpose, whether above or below the ground, is distinguished as a *silo*, a designation recalling the pits or excavations used from remote antiquity in various parts of the world for the preservation of cereals. The individual silos in a group are not infrequently called *bins*, and a group of lofty silos combined to form a granary building is frequently, and very inaptly, designated a *grain elevator*, a term recognising nothing but the hoisting appliances incidentally employed in connection with the essential purpose of the structure.

Receptacles for storing materials other than grain and cereal products should be described as *bunkers*, and not as *silos*, the term *bin* being unnecessary, except as an alternative denoting a small bunker, and the American designation *pocket* being inappropriate, because its real meaning is a cavity in the earth or some structure, and not a structure specially erected for the specific purpose of storage. The term *hopper* is also an undesirable one, for the reason that it gives to an entire structure the name of what is essentially only a part of it.

It may here be mentioned in passing that reservoirs and tanks for the storage of water and liquids generally, and vats for liquid or semi-liquid materials, do not differ essentially in respect of design and construction from silos for grain and bunkers for miscellaneous materials.

Silo and Bunker Construction.

Up to about 20 years ago silos and bunkers were generally built of wood, brick, iron or steel. Ferro-concrete has now virtually taken the place of other materials, being free from the fire risks, decay and other disadvantages attaching to wood, from the clumsiness and transverse weakness of brickwork, and from the corrodibility of iron and steel—the last mentioned being objectionable owing to their heat conductivity and the formation of mould consequent upon condensation of moisure against the interior walls of the compartments.

Ferro-concrete silos may be either square, oblong, circular, hexagonal or octagonal in cross-section, and either built independently or in groups. In the latter event the silo compartments constitute the characteristic portion of a framed structure comprising chambers at the bottom for the reception of grain and the delivery of grain from the silos, and chambers at the top for the distribution of grain, received from below, to the various storage silo compartments. Suitable provision is made by stairways for access to the upper floor or floors, and for the installation of elevators, conveyors and other plant for mechanical handling of the grain. As a general rule, the depth of a grain silo is much greater than its diameter. Consequently, the maximum pressure against the sides is very considerable, and in the case of grouped silos it is essential to reinforce the concrete near both faces of the division walls, so as to provide for resistance to either compression or tension, the character and intensity of the stresses varying as the compartments are filled and emptied.

Coal Bunkers.

Bunkers for the storage of materials such as coal, stone and ore are sometimes built in groups consisting of two or more rows, but more generally either as independent structures or in single rows. Bunkers for powdered or granular materials are usually much greater in depth than in diameter, while those for the storage of materials in comparatively large fragments are of shallow proportions.

Ferro-concrete silos and bunkers, whatever their actual form and intended purpose, are always designed as monolithic self-contained structures, where the load of material stored and all other loads are transmitted from member to member until they are finally distributed over the ground by means of the column bases or by the aid of a continuous foundation raft, and where all parts of the construction are able to co-operate mutually by helping each other to withstand ordinary working stresses, and abnormal stresses due to exceptional conditions.

Some Ferro-concrete Experiences.

Two or three remarkable illustrations of this valuable feature of ferro-concrete may well be mentioned. The first example refers to three large granary buildings in Tunis, which, owing to the escape of quicksand from beneath the foundations, gradually settled until they were about 25 deg. out of the vertical, without suffering any structural injury. The buildings were afterwards set straight without serious difficulty, and without disturbing any of the interior fittings or machinery. The work was carried out by lowering the side of each building that had not subsided, so that what was originally the ground floor became the basement floor after the conclusion of levelling operations.

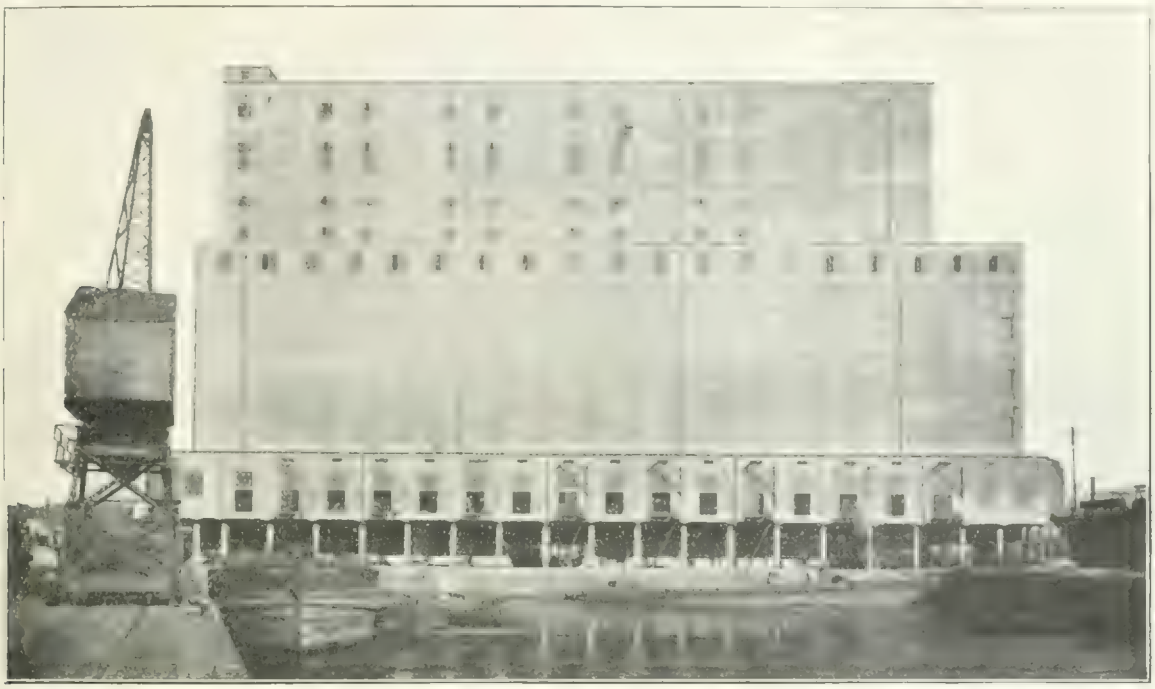


Fig. 1. View of Grain Silos at Manchester Docks. Built on Hennebique System. Capacity 210,000 quarters. View from No. 9 Dock.

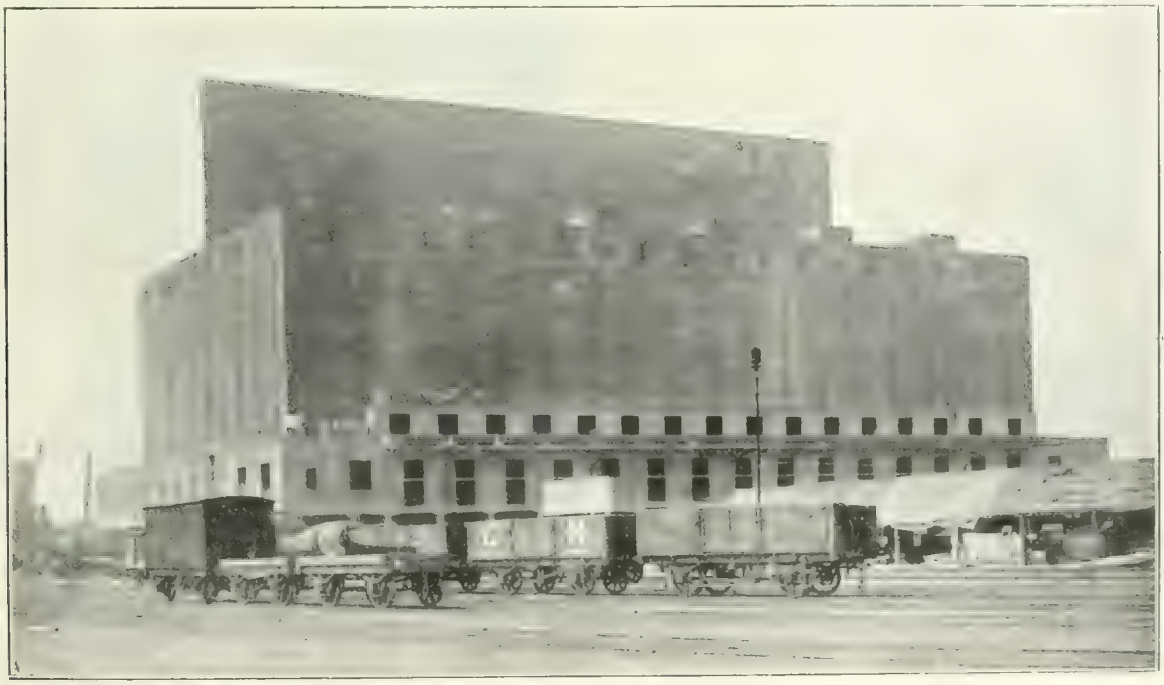


Fig. 2. Grain Silos at Manchester Docks. View of Back of Building taken from the Railway.

A parallel case occurred at Winnipeg a few years ago to a grain silo building 90 ft. high, with a storage capacity of over 125,000 quarters. Owing to some unexplained earth movement, the structure began to settle bodily at one side, until it was 28 deg. out of the vertical. The top then projected 40 ft. beyond the original building line without suffering any damage, although the conveyor housing and a separate roof structure slid off. This building was afterwards restored to the vertical position at moderate cost, and has been in constant use ever since.

Another interesting example was furnished some years ago by an elevated coal bunker at Lens, where one of the main supports was fractured by a derailed train of coal trucks. Although the bunker contained 1,000 tons of coal at the time of the mishap, the other parts of the structure took up the duty of the fractured support, and the only repair necessary was the rebuilding of the damaged member.

Typical Grain Silos.

During the past 20 years numerous large grain silos have been constructed in monolithic ferro-concrete for the port authorities of Liverpool, Manchester, Bristol and other places, to say nothing of those completed for public companies engaged in the grain and milling industries.

The port of Manchester is to be credited with the possession of the largest grain silos in the United Kingdom; the building, of which two views are reproduced in Figs. 1 and 2, which has a collective storgage capacity of 210,000 quarters, or 40,000 tons of grain, is 260 ft. in length, 112 ft. in depth, 110 ft. in height to roof level, whence rises a four-storey extension, 233 ft. by 37 ft. in plan, the roof of this being 163 ft. above basement floor level. The basement storey, extending beneath the whole area of the building, communicates with two spacious tunnels beneath the north and south quays of No. 9 Dock, the tunnels being equipped with belt conveyors by means of which grain is brought from ships for distribution to the silos, where there are 12 elevators, capable of dealing with 1,200 tons of grain an hour. The elevator shafts are constructed in spaces left between certain of the silo compartments. The silo accommodation comprises 260 storage compartments, and 81 compartments for sacking and delivering, varying from 7 ft. square to 13 ft. by 11 ft. in plan, all about 80 ft. high from the mouth of the discharge hoppers to the top. All the silos discharge through hoppers fitted with regulating valves to transmission appliances on the ground floor, the sacking and delivery silos discharging through spouts leading into sacking sheds projecting from the main building. Over the entire series of silos there is a floor for the distribution of grain by means of conveyors, the various floors of the roof extension building being devoted to grain cleaning, blending and other incidental processes. The general designs of the building and the mechanical plant were prepared by Mr. H. A. Reed, M.Inst.C.E., the chief engineer to the Manchester Ship Canal Company, and the ferro-concrete work was executed on the Mouchel-Hennebique system under his superintendence.

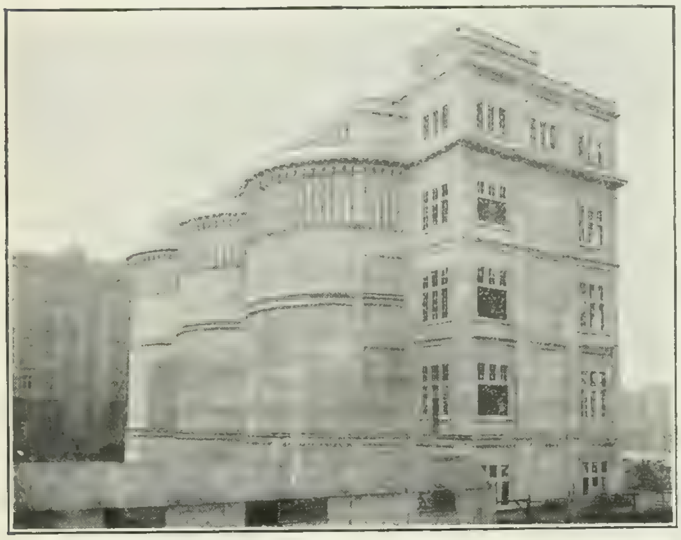


Fig. 3.—Circular Grain Silos at Dunston, Newcastle-on-Tyne. Capacity 60,000 quarters. (Hennebique System.)

A Circular Grain Silo

An excellent example of circular grain silo construction is a building forming part of the extensive works of the Co-Operative Wholesale Society, at Dunston, Newcastle-on-Tyne. As illustrated in Fig. 3, the structure comprises a group of six cylindrical silos, each 72 ft. high by 45 ft. in diameter, with a total storage capacity of 60,000 quarters of grain. Notwithstanding the great size of these compartments, the unsurpassed strength and elasticity of ferro-concrete permitted the designers to make the walls only 9 in. thick at the bottom, tapering to 6 in. thick at the top. At the ends of the group, the silos are flanked by towers containing elevating plant, and on the floor formed at the top there is a roof-house providing accommodation for the mechanical appliances used for the distribution of grain into the silos.

The two views reproduced in Figs. 4 and 5 show parts of the distribution and discharge floors in the grain silo building connected with Riverside Mills, Glasgow. The structure contains 46 silos with a storage capacity of 25,000 quarters, the silo compartments being 61 ft. 6 in. high and measuring 9 ft. 6 in. by 8 ft. 4 in. in cross section. The elevator tower comprises seven storeys and communicates at the top with the distribution floor, on which are band conveyors operated by belting from electric motors, as illustrated in Fig. 4. The hopper, forming the mouth at the bottom of each silo, is fitted with a square discharge pipe with regulating valve permitting the grain to be withdrawn in the required quantities and delivered upon band conveyors, as shown in Fig. 5.

Typical Coal Bunkers.

Bunkers for the storage of coal, coke and kindred materials have been constructed in types which present so many variations that it would be impossible to illustrate or even to describe them all, however briefly, in the present article. In some cases the bunkers are merely rectangular receptacles mounted on square pillars; others are constructed in ranges or groups embodied in lofty structures with platforms and other accommodation for mechanical appliances; others, again, have been built in the form of cylindrical towers, and on several leading railway systems storage bunkers have been incorporated in overhead coaling installations.

Fig. 6 illustrates a very substantial and boldly designed range of rectangular coal bunkers at Levenbank, with a storage capacity of 500 tons. The range is 115 ft. in length by 54 ft. in height, the arched roof constituting an effective and somewhat novel feature. The hoppers for the discharge of ouel are plainly shown in the illustration, as also are the pillars fn which the superstructure is carried.

A Welsh Coal Structure.

A cold-storage structure of unique design and exceptional height is to be found at the Bargoed works of the Powell Duffryn Steam Coal Co., Ltd. The building, as it may well be termed, rises to a height of 110 ft. above foundation level, being 55 ft. 6 in. by 32 ft. 3 in. in cross section. The lower part consists of strongly-framed and well-braced pillars, 24 in. square, each rising from an extended base, 7 ft. square. The superstructure includes 32 bunker compartments, surmounted by a charging floor and coal-drying chamber, the whole covered by a water-storage tank, 4 ft. 6 in. deep. At 32 ft. above foundation level there is a ferro-concrete platform, carrying tramway lines of 12 ft. 10 in. gauge for use by specially-designed trucks used for transporting coal from the bunkers to other parts of the works. The hopper mouths of the bunkers, fitted with the usual discharge valves, terminate about 14 ft. above the tramway platform. Having a storage

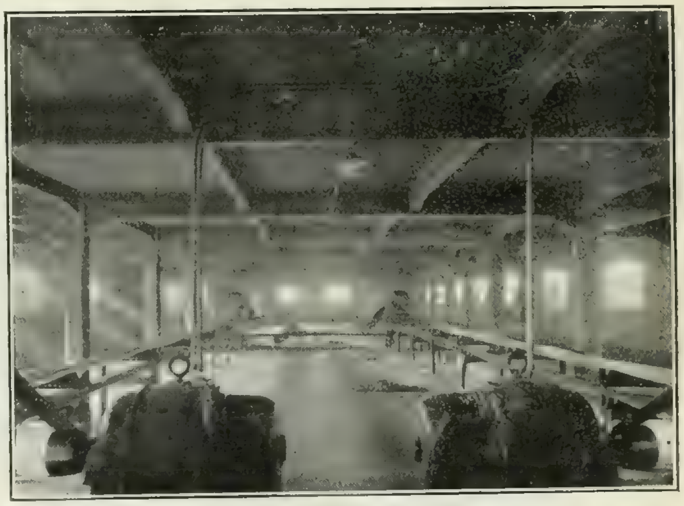


Fig. 4.—Riverside Silos, Glasgow. (Hennebique System.) View of Top Floor. Grain on Travelling Band on Left, showing Distribution of Grain to Silos.

capacity of 1,000 tons, the bunkers are 35 ft. high inside, the walls being 8 in. thick at the bottom, tapering to 4 in. thick at the top. The charging floor and coal-drying chamber are equipped with all requisite mechanical plant, the roof tank providing an ample supply of water at all times. The bunkers are used in connection with an extensive coke oven plant.

Another type of coal bunker is represented by a circular tower constructed for the Britannia Colliery of the Powell Duffryn Steam Coal Co., Ltd. Rising to a height of 95 ft., the bunker has a diameter of 32 ft., the storage compartment being 66 ft. deep, with a capacity for 1,500 tons of coal. Bunkers of this type constitute a very economical means of storage, and a good artistic effect has been given to the example cited by the addition of a cornice and string course.

The Elasticity of Ferro-concrete.

An elevated ash bunker, built at the Kilmarnock Electricity Works, is interesting as a demonstration of the manner in which the great elastic strength of ferro-concrete can be utilised in the design of slender structures under conditions where steelwork would be the only alternative. The elevator to be seen in the foreground is employed in delivering ashes, or clinkers, brought to the foot of the bunker from the boiler house of the works by means of a conveyor installed in the trench, of which part is shown at the foot of the photograph.

Typical Ore and Stone Bunkers.

So far as design and construction are concerned, bunkers for the storage of ore and rock differ very little, if at all, from coal bunkers. It may perhaps be thought ferro-concrete surfaces might possibly be chipped or otherwise damaged by the loading and discharging of fragments of ore or hard stone, as well as by attrition due to movement inside the compartments. Experience shows, however, that nothing of the kind need be feared. Before ferro-concrete was adopted for the storage of such materials, timber bunkers were largely used, but their life rarely exceeded 20 years. Therefore, taking into account the cost of annual repairs and maintenance, the total outlay was greatly in excess of that for ferro-concrete during an equal number of years, without taking fire risks and premiums into account.

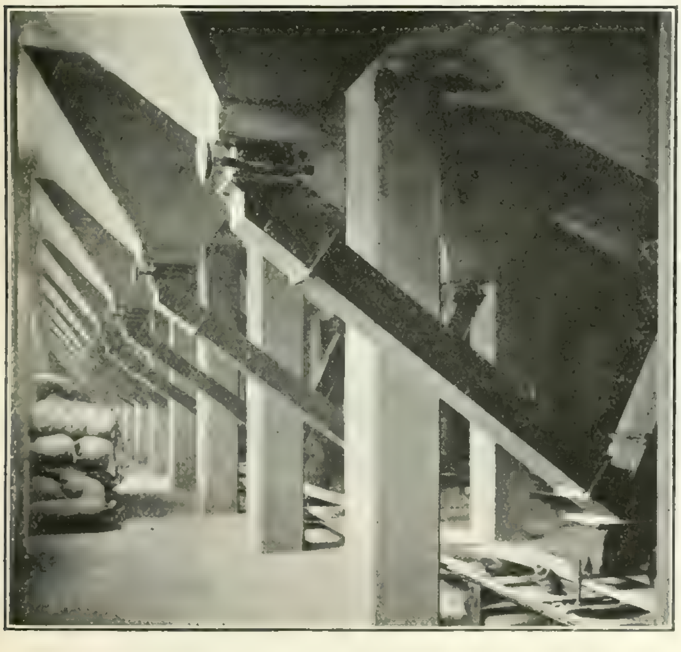


Fig. 5.—Riverside Silos, Glasgow. (Hennebique System.) View of Ground Floor on N. Side, showing Outlet Valves of Grain Silos and Conveyor Band.

Two or three examples will suffice to give a general idea of some ore and stone bunkers recently constructed in this country. The largest in existence, so far, is a long range of ore-storage bunkers at the Port Talbot works of Messrs. Baldwin, Ltd., the storage capacity amounting to 21,000 tons. The structure is monolithic from end to end and in monolithic connection with three counter-forts, which resist the heavy thrust of steel framework erected immediately behind the bunkers, and forming part of the steelworks plant of the firm.

Another good example is a massive set of stone bunkers constructed at Dundonald for the Hillhouse Quarry Co., Ltd. Being of plain and substantial character, the structure provides for the storage of 4,000 tons of stone, and is supported entirely upon three rows of ferro-concrete pillars, at sufficient height to allow two railways tracks to pass beneath.

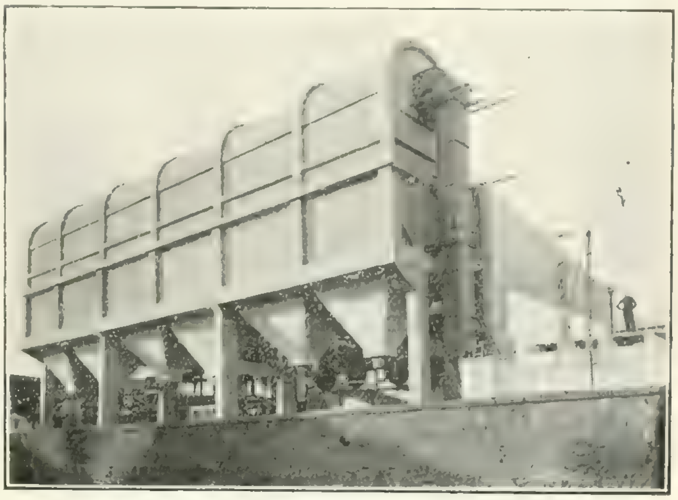


Fig 6.—Coal Bunkers at Levenbank.

An interesting series of stone bunkers is one constructed on the seashore at Newlyn for the Penlee & St. Ives Stone Quarries, Ltd. The bunkers, constituting a structure about 120 ft. by 60 ft. in plan by 27 ft. high, are served by railway lines, by which material is brought from the breaking and screening plant, another railway line being laid in a tunnel passing through the lower part, so that the stone discharged form the hoppers may be received in trucks for transport to any part of the Kingdom.

Miscellaneous Bunkers.

Ferro-concrete is employed for the construction of bunkers devoted to the storage of many solid materials, among them being such as chemicals, cement, cement clinker, artificial manures, plaster of Paris, refuse destructor clinker, sand, sugar, whiting and wool. The impenetrability and damp-proof properties of the material render it exceedingly suitable for storing perishable materials and products, which like cement and sugar, for instance, must be kept perfectly dry. One of the structures which came through the great Silvertown explosion without the least injury was a group of ferro-concrete bunkers for sugar, very much resembling the grain silos which have been described. One deserving special mention is a range of three circular bunkers for the storage of Portland cement at the Southam works of Messrs. Kaye & Co., Ltd., near Rugby. Cement leaving the tube mills is delivered by an inclined conveyor to a horizontal conveyor in a gallery across the conical tops of the bunkers. Cement drawn off from the hoppers below enters a ferro-concrete sub-way equipped with a worm conveyor, whence the cement is transferred to the packing department.

Although it has been only possible in the narrow limits of this article to deal with a few of the numerous types of ferro-concrete silos and bunkers, it is hoped that the representative examples taken may serve the purpose of indicating the general applicability of ferro-concreto to the storage of every class of material. In conclusion, the writer wishes to express his indebtedness to Messrs. L. G. Monchel & Partners, of Westminster, for the illustrations of Hennebique structures accompanying this article.

New Cranes at the Tilbury Docks.

By A. W. CAMPBELL, A.M.I.Mech.E.

THE period of transition from hydraulics and steam to electricity as a motive power for the operation of wharf or cargo cranes may be said to have commenced in this country over two decades ago. The design of the electric wharf crane has advanced by stages. Early practice arranged the revolving superstructure as a single motor unit; quite a natural development, when it is remembered that many makers utilised existing steam crane patterns and dispensed with boiler and engines. A motor with starter and switch was substituted to operate the various motions through the usual cone or expanding ring friction clutches. The electrical equipment was only a small part of the whole mechanism, and was frequently ill-considered. This constituted an electric crane.

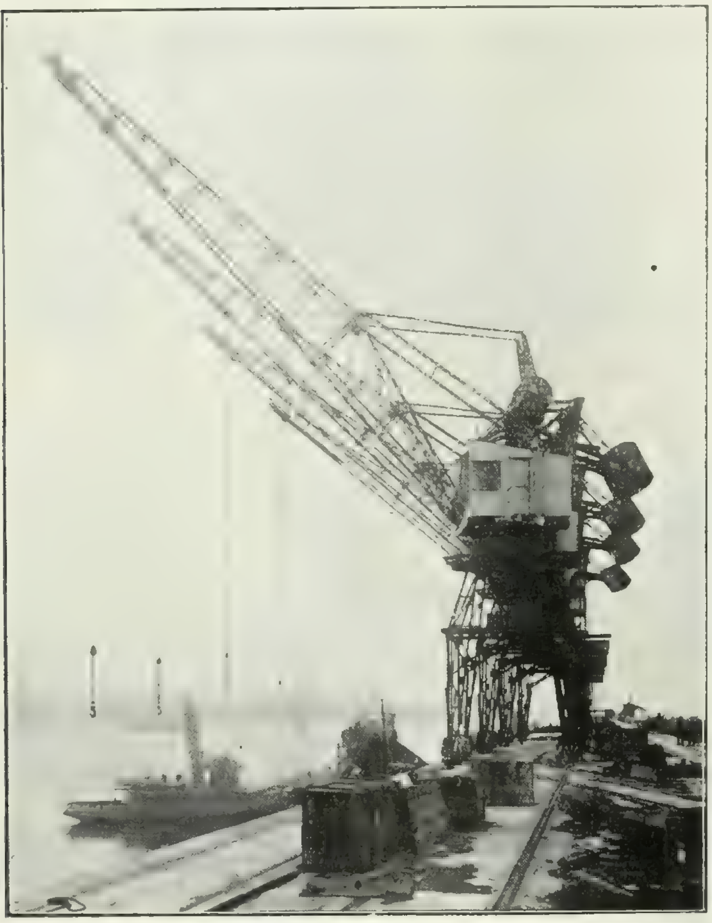


Fig. 1.—View of Four 2-Ton Electric Level Luffing Wharf Cranes.

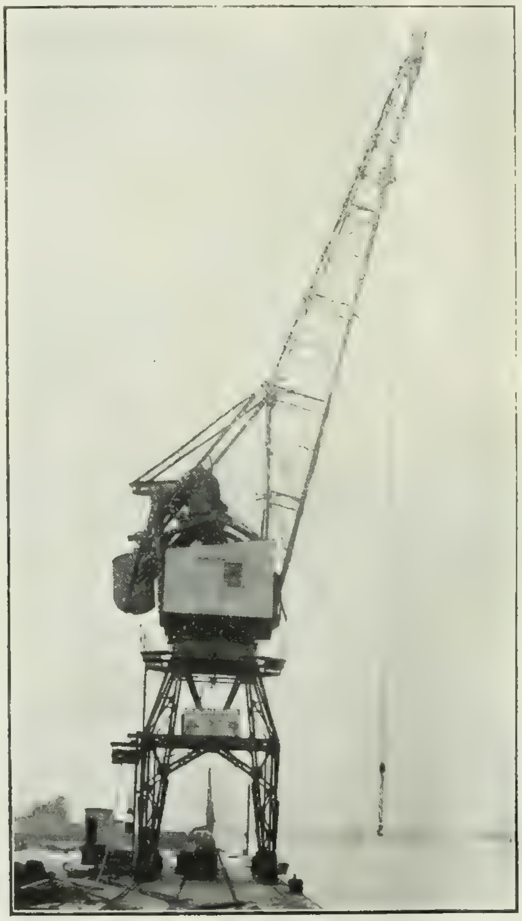


Fig. 2.—Two-Ton Electric Level Luffing Crane at Minimum Radius.

One Motion—One Motor.

The next stage in development witnessed the introduction of two motors, regulated by controllers, one to operate the hoisting and derricking motions alternatively, and the other to operate the slewing motion. Separate motors for each motion, similarly controlled, quickly followed, and became, and has since remained, the accepted practice. A "free barrel" was adopted on the hoisting motion with advantage, and is still frequently supplied. This arrangement permits speedy lowering, but possesses an element of danger. The load is lowered under control of a mechanical brake applied by the hand or foot; an exceedingly dangerous provision when controlled by a careless operator, or, as too frequently occurs, by a workman who is called upon to perform other duties when the crane is not in use. Nevertheless "free barrel" cranes have become exceedingly popular, and there are now several types of this gear commonly employed.

Luffing and Derricking Cranes.

The most recent development in electric wharf crane practice is what is known as the level luffing crane, of which there are at least ten well-known types in actual operation. The terms "luffing" and "derricking" are both used with a certain amount of licence to describe the motion, which alters the radius of a crane. It will therefore serve a useful purpose if we distinguish that which differs in principle. A "luffing" motion is one of a cycle of operations wherein the jib is moved inwards and outwards with every load. A "derricking" motion, on the contrary, is not one of a cycle of operations. It is the movement of the jib inwards or outwards for the purpose of altering the radius at which the crane will operate. This motion is frequently of sufficient power to alter the radius with the load suspended from the hook. During such movement the load rises and follows a parabolic curve.

The motor for a derricking motion, capable of lifting both jib and load, must be of sufficient power to exert the necessary starting torque, when the maximum load is suspended at maximum radius. This necessitates a motor of at least 20 B.H.P. for a 3-ton crane, with a maximum radius of 45 ft., and will permit of a speed of about 45 ft. per minute measured horizontally. A crane of similar capacity and dimension fitted with a level luffing motion will only require a motor of 5 or 6 B.H.P., and will permit a horizontal luffing speed of 120 ft. to 150 ft. per minute.

The Jardine Luffing Crane.

The advantages of the level luffing wharf crane will be obvious, and it will therefore be of interest to readers of The Electrician to describe the latest type of this crane which has been put into commission. We refer to the Jardine patent level luffing cranes recently supplied to the specification of the chief engineer to the Port of London Authority for use at the new river jetty, Tilbury (*see* Figs. 1 and 2.)

The luffing motion provided by these cranes maintains a perfectly level load line between maximum and minimum radius, the load being compensated by the movement of the hoisting jib head sheave and carriage within guides situated at the upper end of the jib. This movement is regulated by ropes attached to the carriage, which pass over sheaves at the extremity of the jib, to anchorages on the superstructure, after their passage round movable sheaves guided along a specially curved path on the superstructure frame. The sheaves moving along this path are actuated by links connected to the jib. The luffing motion is operated at full speed, except when approaching maximum or minimum radius when the speed is automatically reduced and current gradually cut out by a series of limit switches before the final application of the automatic brake. The forward and rearward moments of the revolving superstructure are approximately proportional at any point between maximum and minimum radius, by reason of the direct connection between the jib and movable rear ballast. The centre of gravity of the revolving superstructure consequently moves through a very short horizontal distance within the roller path with an effective reduction in wear on the latter and centre pin bearing.

This luffing motion does not increase the stresses about the apex of the superstructure, since the forces due to the tension of the luffing ties tend to contract the compensating sheaves moving in the curved path and those fitted at the apex of the superstructure. The luffing bell cranks are each fitted with a spur gear rim engaging with pinions operated through bevel gearing from a vertical shaft actuated by worm gearing. The bell cranks carrying the movable rear ballast are coupled to the luffing cranks to balance the jib and revolving superstructure.

Unique Hoisting Control.

The system of hoisting control is unique, and its application to wharf crane practice for the first time marks a distinct advance on anything hitherto attempted. It consists of an enclosed contactor panel in conjunction with a master controller adapted for dynamic and potentiometer regulation of the lowering speed with any load and on any contact of the controller. Series regulation governs the hoisting speed and the first contact on the controller permits a slow speed of operation. The potentiometer system of control places the armature in parallel with the series field, the brake and a separate resistance and automatic regulation of the motor is effected. Light loads are driven in the lowering direction, whilst loads of greater magnitude overhaul the hoisting gear and convert the motor into a generator, the energy of the falling load being dissipated through resistances. The motor is always across the mains and the load is consequently under complete control from a maximum to a "creeping" speed. The maximum lowering speed on the last contact of the controller under full-load does not exceed twice the maximum hoisting speed under similar conditions. The maximum lowering speed with empty hook is 2½ times the maximum hoisting speed with full load. The motor is therefore adequately protected against excessive speed in the event of the controller being operated by an inexperienced driver.

Contact Arrangements.

The control panel is totally enclosed, and is fitted with a contactor breaker and an overload relay for the main circuit, together with separate time-lag relays for each motor circuit. The latter are connected with interlock contacts and limit switches. Failure of the current, an overload or an overwind on any motion will operate a relay and open the contactor breaker. The crane driver brings his controller handle to the "off" position automatically to re-set the contactor, which does not necessitate his leaving the control position, and a push button switch is mounted within his reach to open the contactor breaker in an emergency. Magnetic brakes and safety devices are fitted to each motor and motion respectively. Operating levers other than the four controller levers have been entirely eliminated.

Each crane is capable of lifting a working load of 2 tons at a maximum radius of 60 ft., and consists of a braced pedestal of the portal type for the passage of railway traffic. A revolving superstructure is superimposed thereon, and the jib is of ample length to afford an additional radius of 5 ft. with a reduced load. The pedestal runs on two rails, one being located near the face of the jetty.

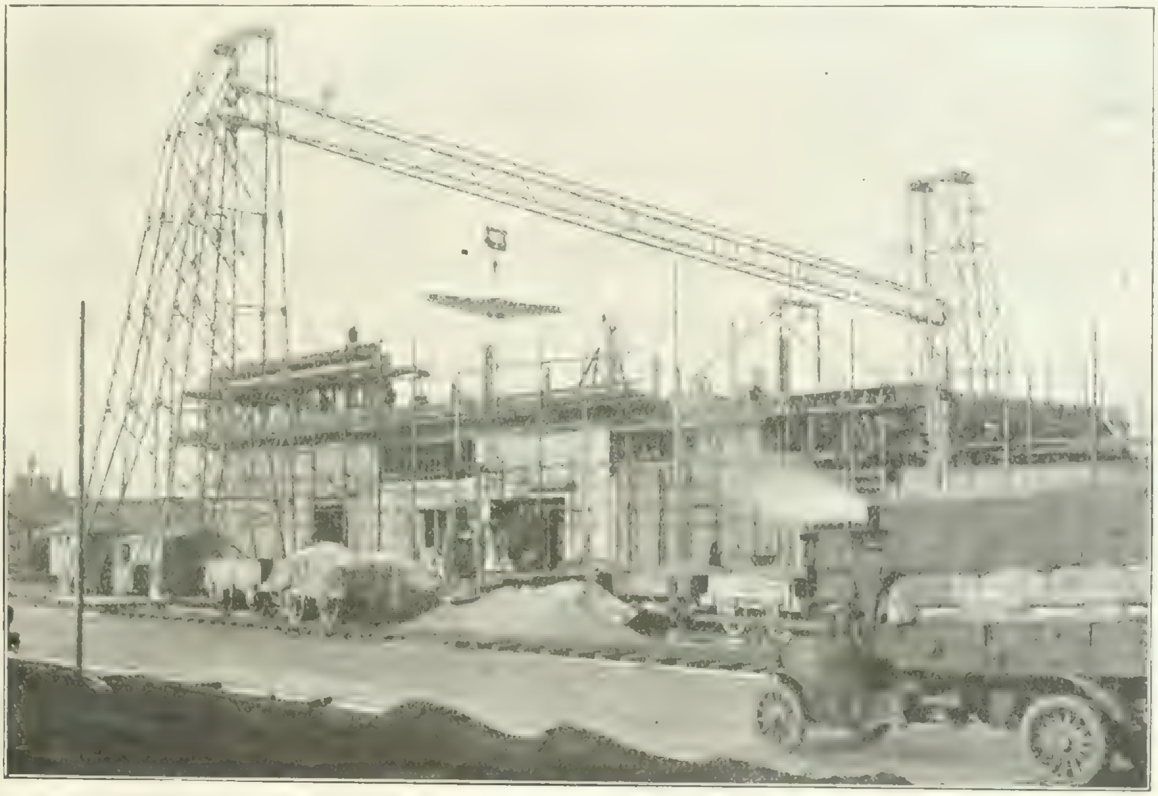


Fig. 3. View of 3½ Ton Walker Transporter.

An Interesting Transporter Crane.

Another interesting crane, and the first of its kind, has been in use for some time at the Royal Victoria Docks on the erection of a two-storey reinforced concrete quay warehouse, 1,000 ft. long by 120 ft. wide by 45 ft. high. The crane, as will be seen from the illustration, is of the transporter type, and is the invention of Mr. J. H. Walker, Assoc.M.Inst.C.E. It was designed to command the complete building area, and to place 3½-ton pre-moulded members and wet concrete in position. The height of each tower is 76 ft. 3 in., and the distance between towers 142 ft. Each tower travels on two pairs of wheels, with a wheel base of 32 ft., and a gauge of rails of 18 ft. As will be observed, the towers have vertical recesses to accommodate the ends of the suspended cross girder, which is 151 ft. in length. The ends of the girder are suspended by block and tackle from a stationary pin on one tower, and from a carriage on the other which is free to move in the direction of the longitudinal axis of the girder. The latter may be raised or lowered at one or both ends for horizontal or inclined use. It will be apparent that the flexible suspension of the girder prevents any end pull on the towers, and that the operation of the crane is independent of their alignment. A cableway is suspended below the girder, and is attached to its ends in line with the points of suspension. A trolley runs on the cableway, and is fitted with the necessary sheaves and attachments for the hoisting and hauling ropes, which are operated by an electric twin drum winch at the base of one of the towers. The effect of the loaded cableway on the girder is to reverse the stresses in the booms of the girder due to the horizontal component of the pulls on the ends of the rope. The upper boom is in tension and the lower in compression. This result tends to neutralise the stress due to the dead weight of the girder, and allows of a lighter structure than would have been necessary if the trolley was running on the lower boom. The buckling effect in an upward direction varies directly with the horizontal pull of the loaded rope, but the pull for a given load varies directly with the amount o sag in the rope. If a greater load be placed on the rope the latter naturally lengthens, with a resultant increase in sag Therefore, twice the load with a certain girder and length o rope does not necessarily mean twice the stress in the rope or girder, as the sag in the rope increases with a greater load The dynamic effect of arresting a load during lowering causes extra sag in the rope, and the whole arrangement acts as a spring, with a consequent greater factor of safety in working, and permits lifting and lowering to be performed with ease and not suddenly. The total weight of the crane is relatively small, and dispenses with costly foundations for the track, as sleepers under each rail is all that is necessary.

The author is able to illustrate and describe these cranes with the kind permission of Mr. C. R. S. Kirkpatrick, M.Inst C.E., the chief engineer to the Port of London Authority, and is indebted to the makers, Messrs. The Wellman Smith Owen Engineering Corpn., Ltd., London, for the photographs illustrating the article.

Pneumatic Intake Plant for Road or Water Borne Grain.

By M. JENNINGS.

In the mechanical handling of grain and other similar substances the pneumatic system is rapidly becoming an important factor, and although its application is limited to special conditions, there are now many plants in use, where, previous to their being installed, manual labour was considered to be the only practical method of dealing with the material. Many such instances could be quoted, but it is here proposed to give a description of one installation only, in order that as far as space permits, the reader may have placed before him a typical plant together with brief results of tests which have been conducted upon it from time to time.

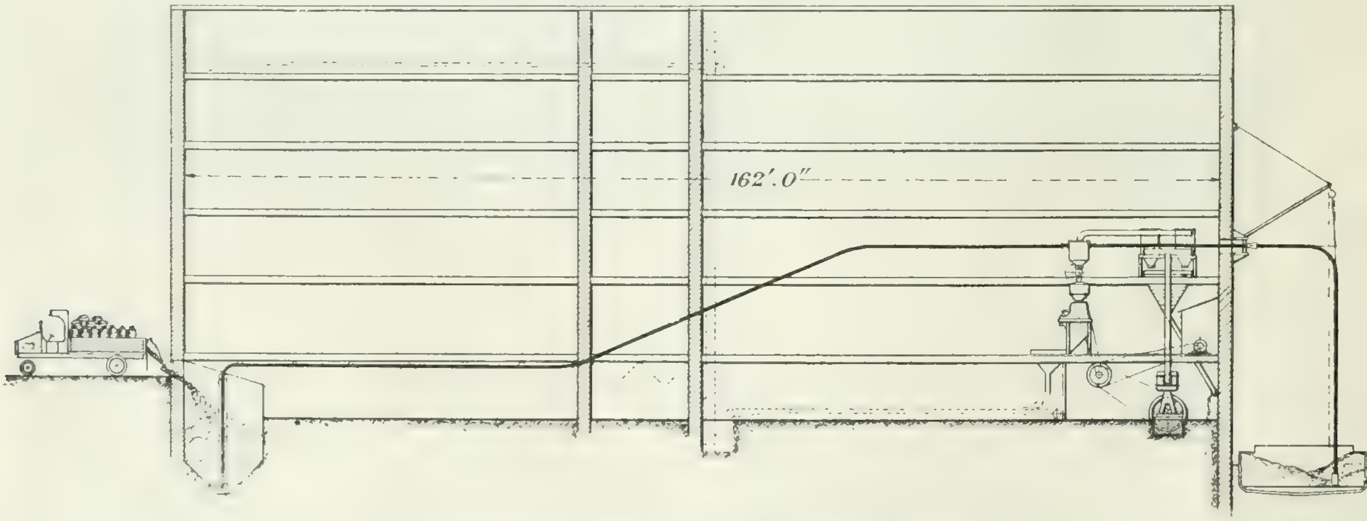


Fig. 1. General Arrangement of Pneumatic Intake Plant.

A Flour Mills Installation.

The plant under consideration is installed at Messrs. Humphries & Bobbetts, Castle Flour Mills, Bristol, and has been in daily use for over a year for the unloading of imported wheat which arrives at the mill in barges. Up to September 1919, the only intake for the mill consisted of hoists, which necessitated all grain being delivered in sacks. The increasing difficulties of sack hiring and the extra cost of lighterage as compared with taking delivery in bulk, were responsible for the introduction of the new method. Its arrangement is shown in sectional elevation in Fig. 1, but as the distance which separates the road from the river is so great in proportion to the space occupied by the machinery, the river end of the building has been shown on a larger scale in Fig. 2, the several details of the plant being lettered for reference. Primarily intended for the unloading of water-borne grain only, the extension shown upon the left hand of Fig. 1 is a recent addition, and the description of this portion is given towards the end of the article.

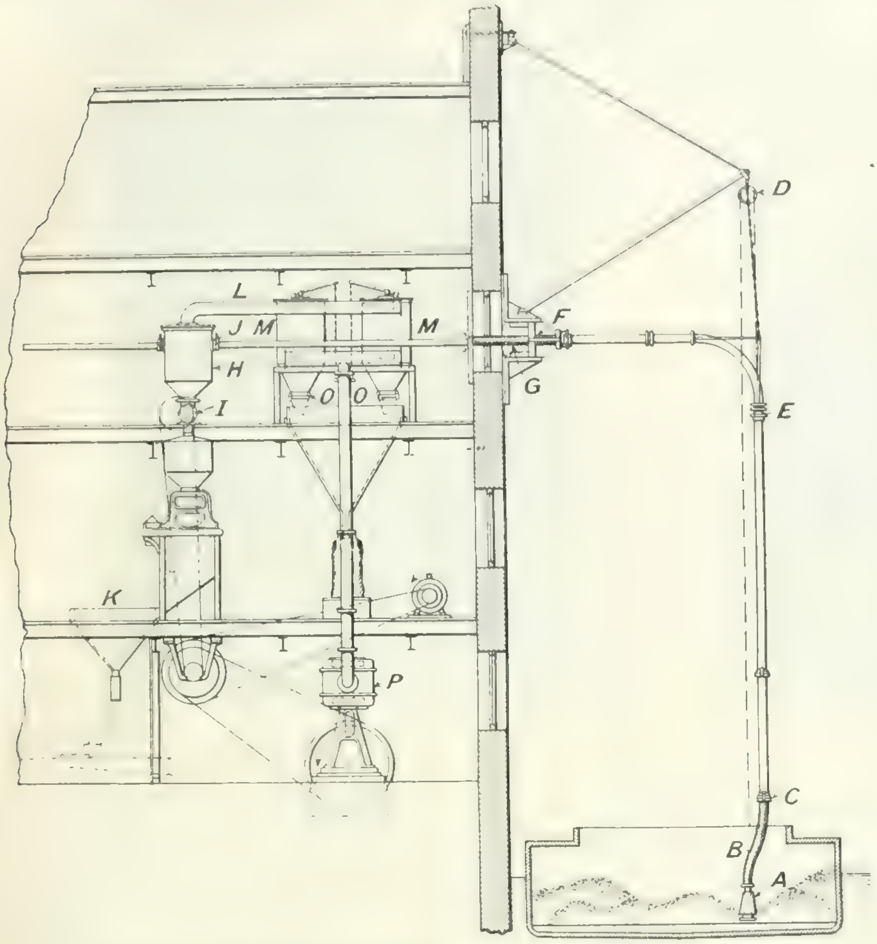


Fig. 2. Arrangement of River Portion of Pneumatic Intake Plant.

The Transport Pipe.

The external appearance of the plant as viewed from the river is shown in Fig. 3. This part chiefly consists of the transport pipe which projects over the river a distance of 16 ft. from the side of the building, and is provided with a universal movement. When the use of the plant is not required, the entire gear folds flush with the wall, thus offering no obstruction to river traffic. Referring to Fig. 2, the nozzle (*a*) is attached to the lower end of the vertical portion of the transport pipe; one or more lengths of flexible pipes (*b*) being employed as may be required; these flexible pipes are of light metallic construction, fitted with easily detachable couplings (*c*). When commencing to unload a barge, the pipe is raised by the block tackle (*d*) to its highest position, and is gradually lowered as the level of the wheat falls in the barge.

Pipe Control Arrangements.

Fig. 4, which is reproduced from a photograph obtained during actual work, shows this sinking motion with good effect; and also the manner in which it is controlled, viz., by the nozzle attendant, the operating chains of the hoisting tackle being at his command. The advantages of this method of pipe manipulation as compared with a winch and crane tackle are two-fold; firstly, the great saving in cost of tackle; and secondly, there is no time lost in keeping the nozzle well buried in the grain as must occur when the man in the barge depends upon someone within the building for lowering the pipe. The block tackle is supported from a steel tubular jib which presents very little resistance to the wind, and combines great strength with a neat appearance. The ball joint (*e*) at the top of the hanging portion of the pipe allows of unloading a barge lying "second-off," without interrupting any loading-out operations which may be in progress upon the barge adjacent to the mill—such a case is presented in Fig. 3.

The movable transport pipe terminates in a universal swivelling box (*f*) and is connected to the transport pipe within the building by a short length of specially constructed flexible tube (*g*). By a compensating arrangement, the distance between the ends of this tube is kept constant, no matter at what angle the pipe is standing with respect to the wall; this prevents any puckering of the flexible portion of the pipe which would, of course, be detrimental.

Receiving Vessel and Discharger.

The remaining horizontal pipe ends in a receiving vessel (*h*) into which the grain rushes from the pipe. The sudden decrease in the velocity of the air results in the grain falling to the bottom of this receiver, from which it is removed by the rotary discharger (*i*). By this discharger the entry of air at this point of the system is prevented. A slide valve (*j*) placed at the junction of the transport pipe and receiving vessel can be closed when it is desired to use the English wheat intake. The grain, after leaving the discharger, passes into an "Avery" automatic weighing machine, and is discharged therefrom into the hopper (*k*) for delivery to the silos.

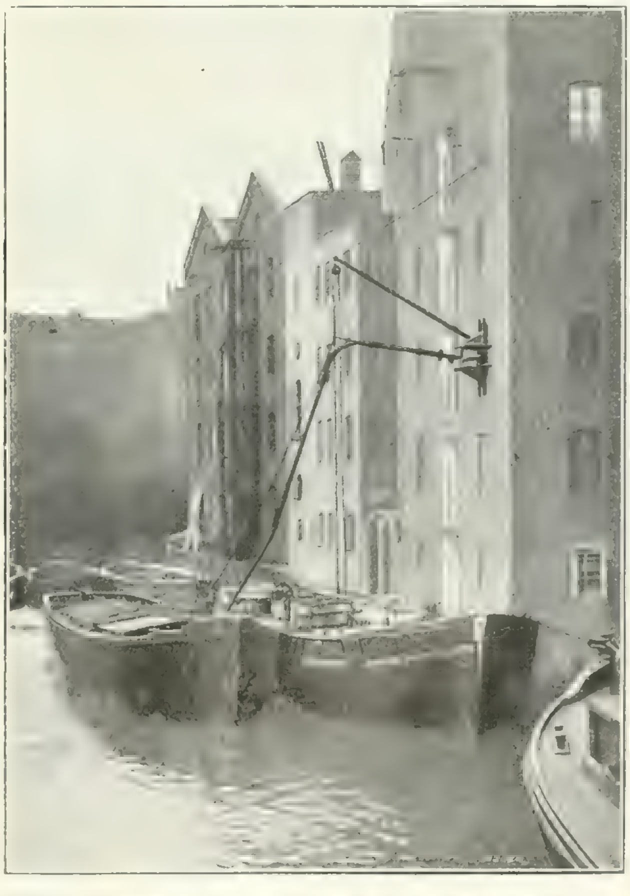


Fig. 3. Pneumatic Intake Plant as seen from the River.

Dust Filters.

The air, no longer moving with a velocity sufficient to carry grain, but still dust-laden, leaves the receiving vessel through the pipe (*l*) and enters the filters (*mm*) which are placed in parallel. Each of these filters contains a number of textile sleeves through which the air must pass before it can be delivered to the atmosphere by the pump (*p*). The dust is arrested on the inner surface of these sleeves from which it is periodically removed by an externally operated shaker. As this cleaning process is dependent upon the dust readily falling from the fabric, very little good would result from shaking these sleeves while the air is passing through the cloth. To avoid stoppage of the plant, each filter can be isolated for cleaning purposes. The outlet (*o*) may also then be opened and the accumulation of dust dropped into the sacking hopper below. Fig. 5 is a view taken from the doorway on the second floor, and shows all the details which have just been described.

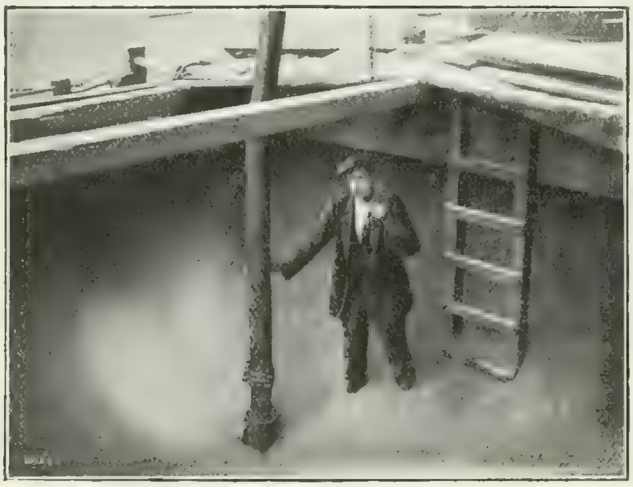


Fig. 4. View of Suction Pipe in hold of Barge.

Pump Installation.

The pump, which is illustrated in Fig. 6, forms a conspicuous feature of this plant, and it may be mentioned here that the choice of a suitable exhauster is a matter of vital importance in the designing of a pneumatic conveyor. The abnormal power required to work some of the earlier plants may often be traced to the employment of an inefficient type of exhauster, and in the several plants which have been reconstructed during recent years, the chief modification has always been the substitution of an up-to-date exhauster.

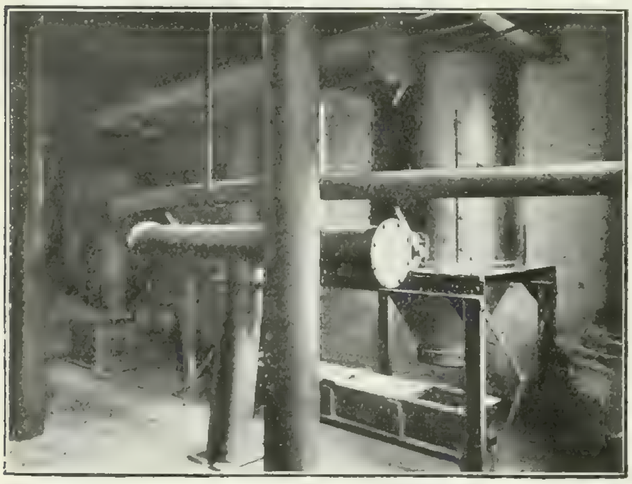


Fig. 5.—Receiving Vessel and Filters showing Isolating Valves and Shaking Chain.

The pump at Messrs. Humphries & Bobbett's is of entirely new design, and some details of its construction will be of interest. Outwardly, it closely follows the conventional design, except for the cylinder, which at first sight creates an impression of top-heaviness. This is due to an annular chamber or jacket extending round the cylinder, in which are placed the inlet valves. The exhaust valves are situated directly above or below in the respective cylinder covers, and a single bolt holds a pair of valves in place. Doors in this chamber and in each cover, allow of ready access when inspection becomes necessary, and both sets of valves can be removed from the pump within a quarter of an hour. The total valve area is approximately one-fifth of that of the piston, in consequence of which the air passes through the valves at a relatively low speed. This, combined with the use of "Duralumin" valve plates and very light springs, considerably reduces the energy which is commonly expended in operating automatic valves.

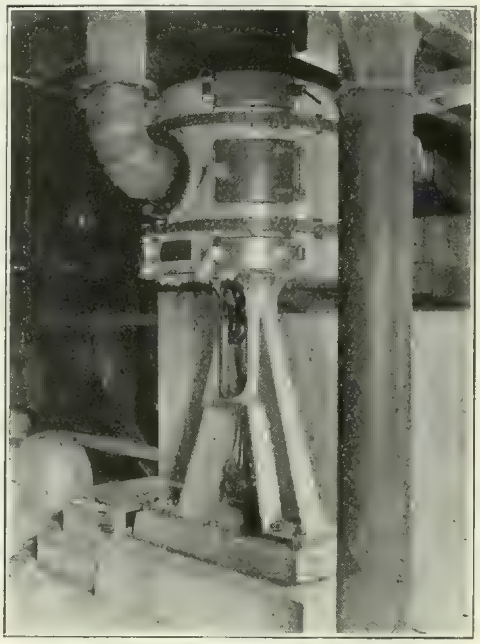


Fig. 6.—View of the Pump.

The effect of this is shown by the indicator card, Fig. 7, upon which the absence of exhaust pressure is very noticeable.

Capacity and Power Tests.

Numerous tests have been carried out upon this plant from time to time, and it is proposed to cite some of these as being of practical utility. From the drawing shown in Fig. 2, it will be seen that the plant is entirely self-contained as regards driving arrangements; and a separate current meter having been provided for the motor, the actual amount of current used can be recorded against the readings shown by the counter on the automatic weighing machine. By reading these two meters at frequent intervals the power consumption for a given capacity can be more closely determined than is possible by the use of an ammeter, as the load fluctuates considerably. Of course, the efficiency of the motor must be taken into account, but as the purchaser invariably wants to know what the overall running costs of the plant will be, the tables given herewith show this without further calculation.

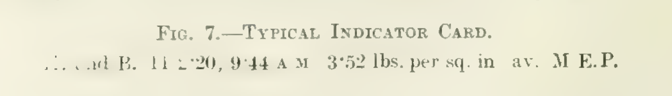


Fig. 7.—Typical Indicator Card.

[illegible]ad B. 11 2·20, 9·44 a m 3·52 lbs. per sq. in av. M E.P.

Table I.

No. of reading.	Time.	Weigher 496 lb. weighing	Current meter B.O.T. units.	Average capacity between intervals tons hr.	Current consumed per ton lifted.	Approx. B.H.P. at pump (Power factor of motor 0·87)
1 ..	10·55	23,528	1119·0			
				14·8	0·77	13·4
5	11.38	23,576	1127·2			
				18·1	0·72	15·3
9 . . .	12.0	23,606	1132·0			
				14·3	0·78	13·0
15 . . .	12·26	23,634	1136·8			
				11·9	1·02	14·3
23 ..	12·55	23,660	1142·7			
Summary	2 hours	132 qrs.	23·7	14·6	0·81	13·9

Table II.

No. of reading.	Time.	Weigher 496 lb. weighing	Current meter B.O.T. units.	Average capacity between intervals tons hr.	Current consumed per ton lifted.	Approx. B.H.P. at pump (Power factor of motor 0·87)
1 .	9.27	23,992	1205·0			
				16·7	0·7	13·7
7 .	9.50	24,021	1209·5			
				15·0	0·71	12·4
14 .	10.21	24,056	1215·0			
				15·8	0·79	14·5
18	10·57	24,099	1222·5			
Summary	1·5 hrs.	107 qrs.	17·5	15·8	0·74	13·6

Table III.

Date.	Weigher (Qrs.)	Current Meter B.O.T. units.	Current consumed per ton lifted.
February 11, 1920.........	24,056	1,215	
			0·985
April 19, 1920	37,020	4,043	
			0·965
June 14, 1920...............	49,580	6,727	
			0·952
July 12, 1920	54,823	7,832	
			0·960
September 9, 1920.........	68,764	10,792	

Modern Improvements.

For those who have followed the development of the pneumatic conveyor, and wish to compare the power consumed by a modern plant with those of 20 years ago, the approximate brake-horse-power at the pump flywheel is given in column 7 of the tables. Only in one case does this exceed 1 H.P. per ton per hour. It is rather misleading to attempt to state the overall efficiency of a pneumatic conveyor, as, theoretically, no work is done in conveying horizontally; but an approximation may be made by assuming that the grain has to be lifted vertically to such a height as to enable it to fall by gravity to the desired position within the mill. This height, in this particular instance, is about 60 ft., and for lifting 1 ton per hour through this distance the theoretical power required would be

$$\frac{2{,}240 \times 60}{60 \times 33{,}000} = 0{\cdot}068 \text{ H.P.}$$

Thus it will be seen that during its performance upon a barge lying adjacent to the mill the overall efficiency of the plant excluding motor losses is

$$0{\cdot}068 \times \frac{16{\cdot}7}{13{\cdot}7} = 0{\cdot}083, \text{ or } 8{\cdot}3 \text{ per cent.}$$

Table I. contains five selections out of about 30 observations taken in February last. The cargo was wheat, and the barge lay "second-off." The rated capacity of the plant is 15 tons per hour when working upon the near barge, and it will be seen that this was nearly maintained over a two-hour run upon the "second-off" barge. The capacity rose as high as 19 tons per hour during the early part of the time, but as the quantity in the barge diminished, more bending of the flexible pipe became necessary, which resulted in dropping the capacity, and a very marked increase of current consumed per ton lifted.

In Table II. are similar selections from a test carried out two days later, but on this particular day the barge was lying alongside the mill. In this instance there was much less fluctuation, and although, momentarily, the capacity sometimes touched on 20, it never dropped below the guaranteed figure of 15 tons per hour. It will also be noticed that the values in column 6 of this table are fairly constant and do not sensibly differ from the average.

Energy Consumption.

It may be argued that these tests are not necessarily indicative of what may be expected to happen in practice: certainly they are not, for here we meet with the human element; and it is interesting to glance at Table III. in which are given five readings of the current meter and weigher counter, extending over a period of seven months. The fourth column of this table corresponds with column 6, of the previous tables, and it will be seen that experience in handling the plant has favourably affected the current consumed. When it is further considered that all cleaning-up of barges, together with the current consumed while the plant is running light, is included in these averages; the percentage of the actual to the test figures is remarkably high.

Working Costs.

With such a plant as has just been described, in fairly continuous use, say, 300 working days per annum up to about six hours per day, the working cost is approximately 5d. to 6d. per ton lifted; while the interest on capital involved, together with depreciation, maintenance, and other overhead charges, would be somewhere from about 4d. to 5d. per ton.

Reasonable latitude must naturally be given in estimating what the over-all working cost of any conveyor is likely to be, and it is always advisable to secure an arrangement which is favourable to low power consumption, as this has an important bearing upon both the above items. Against this expenditure can usually be set off the cost of sack hiring, which alone often defrays the greater part of the total working cost of these plants—6d. per ton may be taken as an average figure. Also, the increased accuracy of weighing and checking eliminates accumulative errors, which are bound to accrue in sack weighing.

Further advantages obtained in this mill are that loading-out operations can be carried on simultaneously with the loading in. This reduces the congestion of barges in the river, in consequence of which demurrage charges are considerably lessened.

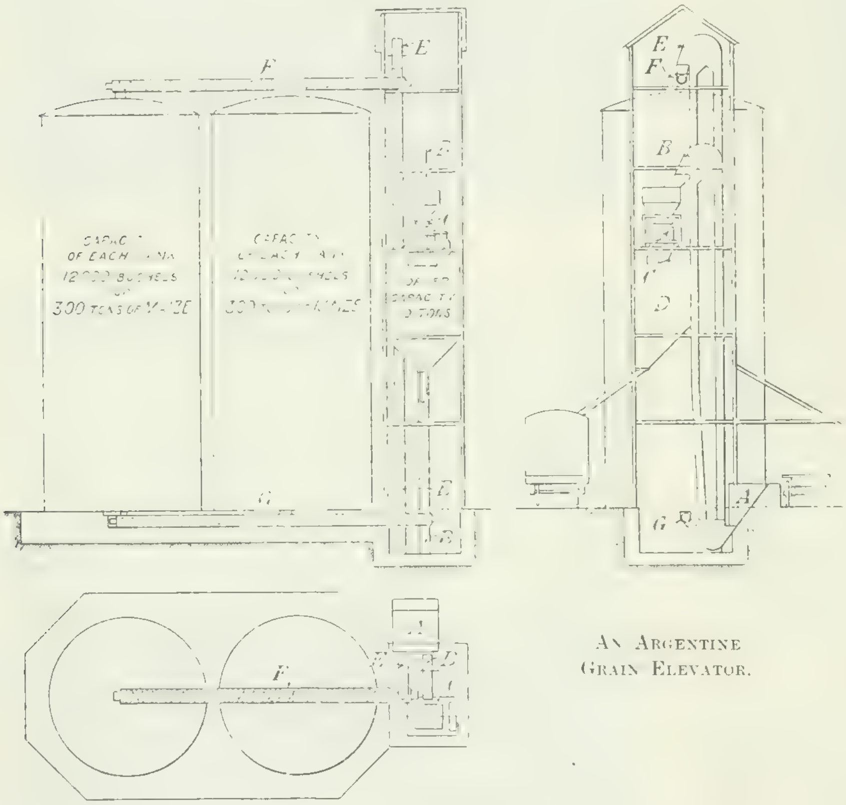
Such being the superiority of the new system over the old, less than a year's experience decided Messrs. Humphries to extend this plant for dealing with their English wheat. A large hopper has been made adjacent to the street on the other side of the mill, into which sacks can be quickly emptied through doors in the wall. From this hopper the wheat is drawn through the auxiliary transport pipe which is ordinarily kept closed by a valve as described in the river intake portion. As this extension has not long been in use, no test figures such as have been given above are available; and it is rather unfortunate that future observations as recorded in Table III. will not be of much service, as it would be necessary to record the readings of both meters every time the plant was used, on account of the difference in capacity of the two sides. The capacity on the road-borne side is about 10 tons per hour.

The author gratefully acknowledges Messrs. Humphries & Bobbett's permission to describe their plant, and is indebted to Messrs. Robert Boby, Ltd., Bury St. Edmunds, for their consent to the publication of the technical details.

The Elevator System and Grain Production.

By JAMES WHITAKER, Assoc.M.Inst.C.E.

THE demand for wheat and other food grains continues to be greater than the supply, in spite of the fact that two years have elapsed since the armistice and shipping is more plentiful and is no longer threatened or sunk by submarines. The world's requirements in the matter of food are by no means satisfied by the existing sources of supply. Russia was one of the world's largest suppliers of wheat before the war and is now cut off. Roumania formerly exported largely, but cannot now do so. The Argentine Republic, another of the great suppliers of grain, recently prohibited the export of wheat. The United States of America has been for many years the largest and best source of supply of Europe's wheat, but the ability of the United States to export is lessening. In a normal year that country may be expected to consume its own supplies, and even to import a part of the grain crop of Canada. There is now a condition of famine over the greater part of Europe, and over the greater part of China. How to make good the world shortage is a very serious and pressing problem. It is not going to be solved in one year or two years, or even in 10. A large and growing expansion of supplies must be planned for, and the plans must look well ahead, because the world's needs are growing at an ever-increasing rate.



An Argentine Grain Elevator.

Grain, Increased Production and Elevators.

The highest authorities have insisted on two things being necessary for the improvement of trade, and for bringing about a reduction in the cost of living. These are: Increased production; the avoidance of waste. These recommendations, intended to be of general application, are of special appropriateness as applied to grain production.

The writer wishes to point out the use and importance of what has come to be called the "elevator system" in developing and encouraging grain production, and in avoiding waste in connection with the grain trade. The so-called elevator system had its genesis in North America, and although not everywhere in use there in its logical completeness it has been of immense value, and has been a principal cause in making North America the world's greatest and most profitable grain growing region. Grain growing in the older countries has depended on manual labour, and in many instances on the cheap labour of backward peoples. In North America, however, the industry is based on the use of machinery, the workers employed being of good class. Elevators can be regarded as the application of more machinery for the assistance of agriculture. They have an equally important use in the sphere of finance and economics as will be explained presently.

New Sources of Wheat Supply.

The countries of the Southern Hemisphere offer the likeliest fields for raising of the additional grain supplies for which the world is hungering. I refer to the Argentine Republic, Australia and South Africa. Another country from which greatly-increased supplies may be looked is India. Various suggestions could be made for increasing the grain supplies from these countries, such as more and better agricultural machinery, suitable seed, and the application of manures. These suggestions, however, are but of secondary importance, compared with the following: Enable the producer to dispose of his produce easily and without loss immediately it is harvested; give financial assistance to encourage men of small capital to take up the business of grain growing. These latter suggestions indicate the *sine quâ non* of rapid expansion of grain production. The other aids would follow naturally. The handling and marketing of grain in the countries just named is attended with very great loss which almost always falls on the producer. For instance, the average loss in quantity of grain in South Africa has been shown to be as much as 7½ per cent. due to ravages of rats and other forms of wastage. In some seasons this loss increases to 20 per cent. Besides this wastage in quantity there is a deterioration in quality of the remainder, causing the prices realised by the grain to be far less than they ought to be. The farmers of South Africa who send their grain to the ports for sale and shipment report that complaints regarding weight and condition are chronic.

The Features of Elevator System.

What is the elevator system, and how does it work? An elevator is a building where grain is received, weighed, inspected, classified, stored, weighed out and delivered to railway wagons for sending away. The movement of the grain in these buildings is effected entirely by machinery. The form of storage is in what are called in Europe bins or silos. The grain is handled in the mass as a fluid, sacks being dispensed with. It was the American passion for economising manual labour, together with the exceeding cheapness of the material at hand, timber, which led to the building of the first elevators.

The early builders had probably no idea in their minds of any elevator "system," but they "builded better than they knew."

The elevators are placed at frequent intervals along the lines of railway throughout the grain-growing districts of the United States and Canada. There are about 3,000 such elevators in Canada, of an average storage capacity of 1,000 tons. Most of them are owned by traders or trading companies. Some are owned and worked by farmers' Co-operative Societies, and a few by State or Provincial Governments. Having access to one of these elevators a farmer may deposit his grain almost as soon as it is harvested. The grain is weighed in the farmer's presence at the time it is received, and its grade or quality ascertained by a competent expert. The farmer receives a certificate naming the quantity and grade of the grain deposited. He may and usually does sell outright to the owner or lessee of the elevator, or he may choose to remain the owner of the grain. In the latter case he pays the charges for storage and insurance.

Shipment Arrangements.

He cannot, however, expect to have his grain held for long in a country or roadside elevator, especially in the season of active movement of grain following on the harvest. Such elevators must hold themselves ready to receive and pass along a large quantity of grain in one season, many times larger than the actual storage capacity. The grain would as a rule soon be sent along by rail to a terminal elevator at some large commercial centre or at a port. On leaving the elevator where it was first deposited the identity of the grain cannot usually be preserved. The grain becomes mixed with other grain of the same kind and grade. The farmer cannot as a rule receive back the actual parcel of grain which he deposited, but his certificate entitles him to receive after payment of the proper charges grain of the same grade and quantity as that deposited. Having deposited his grain at the elevator and received his certificate the farmer can return home relieved of his load. The load off his mind is the principal thing. One can understand that a few hours may be spent in the little town where the elevator is situated and a very happy dinner enjoyed along with some friends before the journey home is made.

The Benefits of the Elevator to the Farmer.

And now we come to the point where the farmer feels the principal benefit of the elevator system. His grain certificate is a negotiable instrument and he may obtain an advance from a banker, who will accept the deposit of the certificate as security. Such an advance will, if required, be of an amount representing a large percentage of the market value of the grain. If the farmer has sold his grain at once on taking it to the elevator he has certainly secured a better price for it due to the facility with which money can be raised on the certificate, the facility enabling more buyers to enter the market than would otherwise be the case. So that whether the farmer sells his grain at once or whether he continues to own it he secures an immediate financial advantage from the existence of the elevator system. The system renders the business of grain growing possible, easy and profitable, where but for the system it could not be carried on. Men of slender means are enabled to go into the business with confidence and men already in it are encouraged to extend their operations. In this way the elevator system is like an actual implement of agriculture, enjoying with the plough and the seeder the honour of making grain to grow where none grew before.

Materials of Elevator Construction.

In the establishing of grain elevator systems in the new great countries of the Southern Hemisphere consideration has to be given to the special circumstances of each country. For instance, timber structures like those in North America are not practicable in countries where timber is scarce and dear, nor in places inhabited by white ants. Timber as a material of elevator construction in the United States and Canada is now giving place to the cleaner and more fire-resisting materials steel and concrete. It may be taken for granted that these latter materials will be used in elevator construction in the new countries. A special circumstancee in connection with grain growing in the Argentine is that grain growers are somewhat nomadic. They work a certain district for perhaps two, three, or four years and then move on to another district. The first district may then lie fallow for a number of years. Grain elevators where such practice prevails should be capable of removal. The illustration on page 30 shows a small country elevator which was designed for this purpose. It is all of steel and removable except the foundation, which is of concrete. Grain is brought to the elevator in sacks. The sacks are emptied into the hopper *A*. The elevator *B* lifts the grain up to the automatic weigher *C*. After passing the weigher the grain falls by spout to the second elevator *E*, by which it is lifted to the conveyor *F* over the two large cylindrical storage silos. The conveyor *F* feeds the grain into either of the two silos. When it is required to withdraw grain from the silos, slides are opened feeding the bottom conveyor *G*, by which the grain is caused to feed to either of the elevators *B* or *E*. If the grain is merely to be turned over for airing, it goes to the second elevator *E* and so back into a silo. If it is to be sent away it goes to the first elevator *B*, then through the weigher into the sending-away hopper *D*. This hopper holds 10 tons of grain, and 10 tons of grain can be run from it in a few moments into a railway truck. This elevator is an example of a country elevator reduced to its simplest possible terms. Various extra facilities easily suggest themselves, such as the provision of a greater number of storage silos so as to provide for storing more varieties of grain. The establishment of a complete elevator " system " implies the provision, besides country elevators, of port or terminal elevators and of suitable and sufficient railway trucks for the carriage of grain under seal.

A discussion of these features of the " system " cannot be entered upon in a short article like the present, nor do they call for consideration in connection with the subject as far as the writer has attempted to present it on this occasion.

The Blaisdell Distributor
and
A Conveyor Applied to Storage Problems.

By W. A. HARRIS.

THE questions of handling and storing materials in bulk, under present conditions of cost of labour and space, call for particular care in the planning of installations for the bagging-off, direct utilisation or shipment of various commodities. It should be unnecessary, at this juncture, to emphasise the desirability of substituting mechanical handling for manual labour, primarily because the former is more conveniently varied in its application both as regards capacity in a given time and suitability to height or distance of movement and secondarily because it is low in upkeep cost, regular in operation and reliable when reasonably supervised. But it is possible that the value of space when expressed as ground area multiplied by height and equalling storage capacity, is not given the consideration it deserves.

The Wastage of Top Space.

In the average storage installation, fed by cranes or railway wagons to elevators and overhead distributing conveyors, it is noticeable that a considerable proportion of the storage space at the top of bunkers is wasted, due to the conveyors discharging on a central " line " or a series of " lines " and that the materials so discharged are allowed to flow on a natural slope which runs down and towards the bunker sides. Several feet of structural height and corresponding storage are consequently lost by such methods of distribution, averaging, say, 5 per cent. or in extreme cases, 10 per cent., of the estimated capital cost and capacity ; or, in other words, the same percentage value of property and rental. Broadly expressed this loss of space due to unequal distribution of stored materials means that the planning engineer must either arrange for 21 or 22 bunkers, where 20 of equal height, if filled, would suffice, or he must put more weight on the foundations by increasing the height of the structures sufficiently to obtain the desired capacity. In congested areas and on loose or swampy ground where every square foot of floor space and ton weight on foundations are relatively expensive items, the above considerations are of more than ordinary importance. The writer proposes to show how floor space and height of structures may be economised.

The Distributor in South African Goldfields.

The Blaisdell Distributor is illustrated by Figs. 1 and 4, from photographs taken during its construction at Erith, and was first applied to filling batteries of circular "leaching" tanks with crushed ore for the South African goldfields. These tanks were suitably spaced and arranged in pairs. The construction and operation are readily understood from the following description and by reference to the illustrations.

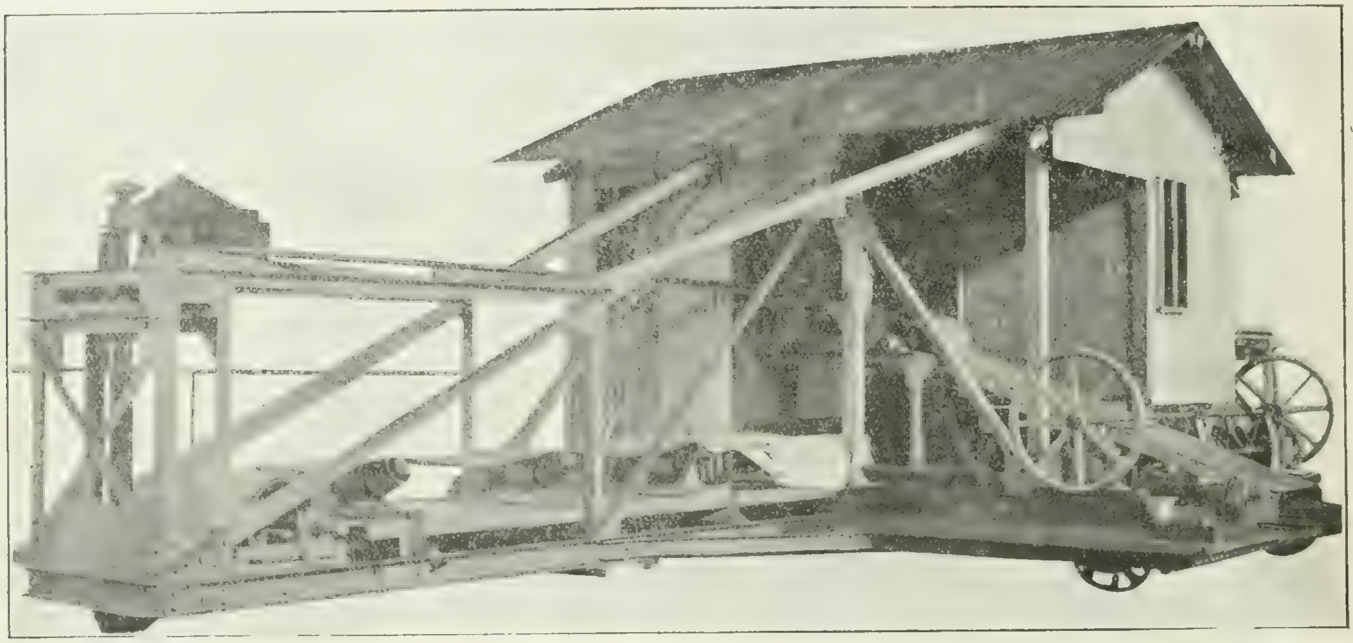
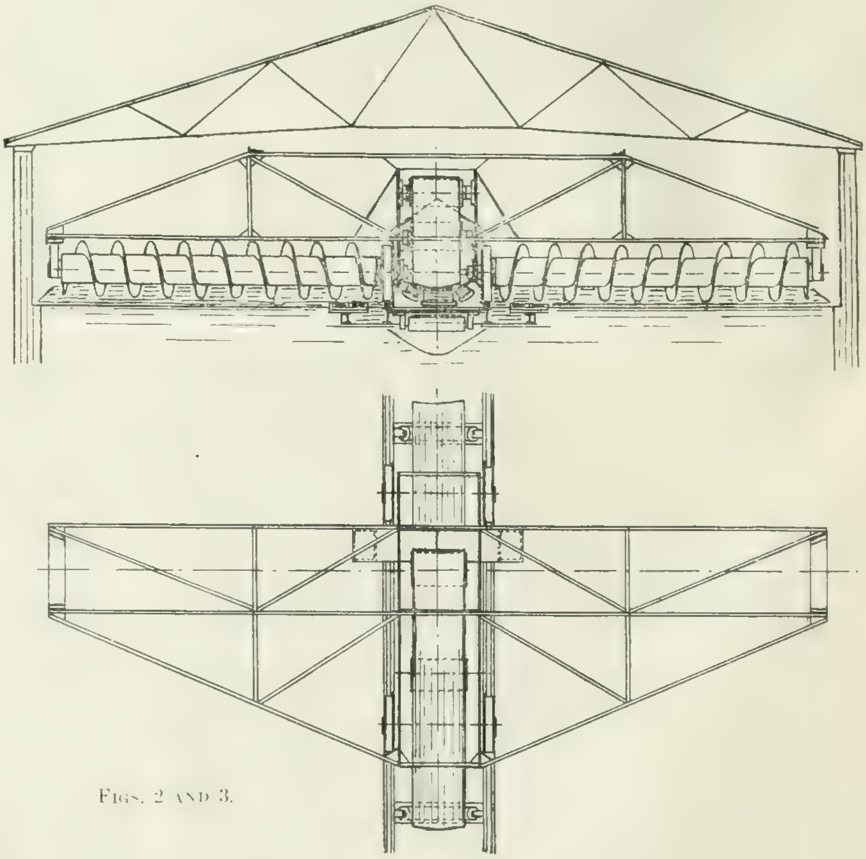


Fig. 1 General View of Blaisdell Distributor.

The apparatus comprises a bridge structure, travelling on overhead rails which are supported by the tanks, and are arranged for moving by hand or mechanically from point to point, corresponding with a central discharge to each pair of tanks. The bridge structure carries deflecting pulleys and acts as an automatic "throw-off" or "tripper" for the crushed ore which is carried to it by a belt conveyor extending lengthwise over the tank battery installation. The bridge structure also supports a cross conveyor which catches the ore as it is thrown off by the lengthwise conveyor and carries it to either distributing head which is situated centrally above one of the tanks. The direction of travel of the cross conveyor can be reversed, so as to feed alternately the corresponding tank of each pair; or it may be in two lengths and feed both tanks simultaneously.

The crushed ore falls on to a revolving plate arranged for variable speed driving, at the distributing heads, which evenly distributes or spreads the ore in the tank. Wind shields are provided around each revolving plate so as to maintain reasonable conditions for accurate spreading in variable weather. These machines will work "out of doors," and, it is understood, have met with considerable success for the purpose described.

The elaborate form of "tripper" described above, though comparatively expensive, was justified by the rate of operation and the extent of the ground area covered by the tank installations, which conditions are peculiar to the method of ore treatment mentioned. A much simpler form is, however, suitable for the average conditions obtaining in connection with a battery of bunkers each of which is rectangular or square in horizontal section as is usual where storage is the chief consideration.



Figs. 2 and 3.

A Simple "Tripper."

Fig. 5 illustrates a type of "Robins" tripper in which the lengthwise travelling conveyor belt is raised and deflected round pulleys so as to discharge into distributing chutes in front (when necessary for feeding other trippers) and to either side or to both sides, as required. This tripper is gripped or

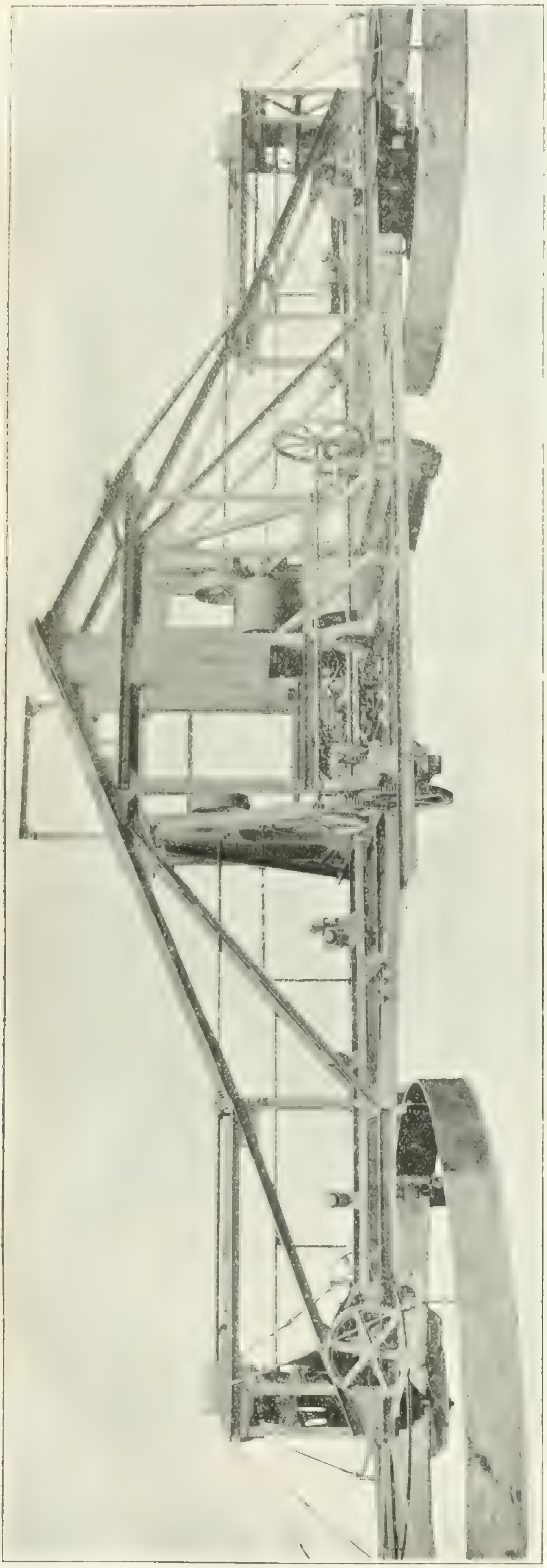


FIG. 4.—ANOTHER VIEW OF BLAISDELL DISTRIBUTOR.

braked on the supporting rails when required to be stationary for a period or moved slowly in either direction along the conveyor path either by hand-driven gearing or by power, automatic, obtained from the travelling conveyor belt.

ANOTHER DESIGN OF TRIPPER.

A modified form of tripper combining some of the features of both the "Robins" and the "Blaisdell" types is diagrammatically illustrated in Figs. 2 and 3. In this design two crosswise worm conveyors having right and left-hand spirals respectively are substituted for the cross-belt conveyor, the distributing heads being eliminated and the bridge structure correspondingly simplified. These worm conveyors only come into operation when the bunkers are nearly full (directly underneath the lengthwise conveyor) and assist the discharged material to slide towards the bunker sides.

It will be appreciated that as the bunkers fill up the resistance of the materials against the worm conveyors will sensibly increase and will tend to push the tripper automatically along the feed conveyor path, thereby obviating continuous watching or adjustment by the attendant. As the worm conveyors are carried at a suitable height to clear the cross walls, or partitions, of the storage bunkers, it follows that they will not become submerged in the mass of materials being distributed and will constitute, together with the lengthwise conveyor belt, a horizontal distributing system of minimum power requirement.

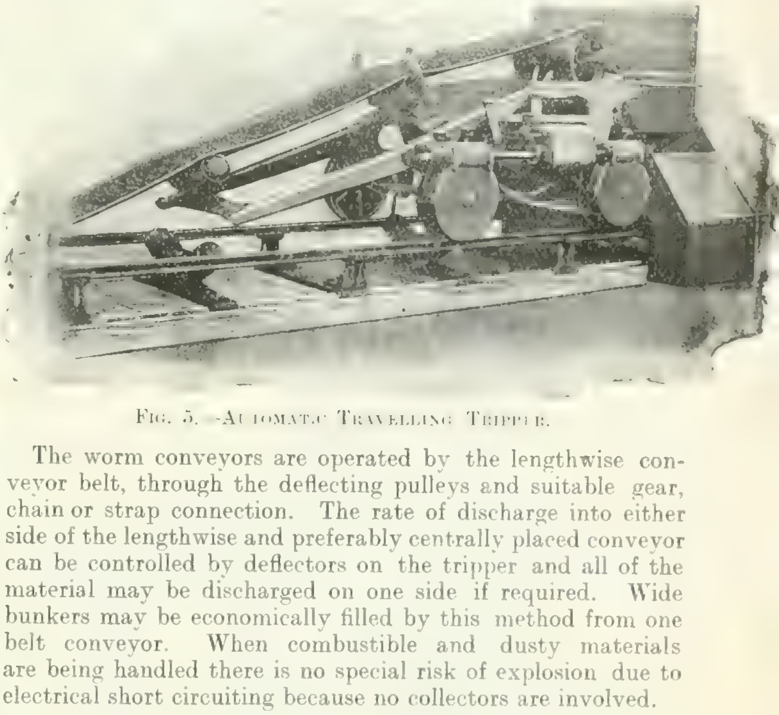


FIG. 5.—AUTOMATIC TRAVELLING TRIPPER.

The worm conveyors are operated by the lengthwise conveyor belt, through the deflecting pulleys and suitable gear, chain or strap connection. The rate of discharge into either side of the lengthwise and preferably centrally placed conveyor can be controlled by deflectors on the tripper and all of the material may be discharged on one side if required. Wide bunkers may be economically filled by this method from one belt conveyor. When combustible and dusty materials are being handled there is no special risk of explosion due to electrical short circuiting because no collectors are involved.

DISTANT CONTROL.

The tripping apparatus and the conveyor can be arranged for distant drive or feed control and an ordinary insulated bell signalling or telephone wiring system installed for the attendants at the feed and discharge ends of such a combination to communicate with one another. For an electrically-driven installation, with a practically constant feed to a large intermediate bunker it would be possible to arrange for the attendant at the top of the storage bunkers to operate the feed to and working of the elevating and conveying installation by means of push-button controlled mechanisms.

Similarly and in connection with coal-handling to a central power station, an intermediate low level bunker of large capacity, intermittently fed, could be arranged for so as to accommodate the coal supply during "peak" load periods and assist in keeping down the power demand on the station. Incidentally by providing immediate accommodation for the incoming supply, transport to the station is facilitated.

The writer is indebted to the Fraser & Chalmers Engineering Works (The General Electric Company, Ltd.), London, E.C., for the information on which the illustrations are based.

Modern Ropeway Transport.

By RICHARD KENDALL, A.M.Inst.C.E.
(Engineer of Ropeways, Ltd.)

ONE evil resulting from the war is the present famine in unskilled labour, its reduction in efficiency and its abnormal rise in cost. This result has awakened keen interest in the employment of conveying machinery, whose end is a reduction in labour costs, together with an increased convenience in working.

The aerial ropeway is amongst the most valuable of these machines (to those interested in the economical transportation of material). Taking unskilled labour alone into account, it has been estimated that if two labourers (each costing £200 a year) are employed on work for which a ropeway is suitable, and one man is dispensed with, a line could be economically installed, whose capital value erected does not exceed £1,000. The working costs on such an installation, conveying about 5 tons per hour (excluding the necessary attendant, but including all other standing and running costs), should not be more than £175 to £200 a year.

Modern Ropeway Systems.

Aerial ropeways are plants for carrying goods, materials or passengers on overhead tracks (formed of steel wire ropes), supported above ground level on trestles, spaced at convenient distances apart. There are two main systems of aerial ropeways: I. The continuous system; II., the intermittent system.

These two systems can be arranged as under:—

Aerial ropeways.

- (I.) Continuous.
  - Bicable.
    - Undertype grip.
    - Overtype grip.
  - Monocable.
    - Hallidee or fixed clip type.
    - Roe or boxhead type.
- (II.) Intermittent.
  - To and fro.
    - Single endless monocable 1 or 2 carriers.
    - Double track 2 carriers.
    - Single track 1 carrier.
  - Inclined Shoots.

In both systems the ropes forming the overhead track are supported above ground level by trestles placed at a convenient distance apart.

The Continuous System.

This system was invented by Adam Wybe in 1644, and was first used on a practical scale by Charles Hodgson in 1867. In this system (*see* Figs. 1 to 4) the endless traction rope is kept in constant motion in one direction by the application of power in a terminal. The twin ropes are laid at a fixed gauge, one side forming the outward track for the loaded cars, the parallel cable being used as the return track for the empty cars. On the track, the trestles support sheaves of large diameter, on which the traction rope runs; and in the end stations the traction rope passes round horizontal sheaves, one connected with the motive power, the other to a tension arrangement which maintains a uniform tension on the rope.

Excluding the Hallidee variant, the tracks are connected in the end stations by shunt rails (Fig. 3), on which the loaded cars pass to the empty track and vice-versa. The carriers containing the loads are automatically connected to and disconnected from the constantly moving rope in the end stations, and travel along the track at predetermined space and time intervals.

The Bicable Type.

In the Bicable type (Figs. 1 and 2) the carriers are fitted with wheeled carriages, which run on fixed rail cables, and are hauled along by a separate light endless traction rope (Fig. 2).

The Monocable Type.

In the monocable type (*see* Figs. 3, 4 and 5) a combined endless carrying and running rope of moderate size is employed, both to support and haul along the carriers suspended therefrom. The Hallidee system (Fig. 5), introduced by A. S. Hallidee in 1871, is a variation on the monocable type, in that the carriers are permanently attached to the rope and pass round the terminal sheaves without being disconnected.

Intermittent System.

In 1411 a certain Johann Hartlieb described a ropeway on the intermittent system, this being the first written description of a ropeway. In the jig-back, or to-and-fro type, the carriers are permanently attached to the traction rope, are not disconnected therefrom, and do not pass round the terminals; but are brought to rest alternately at opposite ends of the line for unloading and loading purposes. The direction of travel of the traction rope is reversed after every journey.

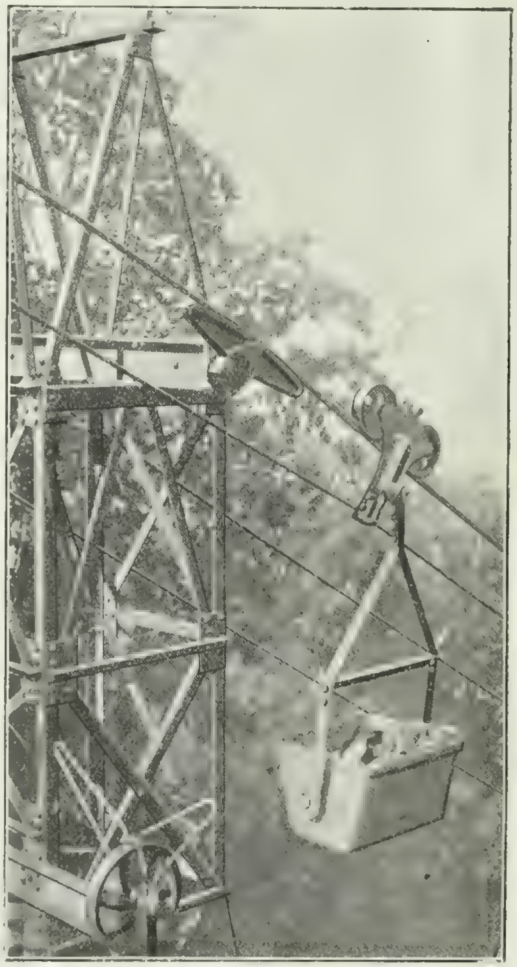


Fig. 1. Line Constructed for the Bengal Iron and Steel Co.

Inclined Shoots.

This type, invented by Pradi in 1857, is in use abroad in timber districts. A fixed rail cable is anchored at the top, and tensioned at the bottom terminal, and down which rope carriers run by gravity, uncontrolled from a traction rope.

The Choice and Application of Systems.

As regards the choice and application of systems, it is advisable to consult firms specialising in this branch, who will investigate closely all local conditions affecting the design, before coming to a decision on the best system and type to employ. Each type has its special field of application, and its advantages and disadvantages for any specific scheme. No hard and fast rules can be laid down, therefore; but it is possible to indicate roughly several of the conditions determining the choice of system and type.

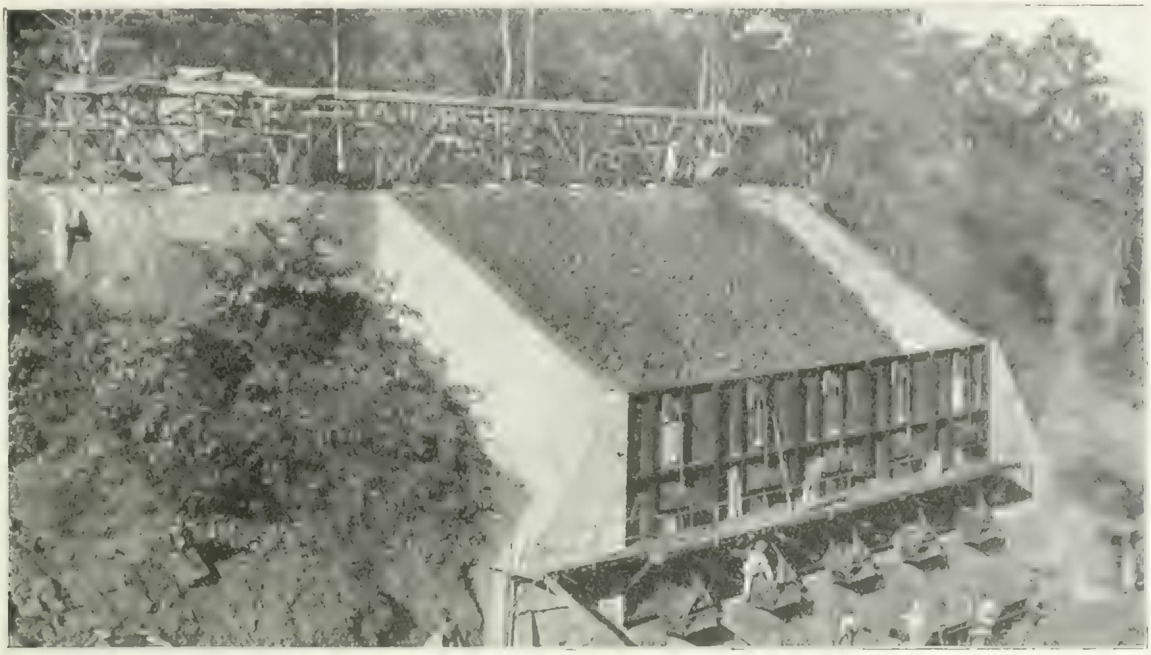


Fig. 2. Unloading Arrangements on Ropeway Constructed for the Bengal Iron Company for the Handling of 40 tons per Hour.

The choice of system, continuous or intermittent, depends on (*a*) the length of line between end stations; (*b*) the capacity of plant in tons per hour; (*c*) the individual weight of the load; (*d*) the terminal requirements; and (*e*) the capital available for investment in plant.

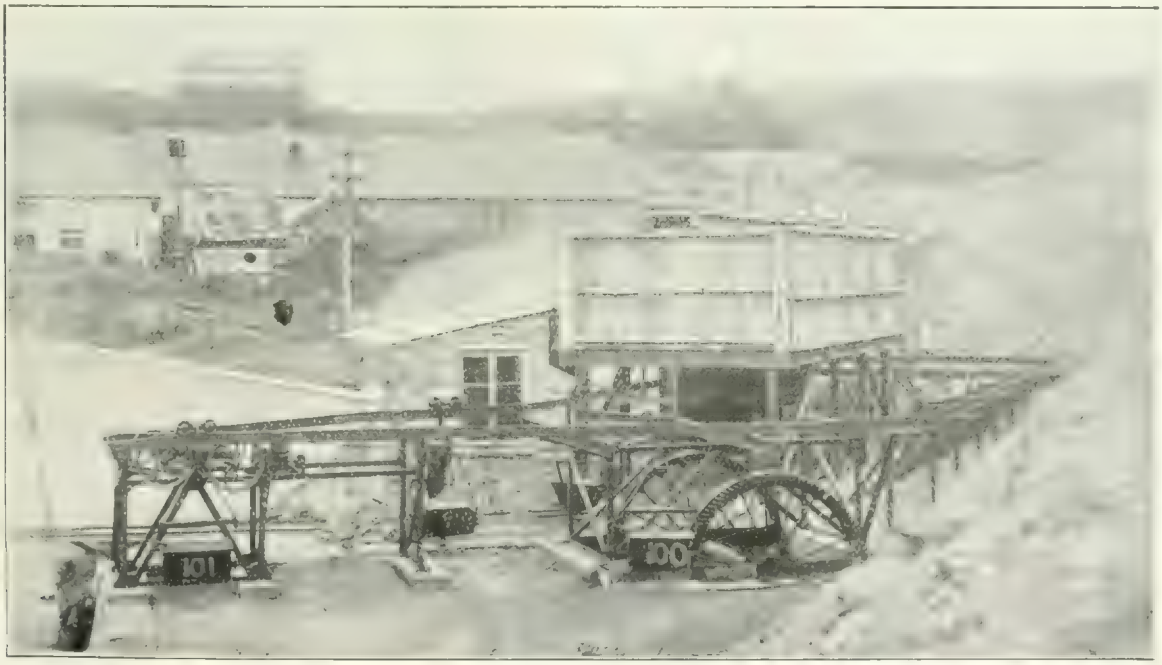


Fig. 3. Loading Station at Shropshire Mines, Minsterley.

The choice of type depends on the above, and also on the following additional conditions: (*f*) The nature of the material to be carried; (*g*) the character of the country crossed by the line; (*h*) whether angle stations are required; (*j*) the gradient on line; and (*k*) the working costs on type chosen.

Excluding the Hallidee variant, continuous ropeways can be built of any length and for almost any capacity. Practically any class of material can be conveyed, with individual weights up to 2 tons and over. Any kind of country can be crossed, with gradients on line up to 1 : 1; and automatic angle stations and end returns and even slight curves (Fig. 4) on the line can be arranged. The terminals can be adapted to meet local conditions exactly.

Generally, of the two types (bicable and monocable) included in this system, and under equal working conditions, the monocable (if properly designed) is to be preferred. The capital cost of this type is less, and therefore the working costs are lower; it is simpler in design, and therefore easier to erect and maintain. In some cases, few and far between, a bicable is to be preferred on account of technical difficulties; chiefly where very steep gradients are combined with a very heavy hourly capacity.

The Hallidee Ropeway.

The Hallidee Ropeway can be built of any length; but where intermediate stations are required, the loads must be transferred by hand, or other means, from one line section to the next. Further, it is adaptable for small individual loads up to 2 cwt. only; and as the loading of carriers is usually effected by hand while these are in motion, the velocity of the rope does not exceed 2½ miles per hour; the resultant hourly capacity being rarely more than 8 to 10 tons. Any line gradient can be taken with safety; automatic angle stations can be arranged for; and the loads can be discharged automatically at the end unloading station.

The capital and working costs on this type are very low. These fixed clip lines are extensively employed on plantation work in Ceylon, Sumatra, &c., and for the transport of valuable ores.

The Intermittent System.

The intermittent system is limited in its application, and is principally employed when it is required to transport heavy individual loads in relation to the capacity, over short distances. It is also employed where small quantities of material are transported daily over short distances. In this latter case, it is often preferable to install a light monocable with detachable carriers. Shoots are used to a limited extent in the timber trade abroad, but are being replaced gradually by the to-and-fro type, with a single fixed track and one carrier.

Modern Installations.

The plant shown in Figs. 1 and 2 is a typical modern installation. It is on the bicable system, and was built to the order of Messrs. The Bengal Iron & Steel Company, by Messrs. Ropeways, Ltd. It is designed to carry iron-ore from the Manharpur mines to an unloading station situated on a branch railway. Although the line is of no great length it is interesting from the fact that for its whole length it runs down a very steep grade—nearly 900 ft. in 2,900 ft., or a mean grade of 1 : 3·2. The line works by gravity, and surplus power is generated, which is absorbed by a fan brake.

The brake and speed-regulating arrangements are arranged at the loading terminal, the brake being of the ordinary heavy-pattern band type, whilst the speed is regulated by means of a fan enclosed in a casing. When regulating the speed of the ropeway, the resistance of the fan is altered, by opening or closing an aperture. This station is built on sidelong ground, and bunkers of 150 tons' capacity are built on one side of the station, and arranged for feeding the ropeway buckets through mechanically operated chutes. The tension gear for the rail cables and the hauling rope is arranged at the lower terminal. The incoming loaded carriers discharge their contents into bunkers holding about 1,000 tons; and from these bunkers (built on one side of station) the material is loaded through chutes into railway wagons on the siding. The line is worked by native labour throughout, about four coolies being required at either terminal.

Another modern installation is shown in Figs. 3 and 4. It is built on Roe's monocable system for Messrs. The Shropshire Mines, Ltd., and is used for carrying lead-ore, barytes, and roadstone from the mines in the Shropshire hills to a siding on the Minsterley-Shrewsbury branch railway. The loading arrangements are shown in Fig. 3. The minerals are brought from the mine or quarry in mining wagons running on a narrow-gauge line, and their contents tipped into a wooden hopper, from which the ropeway cars are loaded. On arrival at the unloading station the contents of the carriers are tipped into a steel bunker, from which the railway wagons are loaded.

The chief features of interest about the line are: First, its total length, about 6 miles, which makes it the longest line yet erected in Great Britain. Secondly, a portion of the line is laid on a curve embracing a total angle of about 7 deg., which normally would have meant the introduction of an expensive angle station. This angling on trestles is shown clearly in Fig. 4, and is made possible by the use of Roe's patent self-aligning mount beams (*A*) (Patent 128650, of 1917) which enables angles up to 2 deg. to be taken on each trestle, with a total maximum angle of about 20 deg. (which would normally be distributed over about 10 trestles).

In this invention the beams used for supporting the sheaves, on which the rope runs, are pivoted on hangers suspended from the trestle cross-tree, and arranged to swing freely in any direction on a universal joint. The sheaves supporting the rope automatically adjust themselves to take up the pull due to the small horizontal change in direction of the rope. For small angles these mounts are quite as efficient as angle stations, and, of course, their cost is much less.

Fig. 5 shows a line built by Messrs. Ropeways, Ltd., for Messrs. Avelino Aramayo & Company, Tasna, Bolivia. This is a typical example of a modern line on the fixed clip system, and is used for transporting tin ore from the mines to a mill, about a mile distant. Tin ore brought from the mine (in mine wagons running on a narrow gauge track) is emptied into the steel hopper shown in Fig. 5, from whence it is fed through chutes into the ropeway buckets. At the lower unloading station at the mill, the buckets tip automatically into hoppers, from which the material is taken as required. A uniform tension is maintained in the rope by means of the tension arrangement shown on Fig. 5; any slack in the rope being automatically taken up by the sliding terminal sheave in the loading station.

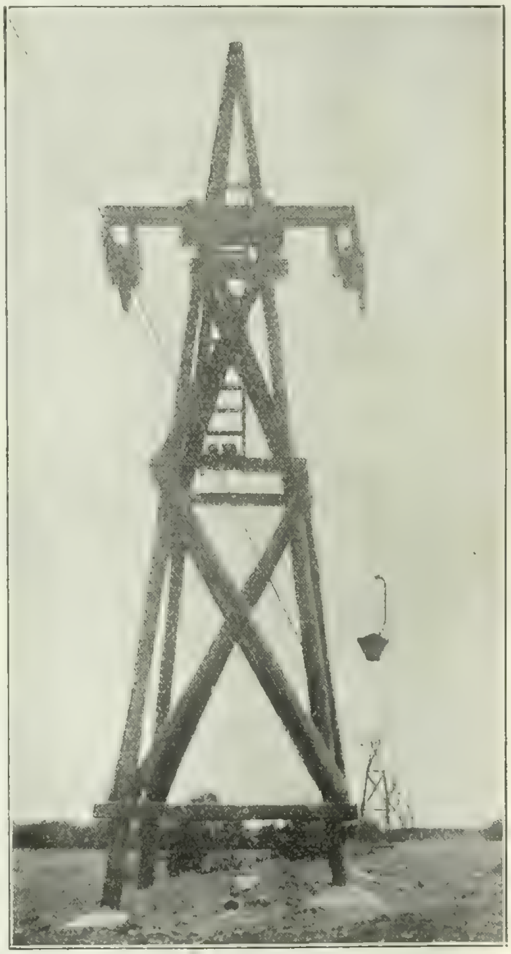


Fig. 4.—View showing Curve on Ropeway Constructed for the Shropshire Mines, Ltd., Minsterly, Shropshire.

A Modern "To and Fro" Line.

Fig. 6 illustrates a "to and fro" line, built to the order of Messrs. Joseph Sankey & Sons, Manor Hall Iron Works, Bilston, by Messrs. Ropeways, Ltd. The line consists of two tracks (each of equal diameter) and two carriers (travelling in reverse directions). Ashes collected from all parts of the works are emptied into the boot of an elevator, which discharges into an elevated bunker, arranged for feeding through chutes into either of the two ropeway buckets employed. By means of an adjustable tipping gear the buckets can discharge their contents automatically at any part of the line between the trestles.

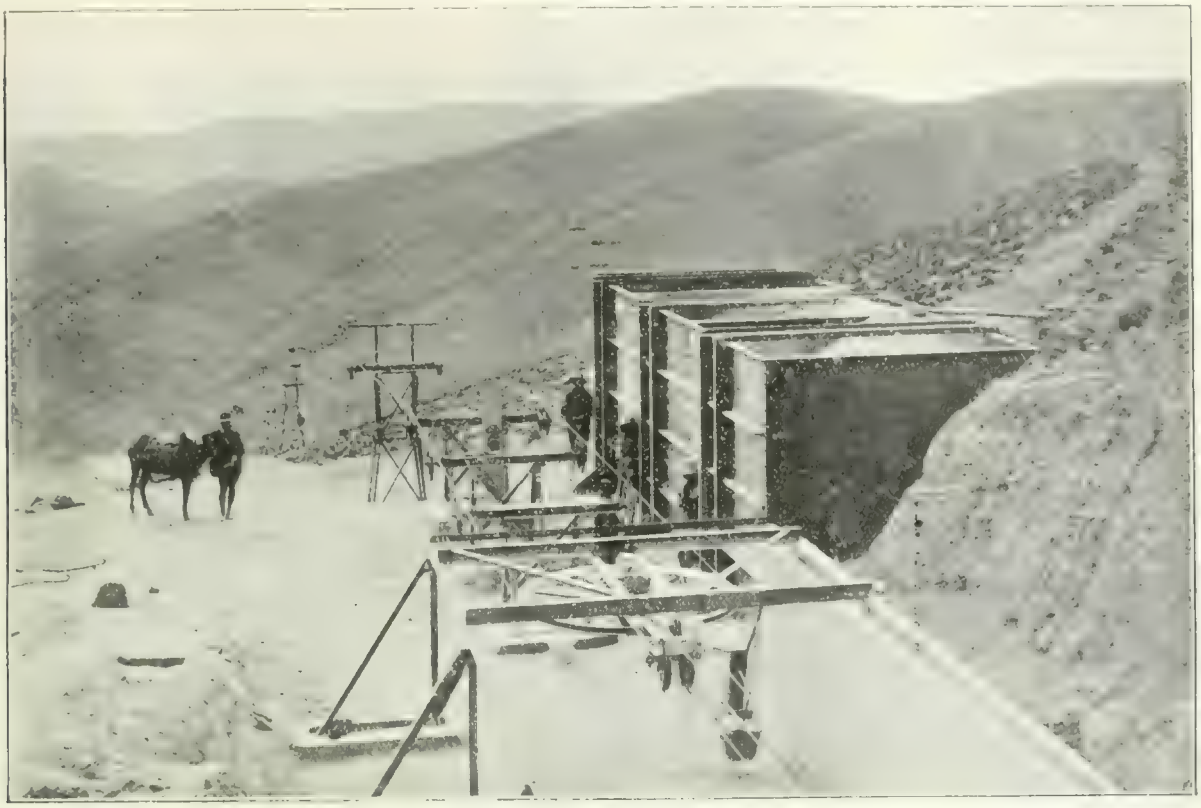


Fig. 5.—View of Line Constructed for Messrs Avelino Aramayo and Company, Bolivia.

The most interesting feature on this line is that, so far as is known, it is the only line in England operated solely by woman labour, one girl only being employed. This improvement can be applied to both the monocable and bicable systems ; and is not limited to the normal standard form of U shaped terminal, as a terminal having an irregular path for its shunt rail can also be made automatic. The invention consists in the replacement of the usual standard fixed rail, by a slowly moving flexible shunt rail, consisting of a number of castings in halves, these latter bolted to a flexible endless wire rope in constant motion, driven from the ropeway sheave. Bottom and side rollers guide the rail in its allotted path. On arrival in the station the carriers travel along the flexible shunt rail, until their momentum is expended, when they come to rest relative to the rail, and are carried along by same at about half their former velocity. At the station exit the flexible rail is graded, down which the carriers run, thus allowing of an acceleration in their velocity, sufficient to ensure their taking on to the main ropeway traction rope without shock.

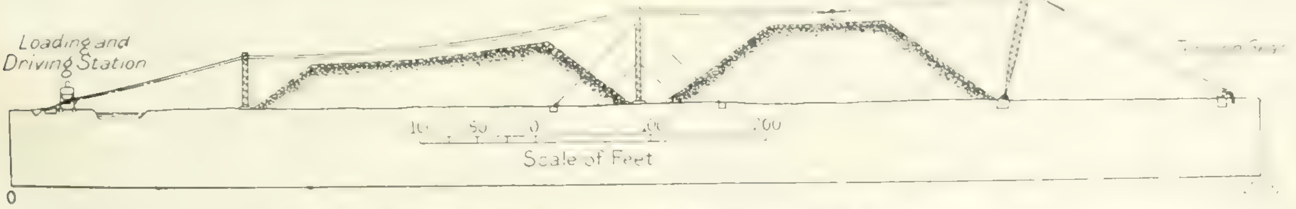


Fig. 6. -Profile of Ropeway for Messrs. J. Sankey & Sons, Ltd.

An arrangement has been patented, by which tipping can be effected at any desired point in the span between trestles ; the actual tipping point being adjustable at will from ground level. This improvement is employed in the formation of dumps by monocable ropeways.

A new boxhead clip for use on monocable lines has been introduced ; the clips are actuated by the weight of the carrier and load, and can take safely gradients up to 36 degs.

New patent depression mounts are now being used, for holding down the rope on monocable lines, and thus enabling long hollows to be worked safely by eliminating the possibility of the rope floating out of sheaves, when using trestles of moderate height in place of very tall ones.

The above inventions have strengthened the British monocable system considerably ; and, together with former inventions now too numerous to mention in detail, have made this system, not only the equal but the superior of the bicable system (invented by Charles Hodgson, but developed by the Italians and Germans).

Working Costs.

The main object of modern ropeways is to effect reductions in working costs. The following example (taken from the writer's experience), will prove that considerable savings are effected by the installation of modern plants.

A certain ropeway is used for carrying minerals from a mine to the railway, some miles distant, and also for carrying fuel from the railway to the mines. Prior to the installation of the ropeway the haulage of the material was let by contract, 4 carts (each drawn by a team of three horses) and four drivers being employed. These carts brought the material down rough country roads from the mines to an intermediate point on the main road; where the material was transhipped into motor-tractors (two tractors and two drivers), and taken to the railway siding. The cost of transportation, including loading and unloading of carts and tractors, and upkeep of roads, amounted to £4,300 on a yearly capacity of 4,400 tons (or a rate of 19s. 6d. a ton). The ropeway is designed for a capacity of 43,000 tons per annum, and cost erected about £20,000. Including all standing and running charges, the present cost per ton carried on the ropeway amounts to about 2s. Due to the introduction of the ropeway, therefore, the output of the mines has been increased tenfold, and the cost of transport reduced from 19s. 6d. to 2s. a ton. If it were possible to have carried 43,000 tons per year, by an extension of the pre-ropeway method of transport, then the use of the ropeway would have saved the company over £37,000 a year; or, in one year, almost double the capital cost of the new plant.

The illustrations in this paper are of lines designed and erected by Messrs. Ropeways, Ltd., to whose courtesy the writer is indebted for part of the preceding information, especially that relating to monocables.

Standard A.C. Geared Winding Equipments.

By CHAS. E. RAEBURN.

THE electrical handling of coal is of special interest at the present period of increased production, and the winding engine by means of which the coal is brought to the surface, and man and material raised and lowered, is perhaps the most important link in the chain of mechanically-operated appliance utilised between the face and the railway transport wagon. Many considerations must be taken into account when designing an efficient winder for a particular output from a given pit, but apart from this it is always desirable to standardise on winder equipments to as great an extent as possible. The two electric winding equipments referred to, and illustrated in this article, may be taken as applications of standard equipments to two typical shafts. These standard equipments differ from each other in respect of one being fitted with a liquid controller and oil-type reversing switches, and the other with contactor rotor and stator switches. The former is installed at Messrs. Bell Bros., Kilton Collieries, and deals with ordinary coal winding, and the latter deals mainly with man winding at Priestman Collieries, Axwell Park Pit.

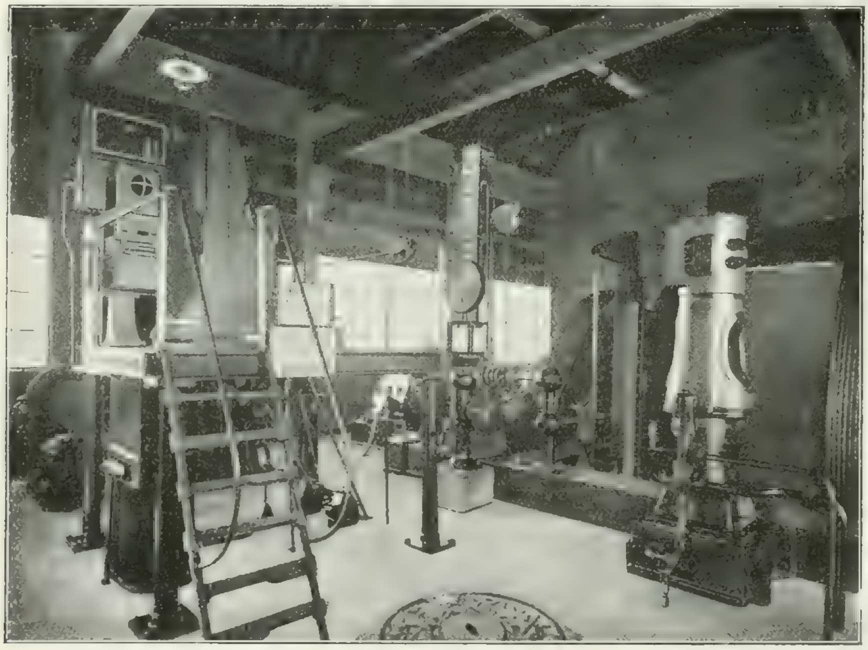


Fig. 1.—Driver's Platform for Control of 370 h.p. Three-phase 40 periods 255 revs. per min. 2,750-volt Metropolitan-Vickers Induction Winder Motor at Messrs. Bell Bros., Kilton Colliery.

Some Details of Satisfactory Winding Design.

In fitting the motor to such machinery care should be always taken that the torque to be dealt with when fitting new ropes or when recapping the ropes is well within the maximum torque of the motor. This means that the machine must be capable of dealing easily with unbalanced loads equal to one cage plus one rope. It will be found as a rule that all conditions will be met if the motor is called for as being capable of developing 2½ times full-load torque momentarily and occasionally

Ease of operation of liquid controllers is to be aimed at, and this means that the operating force should be well within that of the driver's arm muscles when seated, and, at the same time, that this force should not materially vary over the whole range of the movement of the operating lever whilst the variation of the rotor speed is being dealt with. The connecting rods and levers between the controller and the operating lever should be as few in number as possible, in order to avoid a multiplicity of moving joints and their consequent friction. Controllers split up into several units, each having a special function to perform, are to be avoided as introducing a large number of friction-producing connections. In the case of a contactor controller being fitted, as on the second winder here illustrated, a sufficient number of resistance steps, and contactors for same, should be fitted in the rotor circuit, in order that acceleration should be as even as is practicable, and rope swing avoided. On large power winders the number of steps should not be less than nine, or, better, twelve, the last three steps having automatic accelerating relays connected so as to be out with the driver's control.

Safety Devices.

It is not advisable to hang a large number of safety devices on to a winder, but an overspeed device is almost a necessity, and if of a type which will compel the driver to follow a definite cycle of operations, it is a very desirable piece of apparatus. The Mines Act calls for "an effective automatic contrivance to prevent overwinding," and it will be apparent that the use of an overspeed device will best meet the spirit of the Act, although it is not absolutely compulsory.

Gearing should be of the double helical type, and the spur wheel should be split so as to facilitate the easy assembling and dismantling of the equipment. The pinion shaft should be supported on two pedestal bearings, and be connected to motor shaft by means of some type of shock-absorbing coupling. The extending of the motor shaft, and the fitting of the pinion to same, between the motor bearing and an outer bearing is to be avoided, as forming a combination which gives rise to excessive wear on the gearing and damage to the motor windings, besides producing a maximum of noise. The enclosing gear case should be dust tight, free from oil leakage, and so arranged that the spur wheel dips into the oil, and, on large powered equipments, the oil should be sprayed between the teeth on both entering and leaving sides.

The height of the driver's platform from the floor of the engine house should be ample, so as to give the driver a fair view of all apparatus in connection with the winder contained within the house. On the Continent, and in some cases in this country, insufficient attention has been paid to this feature, with the result that in many instances the driver simply stands on the floor, and in consequence his view of the winder is very much restricted.

The lay out of a winder should be on as generous a scale as possible, in order that ample passage ways round about all apparatus is secured. All rods and levers, also all cables, where they would cross the floor or passage ways should be run beneath the floor level, and the apertures in the floor should be case with wood or steel flush with the concrete.

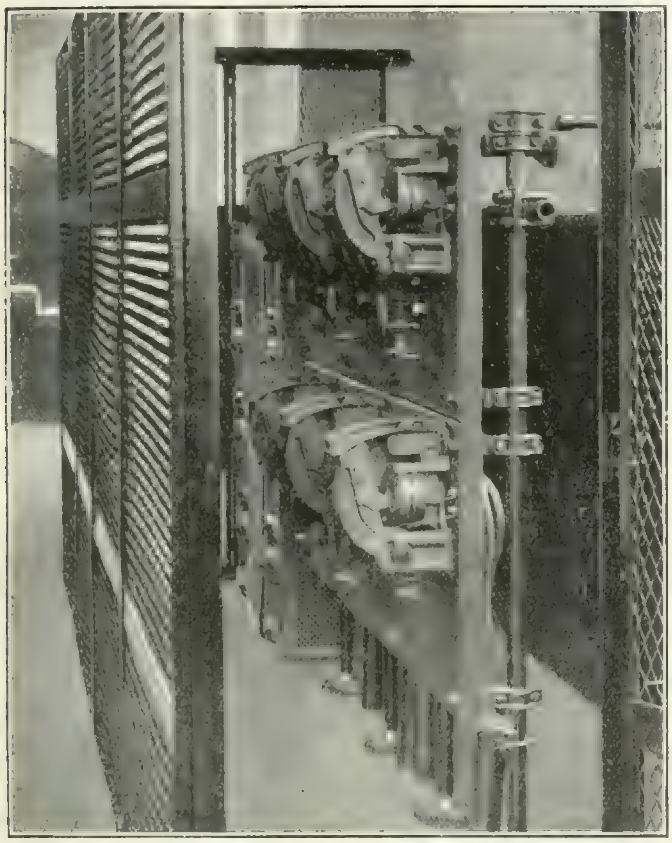


Fig. 2.- Type S Switch Pillar, Brake Engine and Drum for Three-phase 40 periods 500-volt 390 revs. per min. 100-150 h.p. Motor-driven 7ft. 5ft. Cylindrical Drum Winder at Messrs. Priestman's Anwell Park Colliery.

The rods levers. and cables will thus be safe from injury, whilst they will be quite accessible from the basement, being hung from the ceiling of same. The winders described were installed by the Metropolitan-Vickers Electrical Company, Ltd., Manchester.

Electrical Engineers' Ball.

It has been decided to revive the series of Balls, which were held with great success for eleven years before the war. A general committee of 65 members, representative of the various branches of the electrical industry, has been formed in order to make arrangements for the next ball, which is to take place at the Hotel Cecil on Friday, February 4, 1921. Those who take part in the organisation of the arrangements do so with the idea of providing an evening's enjoyment of such a class and character as is afforded by no other fixture of the season, and in this they have hitherto always been successful.

The members of the Executive Committee are O. H. Baldwin, E. J. Fox, C. W. Hill, J. E. Kingsbury, Capt. W. S. Lonsdale, P. V. McMahon, A. M. Sillar and C. H. Wordingham, C.B.E. The hon. secretaries are C. W. Hill and A. M. Sillar, 56, Victoria-street, London S.W. 1, and the hon. treasurer is J. E. Kingsbury

Telephone Charges.

The Report of the Select Committee on Telephone Charges has been issued. As the report of the Departmental Committee of the Postmaster General (dated June 30, 1920) formed the basis of the inquiry, the Committee were precluded from inquiry into the efficiency of the telephone service, but the users' point of view was put before them by several representative bodies.

After a brief history of the telephone service from 1880, the Report gives particulars of the existing tariffs and of the finance of the telephone system. Prior to the war the telephone service showed a fair margin of profit, which the rates then existing would have been sufficient to maintain if conditions had remained unchanged and the system had developed on normal lines. But from 1914-15 onwards the effect of the war became more pronounced each year. By 1918-19 the war bonus granted to the staff had reached £1,200,000, and the charge for the civil pay of men released for military service had risen to £364,000. The revenue from the public, which should have shown a progressive expansion as the result of the large expenditure on development between 1913 and 1915, remained stationary, and would, in fact, have decreased if it had not been for the additional charges imposed in 1915-16. On the other hand, the stagnation was masked by the credits derived from the extensive use of the telephone system by Government departments during the war. These credits rose from £65,000 in 1913-14 to approximately £1,400,000 in 1918-19. The figures of the estimated revenue and expenditure show a deficit of £3,980,000 in 1920-21. A pre-war surplus of between £200,000 and £300,000 is thus converted into an estimated deficit of £3,980,000 in 1920-21, and the gradual introduction of an increasing proportion of plant purchased at present prices will tend to swell this deficit year by year.

Recommendations.

After an analysis of the existing rates and of the tariffs suggested by the Departmental Committee, the Select Committee report that they consider, from the evidence which was given, that in many instances there is undoubted ground for complaint on the question of efficiency. Considerable sections of the public are convinced that Government ownership of itself produces a sort of inertia fatal to any service which is dependent for its success on initiative and enterprise, but in the case of the telephone service it should be remembered that the Department has scarcely had a fair chance, seeing that war broke out two and a half years after the transfer, and that since 1914 circumstances have, to say the least of it, been unfavourable to development. They recommend that Advisory Committees should be set up in all suitable areas and that subscribers should be invited to make complaints to them instead of direct to the Post Office. The Committee regard research as essential to a service involving so much technical work, and recommend a considerable extension of the Research Department, the expenditure on which is at present comparatively small.

Rates.

With regard to the flat rate the Committee, while they are quite aware that large subscribers must receive full consideration, are of opinion that there can be no reason why the State should supply them with services considerably under cost price. After careful consideration of the evidence given on this matter, the Committee have come to the conclusion that no adjustment of the flat rate would meet the case, and they recommend its discontinuance; they also recommend the discontinuance of the measured service rate.

They find themselves in agreement with the Post Office in recommending the message rate as the only equitable system of payment for service rendered, and they are mainly influenced by the following considerations :—(1) The fact that as regards business houses the telephone is essential to the conduct of their business should not be regarded as a reason for allowing them to continue on the flat rate system; (2) under the message rate system there will be an inducement to check unnecessary use of the telephone; (3) the present temptation to overload a line would be less obvious.

Public Call Offices and Accounts.

The message fee was raised in 1915 from 2d. in London to 3d., and from 1d. in the provinces to 2d., and this increase was followed by an immediate drop in the number of calls of 30 per cent. in London and 50 per cent. in the provinces. It is the view of the Post Office that though the present charges are unremunerative, any addition to the number of pennies over three would fail to yield additional revenue, besides causing inconvenience to the public, and greater difficulties of operation; and the Committee assent to this view. They approve, however, of the proposal made by the Post Office, that a uniform charge of 3d. for a local call be made both in London and the provinces.

The abolition of the flat rate will probably lead to an increase of disputes as to the number of calls, and it is therefore of additional importance that a subscriber's check should be introduced at the earliest possible date. The Committee understand that the Post Office propose adopting, when practicable, automatic exchanges; when this is carried out there should be fewer complaints of charges for calls not used.

The Department recommend, and the Committee approve, that, in lieu of the present annual payment, a quarterly system of accounts be adopted for rentals and calls, and that the present system of monthly accounts for trunk calls and telegrams should be continued at the option of subscribers, on payment of a fee of 4s. per annum. In view of the abolition of the unlimited service rate, the Committee consider that an opportunity should be given to subscribers to check their accounts at more frequent intervals than three months, and that, on payment of a fee of 10s. per annum, a monthly report of calls (excluding trunk calls and telegrams) should be furnished.

London and Special Areas.

The Committee regard the Department's proposal for the London area as a reasonable solution of a difficult problem. The London Telephone Directory should be available to all subscribers outside the new London area, but within 15 miles of Oxford Circus, at net cost price; and subscribers in the London area should be permitted to purchase any of the directories supplied to subscribers outside that area, but within 15 miles of Oxford Circus, at net cost price.

The Committee recommend the adoption of the same principle for Birmingham, Glasgow, Liverpool and Manchester as that proposed in regard to London, with certain modifications.

Minor Recommendations.

The Committee recommend the continuance of the rural party (Farmer) lines. The proposed new tariff for private telephone wires appears unnecessarily high, and the Committee suggest some modification wherever possible without undue interference with the necessity for uniformity in the scale of charges. They are of opinion that the charges suggested in paragraphs 80 to 83 of the Departmental Committee's Report are reasonable, but recommend that in the case of imposing a special charge for continuous service, or of even abolishing it in some districts, special consideration should be shown for such exceptional cases as doctors, chemists, fire brigade service, police, &c., and any other national service. The present charges for removals, which are 80 per cent. higher than before the war, should not be increased.

The Postmaster-General should take power to refuse service to any subscriber on whose line the number of "engaged" calls exceeds 25 per cent. of the number of effective incoming calls, if he refuses to rent an additional circuit, and in order to encourage the renting of additional circuits the charge for these should be £1 less than the charges for the original circuit. The surcharge of £4 on new installations should be abolished.

Tariffs.

The tariffs proposed by the Post Office are considered justifiable and they recommend their adoption, but they further recommend that, following the usual commercial custom, a rebate should be allowed to subscribers using 2,000 or more calls a year. It is the view of the Committee that development on commercial lines, combined with economy and increased efficiency, may produce more favourable financial results than those foreshadowed by the Department, quite apart from a fall in prices. Should this anticipation be realised and the accounts in any year show a substantial surplus, the Committee recommend that a proportion of such surplus be returned to subscribers by way of a reduction in installation rentals. They consider it desirable that the question of charges should be reconsidered within the next five years by a Parliamentary Committee.

Amalgamation of German Electricity Works.

The British Commercial Secretary at Cologne has forwarded to the Department of Overseas Trade particulars of the amalgamation of 10 of the largest electricity works supplying the Westphalian industrial and neighbouring district. The united works will be known as the Kommunalen Electrizitätswerkverband, with headquarters at Hagen. The following stations belong to the union :—Kommunales Electrizitätswerk Mark A. G. (Hagen), Lenne-Electrizitäts-und Industriewerke A. G. (Werdohl), the Stadtisches Electrizitätswerk (Dortmund), Westfälisches Verbands-Electrizitätswerk A. G. (Kruckel), Electrizitätswerk Siegerland G. m. b. H. (Siegen), Kreis-Electrizitätswerk Gummersbach (Dieringhausen), Electrizitätswerk Westfalen A. G. (Bochum), the Stadtisches Electrizitätswerk (Barmen), Gemeinachaftswerk Hattingen (Stadt Barmen und E. W. (Westfalen), and the Bergische Electrizitäts-Versorgungs-G. m. b. H. (Elberfeld).

The chief tasks of the new company are the technical co-operation of the existing power stations, the building and working of new water and steam-power works on the basis of the cheapest fuel, and to ensure a good and sufficient supply of electricity in the future. The great question is how to supply communities and industries with sufficient current. Bituminous coal is scarce, and consequently there is a shortage of electricity. The State coal is insufficient, and the Association has taken certain measures in order to supply this want. The points to be considered include (1) the securing of sufficient fuel from the Westphalian coal mines to make full use of the power station of the Association; (2) the giving of mutual help to other existing power stations; (3) the extension of suitable water-power stations; and (4) to obtain large quantities of current from the Rhenish brown-coal district. The Association has planned the construction of an enormous power station with a coal basis of its own. The Bergwerkgesellschaft Lothringen, Gerthen, near Bochum, has joined the Association in order to form the coal basis of the K.E.V. The Ruhrtalsperiverein will also probably join for the purpose of co-operating in the commencement of a large water-power station.

In connection with the proposal to establish James Watt Commemoration Engineering Chairs at Glasgow University, the Institution of Engineers and Shipbuilders in Scotland has been successful in securing about £30,000 for the purpose. Messrs. Ferranti (Ltd.) have presented to the Engineering Department a standard a.c. meter and a c.c. meter.

Electricity Supply.

Bo'ness Council has applied for sanction to borrow £3,000 for extensions of the electricity works.

Fowey Council has appointed a Committee to report upon the advisability of introducing electricity supply into the district.

As Long Eaton Council is faced with a deficit of £3,249 on the electricity undertaking, it has decided to increase the price per unit for lighting from $7\frac{3}{8}$d. to 8d., with 3d. per unit for power, and 7d. and 8d. for factory lighting.

Stafford Electricity Committee has decided, in view of the importance of maintaining a sufficient supply of electricity, to retain Mr. Arthur Ellis, at a fee of 200 guineas, to prepare a comprehensive report on the present undertaking.

The Finance Committee of Walsall Council has received authority to raise loans of £20,400 for the electricity department, including £10,000 for services (repayable in 25 years), £4,764 for buildings (27 years) and £5,636 for plant (13 years).

Hammersmith (London) Electricity Committee recommend the Council to authorise them to expend a sum not exceeding £200 in purchasing and hiring out electric cookers, &c., as an experiment, on the Council's Northern Housing Estate.

Cannock Urban Council has approved the draft of an agreement with Wolverhampton Corporation for the supply of electricity in bulk to Cannock, and the Electricity Commissioners have been asked for their approval. A site for a transformer station is to be obtained.

Accrington Electricity Committee have decided to increase all electricity charges by 5 per cent., except for those subject to the sliding scale on the cost of generation. Big electricity extensions are foreshadowed at involving an expenditure of £150,000. This is the outcome of the permission of the Electricity Committee to complete the existing station.

The accounts of the Halifax Electricity Department for the year ended March 31, 1920, show increase £137,832, compared with £111,574 in the previous year, and working expenses £80,752 (£72,293). Interest required £13,647 (£12,463), sinking fund £15,256 (£14,089) and income tax £5,695 (£5,103), and the net profit was £23,997 (£9,033). The surplus, after providing £6,051 for permanent works, &c., was £17,946, which is equal to a rate of 11·13d. in the £. Units generated were 17,820,820 (19,627,690) and sold 16,161,399 (18,029,244).

Lanark Corporation has received a report on electric supply from their consulting engineer (Mr. J. M. M. Munro), who submitted estimates of the cost of four schemes, as follows: (A) Bulk supply from the Clyde Valley Electric Power Company, £58,000; (B) water power from the river Clyde, £45,000; (C) stean turbines, £48,000; (D) gas or oil engines, £30,000. The generating costs, including interest and repairs for each of the above schemes, would be £17,929; £5,586, £8,348 and £4,130 respectively. Mr. Munro pointed out that the water power scheme (B) had obvious advantages over any of the others in that it held the prospect of a cheap supply of electricity, and the larger it grew the cheaper the cost per unit. The Council has submitted the report and summaries to the Electricity Commissioners for their information with a view to their possibly taking up the matter in the near future, and providing a scheme for the supply of electricity for a great portion of the area of the county, including the Burgh of Lanark as a centre.

Owing to an accident to another 20,000-kw. turbo-alternator at Dalmarnock station, Glasgow Corporation electricity department has been again obliged to impose restrictions on the supply for power. The alternator had only recently been placed in commission after the breakdown which took place on the 8th inst. At present it cannot be definitely stated when the restrictions will be removed. Consumers all over the city are requested to exercise the greatest economy in the use of the supply, especially between 2 and 5.30 p.m. The damage is not nearly so great as on the last occasion, and repairs will be proceeded with night and day. There is no spare plant, owing to the abnormal demands for electrical energy made since the removal of restrictions and to the difficulty experienced in obtaining delivery of generating plant during the war period and since the Armistice, but the position will be improved early in the New Year.

Electric Traction.

The new trackless trolley omnibus service from Parliament-street, in the centre of York, to the Heworth suburb was inaugurated last week.

The London City Council has sanctioned a loan of £9,936 to the Hammersmith Borough Council for the purchase of six $3\frac{1}{2}$-ton electric wagons for house-refuse collection, repayment to be made in five years.

A serious breakdown at the Lancaster Electricity Works has necessitated the suspension of the tramway service for two hours daily, except Wednesdays and Saturdays, and this will apply for several months until repairs are effected.

The accounts of the Blackburn Tramways Department for the year ended March 31 last show income £186,474, and working expenses £147,769; of which £5,583 has been transferred to permanent way renewal fund, and £10,000 to the relief of rates.

It is reported that the directors of the London & North Western Railway Company are to consider a scheme for the electrification of the section from Chester to Holyhead. It is probable that if the proposal be adopted electrical energy will be supplied by the North Wales Electricity Authority.

Tenders Invited and Accepted.

Battersea (London) Council want tenders by Jan. 5 for a 5,000 kw turbo alternator. Specifications, &c., from the Electrical Engineer.

Antwerp municipality require tenders by Jan. 25 for 20 5-ton electric cranes. Specifications can be seen at the Department of Overseas Trade, 35, Old Queen-street, London, S.W.1.

The Commissioners of H.M. Works require tenders by Jan. 6 for the supply of electric wire and cable for six months. Forms of tender, &c., from the Controller of Supplies, King Charles-street.

Leyton Urban Council require tenders by Jan. 11 for electric wiring in 142 houses on the Barclay estate. Specifications from Mr. J. H. Jacques, 2, Fen-court, Fenchurch-street, London, E.C.3.

Manchester Tramways Committee want tenders by Jan. 11 for the supply of electric welding equipment for welding rail joints. Specifications, &c., from the General Manager, 55, Piccadilly, Manchester.

Tenders are required by Jan. 8 for the supply of the following transformers to York Electricity Dept. :—One 200 k.v.a., two 100 k.v.a., one 50 k.v.a., two 25 k.v.a. and two 10 k.v.a. Particulars from the City Electrical Engineer.

Tenders are invited by Jan. 26, 1921, for the supply and delivery to the Postmaster-General's Department, State of Queensland, of telephone apparatus and parts (schedule 509). Tender forms at office of High Commissioner for Australia, 406, Australia House, Strand, W.C.2.

Amongst requirements of the Bulgarian State Railways Department are telephone and telegraph materials, electrical installation material for coal mines, machine tools and various railway stores. List can be seen at the Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W. 1.

Durban (Natal) Corporation require tenders by Jan. 26 for telephone cable (air-space and paper insulated type), paper sleeves, pipes and other electrical accessories. The Corporation also want tenders by Feb. 16 for a 1,000 kw. rotary converter, with transformers. Specifications at the Department, &c. of Overseas Trade, 35, Old Queen street, S.W.1.

Salisbury (Rhodesia) Municipal Council invite tenders for two or three 300-kw., 3-phase, 50-cycle, 2,000-volt generators, direct-coupled to vertical gas engines with producer plant, two converters, switchgear, underground cable, &c. Tenders to the Town Clerk by noon, Jan. 13. Specifications may be consulted at Department of Overseas Trade, 35, Old Queen-street, S.W.1.

The City of Auckland (N.Z.) invite tenders for the supply and erection of one 3,000 kw. and one 5,000 kw. turbo-alternator, rotary converters (1,500 kw. and 500 kw.) switchgear and transformers, also water tube boilers, conveyor pumps, pipework and h.t. and l.t. cables. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew, 8, Queen Anne's-gate, S.W. 1, and tenders by noon, February 22, 1921, to Mr. Alex. Wyllie, C/o. Messrs. Preece Cardew & Rider.

Finchley Urban Council has placed an order for a Brush Ljungstrom turbine set with the Brush Company, at £19,750.

Wrexham Corporation have accepted the tender of E. O. Walker & Company for wiring the Acton Park houses.

Redditch Urban Council has accepted the tender of Ferranti, Ltd., for the supply of meters for the next twelve months.

Doncaster Corporation has ordered a 750 kw. rotary converter from the Metropolitan-Vickers Electrical Company, at £6,528.

Hove Sanitary Committee has placed an order for the supply of four electric motors with Messrs. Crompton & Company, at £1,081. 18s. (acpd.)

Aylesbury Council have accepted the tender for the Ediswan Electric Company, for 500 yds. of cable, and that of W. Lucy & Company for joint boxes.

Marylebone (London) Borough Council has placed the following orders: British Electric Transformer Company, two 1,000 k.v.a. transformers, £3,416; Pritchett & Gold and E.P.S. Company, ten extra cells for battery, £230.

Personal and Appointments.

Mr. P. Davies, executive engineer in the Indian Public Works Department, has been posted to the charge of the Nagpur hydro-electric survey.

The Federation of British Industries has asked Captain Ewald, managing director of the Danish Cable Factories, to represent them in Denmark in succession to Mr. Montague Villiers.

Mr. David Owen, B.A., D.Sc., senior lecturer in physics at the Birkbeck College, has been appointed head of the department of physics and mathematics at the Sir John Cass Technical Institute, Aldgate, London.

Mr. E. A. Wood, of Southampton, has been appointed assistant repair-department superintendent in the rolling-stock branch of the London County Council tramways at £573, rising to £727 per annum.

Mr. Walter Emmott has been appointed consulting engineer by the Mytholmroyd Urban Council which has authorised a committee to open negotiations with the Yorkshire Electric Power Company for a supply of electricity to the district.

Mr. John Ames, General Secretary of the Industrial League and Council, has been appointed a member of the Commercial Panel of the Appointments Department, of the Ministry of Labour. Mr. Ames' long and varied experience in connection with labour matters renders him eminently suitable to assist in connection with the work which will devolve on this Panel.

Institution Notes.

It is announced that H.R.H. Purachatra, Prince of Kambaeng Bejra, Siam, has been elected an Honorary Member of the Institution of Civil Engineers.

In a Paper recently read by Mr. H. M. Dunkerley before the Cold Storage & Ice Association he strongly advocated the use of electric vehicles for the transport by road of refrigerated produce, more particularly meat, in view of the present high cost of petrol. While the accumulator vehicle had definite limitations, he considered it the most economic and suitable for distribution in towns. It could not travel with the speed of a petrol lorry, it could not operate over a bigger radius than 12 miles, and it could not do more than 35 miles in one day unless it returned to its base for a freshly charged accumulator; but that was only a five minutes' job with properly arranged, self-lifting trolleys to take off the old battery and bring up the new. At the same time, it was very handy in traffic; it was the simplest vehicle to drive; the insurance charges were lower than for any other vehicle of like capacity, and, if intelligently looked after, the battery was good for five years' continuous use when of the lead type, and for eight or 10 years of the nickel type.

Last week Dr. C. C. Garrard delivered an address on "Engineering Education" at a meeting of the South Midlands branch of the Association of Teachers in Technical Institutions. Dr. Garrard said there was no ideal method of training engineers. There were competent engineers who had been trained in the most diverse manner, and in some cases not trained at all according to any discoverable method. He considered that the traditional public school education destroyed originality and initiative. All training, even manual training, was chiefly a mental process. He strongly urged the re-establishment of the apprenticeship system in workshops, and said the primary condition for the success of the engineering industry was the existence of a sufficient number of well-trained and contented artisans. He advocated a standard scheme for the engineering industry. He was in favour of the abolition of premiums on the ground that advancement should be independent of any pecuniary position; it should depend upon the pupil's own ability. Professional engineers should proceed straight to the university after leaving school, and be given an apprenticeship after leaving the university.

Business Items, Price Lists, &c.

The following firms have been appointed agents for Mr. H. W. Sullivan's wireless apparatus: G. S. Douthwaite & Company, 25, Dean-street, Newcastle-on-Tyne, for Newcastle and district; and Mr. A. E. Hay, 6, Oxford-street, Mountain Ash, for Wales.

Messrs. Kincaid, Waller, Manville & Dawson have returned to St. Stephen's House, Victoria Embankment, Westminster, S.W. 1, as the Government have reinstated them in their former offices, which were commandeered during the war. The firm have taken into partnership Mr. A. E. Jackson, M.I.E.E., and Mr. H. G. Simmonds, who have been intimately associated with them as principal assistants for many years. There will be no alteration in the style of the firm.

The Sun Electrical Company's High Efficiency Lighting Catalogue gives full particulars and prices of their complete range of sunlite P.E. reflectors of all types, extra extensive, extensive, intensive and angle, for direct illumination and semi-direct and indirect; diffusa semi-indirect, fittings, and sunco lanterns, and a complete range of semi-indirect fittings utilising opal, holophane and alabaster bowls, and indirect fittings utilising matt white composition bowls. There are some excellent illustrations, and the list is practically a complete guide to the lighting of commercial and industrial buildings. Efficient lighting of factories and workshops is essential for increased output and for good workmanship, and the new catalogue will be of assistance to those who wish to improve or to re-organise their lighting arrangements.

Messrs. Ercole Marelli & Company, Ltd., 19/20, Garlick Hill, E.C.4, ask us to deny a rumour that has gained currency in India to the effect that the company's Milan factories had been destroyed partially by earthquake and Bolshevism and that therefore the company was not in a position to supply anything. The company state that their factories in Milan are in perfect working order and extremely busy; they have not been destroyed or damaged in any way. It is true that during September Messrs. Marelli's works were occupied by the workmen, as was the case in all large industrial establishments throughout Lombardy, but at the commencement of October the factories were handed back to the owners in absolutely undamaged condition, with everything intact, and work had been proceeded with during their absence practically in a normal manner.

Calendars and Diaries.

We have received from the General Electric Company the usual Osram wall calendar, which serves as a striking reminder of the well-known Osram lamps.

In a Christmas booklet and calendar issued by the Midland Electric Power Installation Company, Wolverhampton, particulars are given of the company's activities, which include factory equipment, domestic lighting and heating, repairs, &c.

We have received from the British Thomson-Houston Company a copy of their Pocket Book and Diary for 1921. Besides matter of the usual diary character this publication also contains a great deal of interesting and useful information on such questions as motor rating, steel temperatures and wireless signals. This is the first publication of the kind which has been issued by the Company and every effort has been made to ensure that the information contained therein is as correct and useful as possible.

Companies' Reports, &c.

The net earnings of the VICTORIA FALLS & TRANSVAAL POWER COMPANY for the quarter ended Sept., including those of the Rand Mines Power Supply Company, amounted to £203,435 before prodividng for taxation in South Africa and the United Kingdom.

It is announced that the new ordinary shares of the GLOBE TELEGRAPH & TRUST COMPANY, LTD., will, if fully paid, receive on or about March 23 a payment of 4s. 8d. per share, tax free, in satisfaction of dividend for period ending 31st inst., and will rank for dividend for the year 1921 *pari passu* with the existing ordinary shares.

The report of the HUMPHREY PUMP COMPANY, LYD., for the year ended Sept. 30 states that the purchase money for the sale of patent rights for water column pump has been received. In view of the company having ceased manufacturing operations, plant and tools and stock have been written down to their estimated realisable values.

The report of C. A. VANDERVELL & COMPANY, LTD., for the year ended March 31 last states that despite the setback in the motor trade during the autumn of 1919 (owing to moulders' strike) the year's turnover was substantially increased. Extensions to works are nearing completion, which will practically double its capacity. The profit, less provision for income tax (£20,000) amounts to £106,206, and £139,293 is brought forward. The dividend on the preferred ordinary shares of 10 per cent. absorbs £30,000, and the directors recommend placing to reserve £75,000 and carrying forward £140,499. Owing to the general industrial position the directors have decided to retain all available funds, in particular to make provision for the cost of extensions, and, therefore, they do not propose to recommend the distribution of any further dividend this year by way of participation.

It is announced by the URBAN ELECTRIC SUPPLY COMPANY, LTD., that the Ministry of Transport have authorised increased maximum rates of charge for electricity by all the company's undertakings. The increased rates now being charged for lighting, combined with the higher power and heating rates in force, are expected to produce a substantially larger revenue balance for the current year, and in the absence of any further increase in the cost of labour, coal and other materials, or other untoward development, it is hoped that such balance will show a further expansion during the coming year. These rates are, however, under existing conditions insufficient in most cases to give an adequate return on capital, and afford no provision for making good the deficient revenues of the past few years. Until, therefore, the Ministry are empowered and are prepared to give a more generous recognition to the facts of the situation, it is probable that the whole of the company's resources will for some time be required to meet pressing current needs. No capital expenditure is being incurred which can possibly be avoided, but to maintain the supply heavy expenditure has to be incurred on extensive repairs and renewals.

In a circular issued by Vickers, Ltd., to their shareholders it is stated that settlements have now been made with the Government that permit the closing of the books to the end of 1919, subject to certain minor reservations. The matters dealt with were so complicated and the exact apportionment among the various years was so difficult, that it has been found impossible to present separate accounts for each year, and the four years 1916-17-18-19 are therefore taken as one period. The book value of the land, buildings, machinery, &c., after taking additions into account and allowing for depreciation, has risen from £5,724,486 in 1915 to £7,314,094 at the end of 1919. The reserves have increased from £2,064,261 to £6,669,159. Interests in subsidiary and connected companies have risen from £5,448,734 to £17,236,516. Practically the whole of this large increase is due to the purchase of the shares of the Metropolitan Carriage Wagon & Finance Company, which included a controlling share in the Metropolitan-Vickers Electrical Company. The second and third mortgage debentures, of which the outstanding balances amounted to £1,058,200 in 1915, have been paid off, and the 4 per cent. first mortgage debenture stock of £1,250,000 alone remains. The amount distributed in dividends in respect of the four years reached £3,967,112. After payment of these dividends, and providing for all Government taxation to the end of 1919, and after adding £319,749 16s. brought forward from 1915, the amount to be carried forward is £846,363 14s. 2d. In order to give an idea of the immense variety and volume of work dealt with by the company during the war, a special note is circulated with the report. The year 1919 was mainly devoted to clearing up war work and starting up and extending the peace business which had practically been suspended for four years, and to the preparation for the new trades which had been the subject of much anxious study as the war drew to an end, and which the directors hope will enable them to utilise the extensions of buildings and some of the plant put up during the war. Some of the new undertakings show already very considerable promise, but the proper utilisation of the factories near London presents great difficulties mainly owing to labour conditions.

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Arrangements for the Week.

FRIDAY, December 31st (to-day).

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At Caxton Hall, Westminster, London, S.W. Lecturette on "Drying Plant," by Mr. E. A. Alliott.

ROYAL INSTITUTION.

At Albemarle-street, Piccadilly, London, W. Christmas Lectures for Juveniles on "The Haunts of Life," by Prof. J. A. Thomson, M.A.

Saturday, January 1st.
3 p.m. The Open Sea.
Tuesday, January 4th.
3 p.m. The Great Deeps.
Thursday, January 6th,
3 p.m. The Freshwaters.
Saturday, January 8th.
3 p.m. The Conquest of the Land.

WEDNESDAY, January 5th.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. At Royal Institution, Colquitt Street, Liverpool. Paper on "Water Power Problems," by Mr. W. J. E. Binnie.

Forty Years Ago.

(THE ELECTRICIAN, JANUARY, 1, 1881.)

THE CONGRESS OF ELECTRICIANS.—The Prince of Wales is spoken of as the probable president of the Congress of Electricians, and of the Electrical Exhibition.

LIGHT AND SWEETNESS.—We understand that the British Electric Light Company (Ltd.) has been selected by the management of the Seafield Hydropathic Establishment, near Waterloo, for the lighting up of that important institution. This fact will be regarded as an evidence of the confidence already bestowed on a company so recently formed.

EDISON.—Our comic American contemporary, *Puck*, quotes the following from the *S. F. News Letter*: "Edison, the newspaper electrician, is at it again. This time he announces that he has hit the nail on the head, and the consequence will be a brilliant illumination of the entire earth at a cost not worth mentioning. As a means of producing the incandescence, he uses infinitesimal shreds of bamboo, procured at a great expense from Cuba. This new light should be patented under the title of 'Edison's Electric Bamboozler.'"

ELECTRIC LIGHTING AND STREET TRAFFIC.—The other evening a hansom cab knocked down and severely injured a foot passenger in Liverpool-street, London, and the driver, as usual, made off as quickly as his horse would take him. A police constable, however, pursued him for a short distance, and, facing the station where the electric light brightly illuminates the street, was able to take the number of the offending vehicle. Cabby has consequently been summoned—much to his surprise, no doubt, and much, we hope, to the edification of his brethren, whose reckless careers would be speedily checked were electric lighting more general.

Prices of Metals, Chemicals, &c.

			TUESDAY, Dec. 28.	
		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£82 0 0	—	£2 0 0
Electro Wirebars...	,,	£84 0 0	—	£3 0 0
H.C. wire basis......	per lb.	1s. 0[illegible] d.	—	[illegible]d.
Sheet	,,	1s. 2[illegible] d.	—	$\frac{7}{16}$ d.
Phosphor-bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. 4[illegible]d.	—	1[illegible]d.
Brass 60/40—				
Rod, basis	,,	0s. 9½d.	—	—
Sheet, basis	,,	1s. 2½d.	—	—
Wire, basis	,,	1s. 2d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£11 17 6	—	—
Galvanised steel wire, basis 8 SWG	,,	£37 0 0	—	—
Lead Pig—				
English	,,	£24 0 0	—	£1 10 0
Foreign or Colonial	,,	£21 10 0	—	£1 15 0
Tin—Ingot	,,	£199 0 0		£9 0 0
Wire, basis	per lb.	0 2 8	—	1½d.

Salammoniac.—Per cwt. 110s.-105s.
Sulphur (Flowers).—Ton £16 15s.
,, (Roll Brimstone).—Per ton £16 15s.
Sulphuric Acid (Pyrites, 168°).—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £39.
Boric Acid (Crystals)—Per ton £74.
Sodium Bichromate.—Per lb. 10½d.
Sodium Chlorate.—Per lb. 5d.

The metal prices are supplied by British Insulated & Helsby Cables.

THE ELECTRICIAN

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Notes.

False Economy at Birmingham.

There is economy that is wise and an economy that is foolish. An example of the latter variety has just come to light at Birmingham, where the City Council have decided that in view of their heavy commitments and the impossibility of raising further money, no more contracts shall be let for the present on the extension of the electricity undertaking and the housing scheme. This decision is the more deplorable as there is not only a big field in Birmingham awaiting electrical development, but there is a long waiting list of prospective consumers, and even those connected to the mains are on short time, so that the extensions which are deferred by the Council's action are not only desirable but urgently necessary. Now Birmingham has a name of being a progressive city, but even there it does not yet seem to be realised that money spent on electricity supply is productive expenditure, that is, not only do the ratepayers as a whole benefit from it by obtaining a cheap supply of a useful commodity and a return upon their capital, but the individual ratepayer in his business capacity is enabled to market his products in greater quantities and more inexpensively than would otherwise be the case. While we welcome the fact that one municipality at least has some care of ratepayers' moneys, we regret that such a decision should have been reached. We sincerely hope it will be reconsidered without delay.

The Re-Organisation of Electricity Supply.

HAVING divided up the greater part of the country into provisional electricity districts, the Electricity Commissioners will commence on Tuesday next the second and more important part of their work, the consideration of schemes for improving the existing organisation of electricity supply. Up to the present only four draft schemes, relating to three areas, have been submitted; but others are under consideration. Difficulties have arisen owing to the conflicting interests of municipal and company-owned undertakings, and the date for sending in schemes has had to be extended in some instances. In the case of the West Riding (Aire and Calder) district, two extensions have already had to be made—viz., from October 31 to December 31, 1920, and now February 28th has been fixed as the final date for submitting proposals. In South Wales the situation is complicated by the fact that the independent plants owned by industrial concerns have an aggregate capacity greater than that of the authorised undertakers, and a co-operative scheme is therefore being proposed by some of those interested. As a result, the Commissioners are to be invited to allow another six months' grace and, provided a policy agreeable to the majority of the undertakers and large consumers can be found in the interval, an extension of time would probably be advantageous. The first of the public inquiries into the formation of a Joint Electricity Authority will be opened at Bristol on Tuesday, when the scheme for the West of England Electricity District will be investigated. In July last we published an outline of the constitution and powers of the proposed authority, and although no technical details of how the improvement of electricity supply is to be effected has been issued, the Commissioners will doubtless have to be satisfied on this important point before final approval is given.

Mr Pearce's Visit to America.

THERE seems to be a generally held opinion in this country that we have a great deal to learn from America in engineering practice. This idea crops up in all sorts of unexpected places, but it should be laid once and for all by Mr. PEARCE's interim report on his recent visit to America, which we publish on another page of this issue. If it is not, it is a good deal stronger than we imagined. The object of the visit, if it may be so shortly expressed, was to review American electrical engineering practice in the supply world, and to obtain from a survey of what was being done over there a range of ideas which might not only be helpful in Manchester, but tend to that general good of the electrical engineering community of this country which comes from a broadening of ideas. On this score there is at least no need for disappointment. A perusal of the interim report shows that though in matters of detail there are certain things that American engineers do and we do not, the reason for these differences is more to be found in local conditions than in anything fundamentally different in the engineering practices of the two countries. It is fair to add that Mr. PEARCE only visited the eastern and middle States, and that therefore this similarity does not take into account the extensive and very high tension transmission systems which are to be found in California and some of the other less highly developed districts. As far as the report goes, however, we seem to be well up in practice, and though we can doubtless pick up "wrinkles" from the American side, they can equally well learn something from us. We hope, therefore, that Mr. Pearce's visit will only be the forerunner of a series of international exchanges of this kind and that we shall soon have an opportunity of reciprocating the superabundant hospitality with which he was greeted on the other side by some prominent American supply engineers.

An Official View of Electroculture.

The effect of the study of electroculture on the mentality of the worker seems to be the same as that with which we are familiar when the scientific man takes to spiritualism. In both his efforts to employ sound methods of research are replaced by the pursuit of alluring will-o'-the-wisps with the result that the conclusions reached are based on no form of scientific reasoning. We have in the past given many explanations for the discrepancies in the numerous electrocultural experiments which have been undertaken. But the Tenth Report of the Development Commission adds yet another which makes plain a great deal. For it would appear that the most striking thing about the majority of the earlier experiments on this subject is the neglect to measure the currents used. The result of this was the obvious one that one experiment could not be compared with another, and apart from other disadvantages, there could be no certainty whether too much or too little discharge was being given. How important this question of current is, and how much the failure duly to note its amount must have had on the success or failure of the experiments, may be gathered from recent knowledge that the limits between which electricity may have some beneficial effect on the growth of crops is very small. Mr. Llewelyn Atkinson in his recent Presidential Address to the Institution of Electrical Engineers placed them between 0.3×10^{-9} amperes, and 10×10^{-9} amperes. These, however, are extreme figures, and it is quite possible that the time limits may be even more narrow. This indeed is one of the many questions to which any worker on electroculture must pay the closest attention, and in our opinion its solution should be made a preliminary to further experiments on anything like a large scale.

A Fresh Confirmation of Success.

The report also describes a series of plot and laboratory experiments with single seedlings. In all these experiments careful measurements were made of the current supplied, and special care was directed to the determination of the maximum and minimum currents which can be used. These experiments have now been going on for a number of years, and the results obtained seem to indicate that the growth of a cereal crop can be markedly increased by electrical treatment. Increases as high as 50 per cent., 38 per cent., and 35 per cent. being observed in a number of cases. While, however, these figures are distinctly encouraging we have had others as good or even better before, which have been followed by results, obtained under similar conditions, which only seemed to show that electroculture was harmful rather than beneficial. It would therefore be interesting to know whether in all cases the experiments carried out by the Development Commission were equally successful, or whether there were some plots which showed no improvement or even an actual retardation of growth when the electrical discharge was used. One thing is certain, the matter cannot be left where it is, and we hope therefore that the experiments will be continued. And while it is a problem needing study and solution as speedily as possible, the work must be carried out strictly on scientific and not on empirical lines. Experiments on this question require for their conduct men or women with a good knowledge of both the electrical and agricultural sides, and this does not render any easier the early acquirement of accurate and dependable results.

The Physical and Optical Societies' Exhibition.

The annual exhibition of the Physical Society and Optical Society, which was held this week, was more extensive than hitherto and comprised a great deal that was worth seeing. The discourses were of more than usual interest, the one by Prof. Archibald Barr on Dr. Fournier D'Albe's Optophone being particularly popular. Another excellent idea was the special demonstration, by Prof. C. L. Fortescue and Dr. Bryan, of some of the uses of a thermionic valve. There are many people who are by no means clear as to how such valves are used, and this demonstration served to show the uses without the complication of hidden and often mysterious apparatus. With regard to the exhibits, as is usual, there was necessarily a good deal shown that was familiar to regular *habitués* of the exhibition, but here were to be found instruments of some novelty. Of these, brief mention may be made of Watson & Sons' sphere gap voltmeter and an X-ray equipment with a Kenotron valve. Another X-ray equipment was shown by the Cox-Cavendish Electrical Company for the examination of materials, together with a new type of photographic plate by which exposures can be reduced to 1/25th of the normal. In view of the high power required, the increased sensitiveness of plate is most important. There was an interesting exhibit of temperature control by British Oil and Fuel Conservation, Ltd. Messrs. Evershed & Vignoles showed a small high-tension motor generator set for 12,000 volts direct current. This is similar to the set shown last year, but the pressure is much higher and it should prove correspondingly useful. In our next issue we hope to deal in detail with these and many other exhibits.

Expiring Patents

It has been our custom now for many years past to deal in the first issue of the New Year with the patents that are due to expire during that year, under the provisions of the Patent Acts. In this way we give our readers an implicit, though useful, account of electrical progress, and show those interested what apparatus and equipment is shortly to be freed for general manufacture and merchandise. For the first time for many years we are unable to do this, and the omission of this well-known feature from our first Electrician in 1921 perhaps requires some explanation. We might account for this omission on the lines of the old story which is told of a visit of one of our monarchs to a town where the Mayor gave forty reasons why the bells were not rung on the approach of the Sovereign. We are not concerned with thirty-nine of the reasons, but the fortieth was there were no bells, and the fact that no patents will expire during 1921 is a very good reason why our usual paragraphs are omitted in this issue. The reason there are no patents to expire is the simple one that the Patents, Designs and Trade Marks Act, 1919, extended the tenure of all patents by two years, so that those which would, in the normal course, have expired during the present year will not run out until 1923. The subject, therefore, ceases to be one for journalistic comment until next year.

The Engineers' Club.

We hope that in the rush and turmoil of the Christmas festivities the scheme for founding an Engineers' Club in London has only been temporarily forgotten, and that one of the good resolutions for the New Year will be a determination to see such a club formed as soon as possible on a sound financial and social basis. The letter from Mr. C. H. Wordingham, which we publish on another page of this issue, so closely corresponds with our own ideas on this subject, expressed in The Electrician, that we need hardly comment on them, much less criticise them. It is essential that the club should be democratic in the broadest and best possible sense of the word, and that it should be a real engineering centre for London.

1920.

While 1920 opened with a feeling of optimism, at its close there was general disappointment with the happenings of the past 12 months and pessimism about the future. In some ways this is not surprising. The consumer has suffered from higher prices, increased taxation, and the ever-growing difficulties of living. But while these conditions have imposed a greater burden on the consumer they have not benefited the manufacturer and salesman, owing to the increasing demands for higher wages, the slackening of productive effort, the consequent rise in the cost of raw materials and the overwhelming obstacle to development imposed by the high rate of excess profits duty. The one bright spot has been the gradual slackening of Government control over trade, and we hope that the freedom that this will give, and the development that will be possible from the anticipated removal of the excess profits duty, will lead to a greater progress toward stable conditions in 1921 than during the past 12 months.

Nevertheless, it would be wrong to deny that real progress has not been made, especially in the electrical industry, where small obstacles peculiar to the industry alone and checks of the character we have indicated have tended to obscure the manifold developments that have been effected, and to prevent onlookers seeing what a great advance has really been made. We have no reason to doubt that given patience and hard work conditions will improve still further until that stability, though not stagnation, is reached in trade generally which alone can confer lasting benefits on the industry and the nation.

Good from Evil.

Out of the evils which have beset industry emerges a great deal of good. They have necessitated more attention being paid to better methods of manufacture, the employment of more scientific procedure in the works, the consideration of every possible method of cutting down the cost per article manufactured, the use of efficient machinery, and generally that close attention to economic detail which is essential in the highest class of production, whether that production be turbo-alternators with a capacity of several thousand kilowatts or small motors for driving domestic apparatus. On the manufacturing side of the electrical industry the difficulties of the past 12 months may indeed well be the preliminary to a magnificent future.

Electricity Supply.

While on the manufacturing side progress has been difficult and there have really been no great outstanding events to chronicle, the same cannot be said of electricity supply. During the year the effects of the Electricity (Supply) Act passed at the end of 1919 began to make themselves felt in useful preliminary work, and the forthcoming 12 months are likely to see a good deal of real development in the reorganisation and consolidation of electricity supply.

In March we chronicled the appointment of the five Electricity Commissioners provided by the Electricity (Supply) Act with Sir John Snell as their Chairman. Sir John had, however, been clearing the ground for some time before his formal appointment, and as early as May the delimitation of the first of the districts into which the country is to be divided for electricity supply purposes was published for the West of England. Since then twelve other districts have been similarly defined, and the majority of those concerned are preparing the necessary schemes which are to turn them from paper into actual fact both technically and financially. The results of the preliminary deliberations into the important question involved have afforded the engineers and municipal authorities in the areas concerned an opportunity of coming together on a common basis which will, we hope, result in lasting good. The inquiry into the West of England scheme will be opened on Tuesday and the result will be awaited with interest. Within the next few weeks other inquiries, beginning with the West Lancashire district, will take place. Among the most complicated of these inquiries is that which will be concerned with the vexed question of electricity supply in London, but it is to be hoped that the good sense of those concerned will overcome those pettifogging ideas and the desire for personal advantage which have regrettably been too evident in the past.

The Electricity Supply Bill.

The clauses relating to compulsory purchase and other financial matters which had been dropped from the Electricity (Supply) Act of 1919 before it received the Royal Assent were introduced in the early part of the session as a separate Bill. The crowded state of Parliamentary business, however, made the progress of such a contentious measure to the statute book extremely difficult, and in the event no advance with it through the various stages was made. Towards the end of the session it was hurriedly dropped and a new Bill, containing clauses relating to the raising of money by Joint Electricity Authorities, and giving power to the Commissioners to increase the statutory maximum charges for electrical energy, was introduced. This Bill, however, also did not get beyond its first reading, and the position is now most unsatisfactory, for no progress can really be made in the inauguration of the new areas on a practical basis until the authorities concerned are provided with the necessary financial powers.

Fuel Utilisation.

Various interesting problems have come up for consideration on the technical side of the electricity supply industry. The report of the Nitrogen Products Committee published in the early part of the year gave a good deal of detailed information as to various methods of utilising coal for raising steam other than by direct combustion under boilers. The conclusion, however, was reached that any advantages that might accrue by the employment of such methods were likely to be more than offset by the increase in capital charges necessary, and the large acreage of land required for the installation of plant. The problem of how best to utilise the fuel at our disposal in its various phases has been pretty exhaustively explored during the year, especially by the Chairmen of the various territorial centres of the Institution of Electrical Engineers in their Addresses at the opening of the present session. The general conclusion seems to be that economies of a substantial nature can be effected in the boiler-house, the engine-room and on the distribution networks, and must indeed be effected if electricity is to be supplied at a sufficiently low figure to make its universal employment a practical proposition. Thus the employment of pulverised and colloidal fuel and fuel of low thermal value would seem to be ways by which boiler-house engineers may escape from some of these difficulties, combined with improvements in the design of boilers, economisers, super-heaters and other steam-raising plant. The possibilities of increasing the thermal efficiency of the steam turbine and of designing some form of gas turbine must not be neglected, and other cognate improvements in the design of switchgear and in the distribution networks are also worthy of consideration. The more general use of the mercury-vapour rectifier, which as a converting plant is cheap, reliable, and requires no attendance, is likely in the near future.

CONTROL AND ELECTRICITY SUPPLY.

On the financial side the moulders' strike at the beginning of the year and the coal strike later on in the year, together with the bad effects of control, have had a retarding effect on the development of electricity supply on economic lines. The war brought about a great demand for electrical energy, and this demand did not cease after the armistice had been declared. This, far from being an advantage, has placed a number of undertakings in a very awkward position owing to the fact that it has been very difficult to obtain delivery of the large turbo-alternators and other plant required to meet these extra demands. The result is that there are still in many areas long waiting-lists of would-be consumers, and in some cases restrictions on the use of power have had to be applied. The large rise in coal prices and the increasing costs of labour and almost every other commodity have meant a general upward tendency in the tariffs, which we hope will cease before long.

During the year the Glasgow Corporation opened a large station at Dalmarnock to supply the electrical needs of that city which has a present capacity of 75,000 H.P. A large station is being erected at Barton, Manchester, for the supply of electricity to that city and the neighbouring district, and Nottingham Corporation have also obtained permission from the Electricity Commissioners to proceed with the erection of a large station in that area. Various other projects, not omitting the egregious Severn Barrage scheme, are under consideration for the supply of the electrical needs of the country and will be considered by the Commissioners in accordance with their general policy of consolidation.

MEETING PRESENT NEEDS.

More difficult than the future in electricity supply is, however, the immediate present, and arrangements are very rightly being made to extend the more modern stations so that at least the present demands can be adequately met. The question of the generation of electrical energy by water power has also received a good deal of consideration. A scheme for the use of the Dartmoor streams, which was proposed in the early part of the year, has been dropped, but a very interesting scheme for the utilisation of certain of the lakes in the Scottish Highlands for the supply of Dundee and other places is being worked out and will, we hope, be brought to a successful conclusion. The Water Power Resources Committee of the Board of Trade has issued three reports in the course of the year, the most important of which pointed out that there is a good deal more water power available for electricity-supply purposes in this country than is popularly supposed, and made certain suggestions for the development of this power in the best possible way. This is a question, of course, in which the Electricity Commissioners must take a large part, and we hope that their occupation with other matters will not cause this question to be unduly neglected.

TRAMWAY TROUBLES.

The tramways industry during the year has passed through a troublesome time, there having been a series of local strikes, while more than once there has been a threat of a national strike on the wages question, and in this industry the condition may or may not be reached in other industries, where further increases in the wages bill cannot be conceded without bankruptcy. The result of the increased cost of material and the very shortsighted financial provision that was made in certain cases has resulted in a number of undertakings allowing their material to degenerate into a very poor condition. Taken as a whole, therefore, the outlook for this industry is none of the brightest.

ELECTRIC TRACTION ON RAILWAYS.

On the heavy electric traction side actual progress has been disappointingly small. The London & South Western Railway dropped their project of extending largely their electrified lines and the London, Brighton & South Coast Railway, though still considering the details of the electrification of practically the whole of their system have not got beyond the preliminary stage of this important work. Perhaps the most interesting event of the year was the appointment and report of a Committee by the Ministry of Transport to enquire into the possibility of employing a standard system of electric traction in this country. This Committee suggested the adoption of a high tension direct current at a working pressure of 1,500 volts, except on the Brighton Railway, where the single-phase system might be used and on other electrified lines where the system now in vogue might continue to be employed. The report of the Committee, therefore, does not lead us very much nearer to real standardisation, but the useful work on which they are now engaged of considering a standard design of rail and rolling stock arrangements will probably yield more definite results.

THE DOMESTIC FIELD.

The greatest possibility of development is offered by the domestic field. During the year we have shown what is being done in this direction and have indicated the vast amount that still remains to be done. This is a work in which every branch of the industry should take the greatest interest in order that the public may be educated in the " all-electric " idea, that the apparatus which can properly be used in domestic circles may be designed, manufactured and sold, and in order that the price of energy for this purpose may be reduced to the lowest possible level. To do this requires not only hard work and determination, but a good deal of advertisement; and the useful work which the British Electrical Development Association has done and is doing calls for the highest praise. An interesting attempt in the pushing out of the use of electricity into unusual fields is that to be found at Hereford, where a very successful agricultural load has been built up. This development of the use of electricity is most important in connection with the new housing schemes which are now under weigh in many parts of the country, and it is interesting to note that at Hammersmith electric cooking is being adopted on one of the estates which is being developed by the local authority and in the Newcastle area the supply company are installing a very successful range of electric cooking and other apparatus in the houses which are there being erected.

ELECTRIC VEHICLE.

Satisfactory progress is also being made in the use of the electric vehicle, which has great advantages for definite forms of traffic work. In this field, however, greater propaganda is also required, not only to educate the public in the advantages which may be obtained by the use of this form of vehicle, but to impress upon station engineers the desirability of providing proper charging arrangements. Legislation has recently made this much easier, and we hope that there will be no obstacles placed in the way of the development by lack of enterprise in providing the necessary facilities. A question undoubtedly connected with this is that of the provision of electric lighting and starting equipment of both pleasure and commercial motor cars. There has been a tremendous development in this connection quite recently, and some very interesting problems on the technical side come up for consideration which require solution without delay.

Telegraphy and Telephony.

In the sphere of telegraphy and telephony there has been a good deal of satisfactory commercial development and equally satisfactory technical progress. There has been the usual goading by the daily press and by interested authorities of the administration by the Post Office of the telephone system. We are willing to admit that the Post Office has its faults, but we would also reiterate that as far as the engineering department is concerned, it has had to face and overcome great difficulties. It is now proposed substantially to raise the charges and to put the financial side of the telephones on what we hope will be a sound economical basis. This, however, must be no obstacle to real engineering development, so that the telephone may be put within the reach of everyone who requires it at a cheap rate.

We shall refer more particularly to the technical developments in wireless telegraphy and telephony in a later issue, and we need only call attention here to the scheme proposed in February for an Imperial Wireless Network by the Marconi Company, and the report of the Imperial Wireless Sub-Committee in which these ideas were ignored later in in the year. Recent experience has shown that the day of submarine communication has not yet passed, and while we are anxious in every way to further the proper development of wireless communication we hope that every step will only be made after due consideration and not in a rash manner. To do otherwise is to do great harm to a growing industry.

Labour Troubles.

We have referred above to the effect of labour disputes on the well being of the electrical industry, and especially to the moulders' strike in the early part of the year, and to the coal strike towards the close of the year, from the effects of one of which we are only just recovering and from the effects of the other we are still suffering. In addition, there have been sporadic outbreaks in the tramways industry and labour conditions there are still in a very unsettled state. The Electrical Trades Union have also had sectional disturbances, which, in one instance nearly caused a national stoppage in connection with what is known as the Penistone affair. The Electrical Power Engineers' Association after negotiating for some time on peaceful lines conceived it to be their duty to issue what were virtually strike notices, and to threaten a universal stoppage if their wages demands were not immediately conceded. Fortunately, this disaster has been for a time averted, and will, we hope, be prevented altogether. These occurrences, however, form the darker sides of the negotiations which are constantly going on between employers and employed, and with the greater development of the Whitley Council idea, which has made a good deal of progress during the past twelve months, we may hope to see the abandonment of that very two-edged sword, the strike weapon, and to enter on what shall be a real era of industrial peace.

Legal Decisions.

During the year several legal decisions affecting the industry were given, but as these have been fully reported and, where necessary, commented upon, it is unnecessary to do more than recapitulate the effect of the more important judgments. Two cases of pre-war electricity supply contracts came before the Courts for relief under the Courts (Emergency Powers) Acts of 1917 and 1919, and the contract of the Bootle Corporation with a local consumer was amended, while three contracts of the North Metropolitan Electric Power Supply Company with Stoke Newington Borough Council were cancelled on account of the changes brought about by the war. In a third case the Carmarthen Electric Supply Company succeeded in establishing the right to an increased charge allowed by the Ministry of Transport, notwithstanding an old agreement between the Council and the Company restricting the latter's right to increase the price without the consent of the Council.

In the action brought by the Paignton Electric Light Company against a cinema proprietor it was decided by a Divisional Court that energy supplied through a transformer to an arc lantern in the cinema was for lighting and not for power purposes; and in the case of Morrow *v.* Stepney Borough Council an injunction was granted against the latter for committing a nuisance by the emission of dust and ashes from its electricity works. The operation of the injunction has, however, been suspended in order to give the Council an opportunity of providing a remedy.

Of the patent decisions the most important was the judgment of the Court of Appeal, which held that the British Thomson-Houston Company's patent (No. 10,918 of 1913) for gasfilled lamps was invalid, because the claim was too wide, and covered the sole right to apply the principle comprised in the discovery. In some four or five instances extensions of patents have been granted for four years, because the exploitation of the inventions had been interfered with by the war. An application for an extension of a patent for this reason will not be entertained until about six months before the expiry of its normal life.

The Direct United States Cable Company failed to get relief under the Defence of the Realm Act from a penalty clause in a lease of its cable granted to the Western Union Telegraph Company, as it did not establish that it was due to the Government control of cable-repairing ships it was unable to carry out its contract to repair the cable. The Court of Appeal upheld the right of the Postmaster-General to recover the cost of repairing a telegraph cable (laid in 1914) which was injuriously affected by the tramways of the Blackpool & Fleetwood Tramroad Company. The claim was based on the Company's Act of 1896 and on the Telegraph Act of 1878.

Trade Union law was considered in the action Hodges *v.* Webb, and plaintiff, who was dismissed because the defendant would not permit his men to work on an electrical contract on which he was engaged as foreman, was unsuccessful in his claim for damages, because the matter was held to be covered by the Trades Dispute Act. The House of Lords' judgment in the case of Weld-Blundell *v.* Stephens will be looked upon as a leading one on the liability of technical advisers for negligence.

Obituary.

The obituary list for 1920, though no less lengthy than that in previous years, when we do not take into account the enormous additions unfortunately caused by the war, contains, perhaps, fewer names, of outstanding importance than has been the case for some time. We may, however, mention the following pioneers, whose loss will be felt not only by their wide circle of friends, but whose work has left a lasting impress on electrical progress: Sir William Abney, Sir Norman Lockyer, Sir William Mather, Dr. Alexander Muirhead, Prof. John Perry, Prof. A. Righi, Prof. Sheldon, and Mr. T. N Vail.

The Measurement of the Magnetic Blow-Out Forces in Circuit Breakers.[*]

By A. C. BARTLETT.

The design of large circuit-breakers capable of dealing with the very heavy short-circuit currents that are liable to occur in practice, has for some time past been a problem of the greatest importance, and in the operation of circuit-breakers a magnetic blow-out effect exists owing to the magnetic field produced by the currents flowing in the conductors composing the switch and the leads to it. Comparative values of the magnetic blow-out in certain variously shaped circuits were required

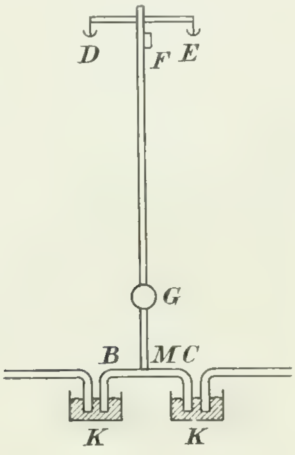

FIG. 1.

The determination of the magnitude and action of the effect does not lend itself readily to theoretical treatment, and to obtain definite results resort to experiment is necessary. The forces acting on copper links of various lengths occupying the positions of the arcs in the circuits of switches were measured by the apparatus illustrated in Fig. 1. The copper link *BC* was fixed rigidly to a rod *FM*, which was hung from pivots *D* and *E*, and was free to swing in mercury cups *K* and *K*; into these mercury cups dipped the ends of the conductors forming the remainder of the circuit. *G* represents a small galvanometer mirror by means of which with the usual arrangement any angular motion of the rod *FM* could be detected. *F* represents a small horizontal wooden rod at right angles to the plane of the paper. In the experiment this apparatus was placed in a circuit, so that the copper link occupied the position of the arc. When a current of several hundred amperes is passed through the circuit the rod *FM* is deflected, and, by means of a weight on the horizontal rod at *F*, it can be brought back to its position when no current passing. This enables a direct measurement to be obtained of the force acting on the link *BC*, tending to displace it to a position parallel to itself. The magnitude of this force divided by the square of the current can be taken to represent the value of the magnetic blow-out.

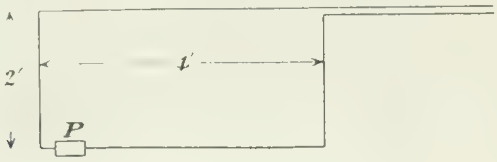

FIG. 2.

The method was applied to the circuits in Figs. 2 and 3, using links of various lengths, the positions of the links being denoted by *P*.

In Fig. 4 the ratio of the force to the square of the current is plotted against the length of the link for these two circuits.

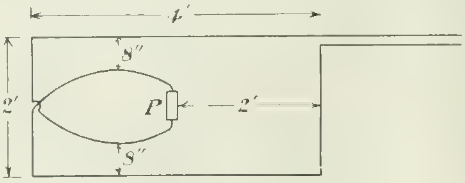

FIG. 3.

It will be noted that the points for the different circuits lie approximately on straight lines. In no case was any force observed tending to move the link in the direction of its own length, whence it follows that in all cases the forces acting on the elements of length of the link were at right angles to the link. The two circuits are seen to give very similar results, indicating no definite superiority of the one over the other, from the point of view of the tendency to blow out the arc on breaking circuit. With this method the relative values of the magnetic blow-out force of any type of switch or circuit-breaker can be rapidly estimated at the instant of opening circuit.

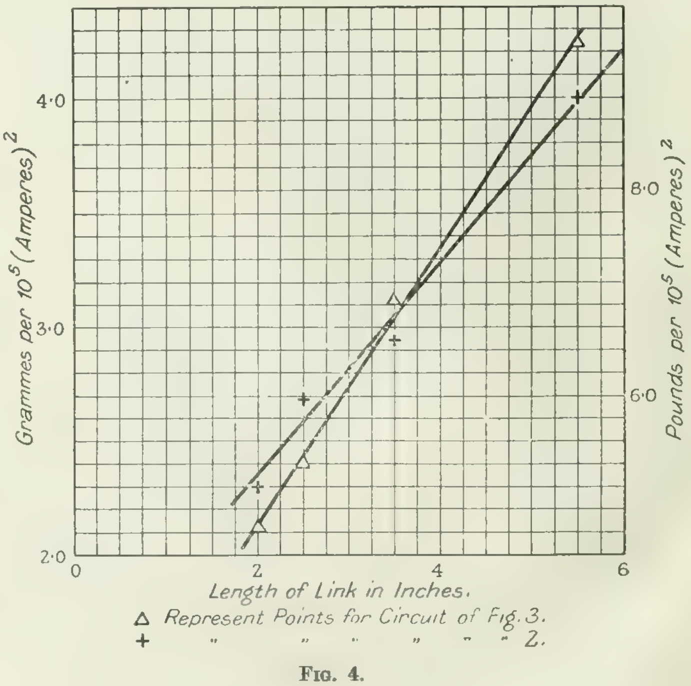

FIG. 4.

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[*] Communicated from the Research Laboratories of the General Electric Co., London.

At the recent complimentary staff dinner, given to the retiring works engineer, Mr. Percy R. Allen, the managing director of the CASTNER-KELLNER ALKALI COMPANY (Mr. A. T. Smith) said that before the war the works produced electricity with Lancashire coal at a lower figure than at Niagara Falls. The increased cost of coal and labour and the reduced price of by-products made a less favourable comparison, but it was still the most economical basis for power production in the United Kingdom. As much electricity was produced at their works as by the electricity undertaking of Liverpool.

Some Modern Developments in Radio Installations for Ships.

At the recent Shipbuilding and Engineering Exhibition at Glasgow some very interesting commercial radio installations were to be seen. Amongst those representing the great developments which have been made in radio engineering during the last few years may be mentioned the installations for ships manufactured and supplied by the RADIO COMMUNICATION COMPANY, LTD., a company of comparatively recent origin, but one which has already made a successful inroad into a business which has previously been virtually a monopoly. The apparatus shown at the Glasgow Exhibition included installations of the type fitted on many vessels of the leading shipping lines, as for example, s.s. "Bonheur," "Caronia," "Carmania," "Empress of Britain," "La Paz," "Oropesa," "Orontes," "Yorkshire," not to mention numerous other vessels.

On account of the rapidly extending activities of this company, we therefore take this opportunity of publishing some further details of these installations, which have been kindly supplied to us by the makers.

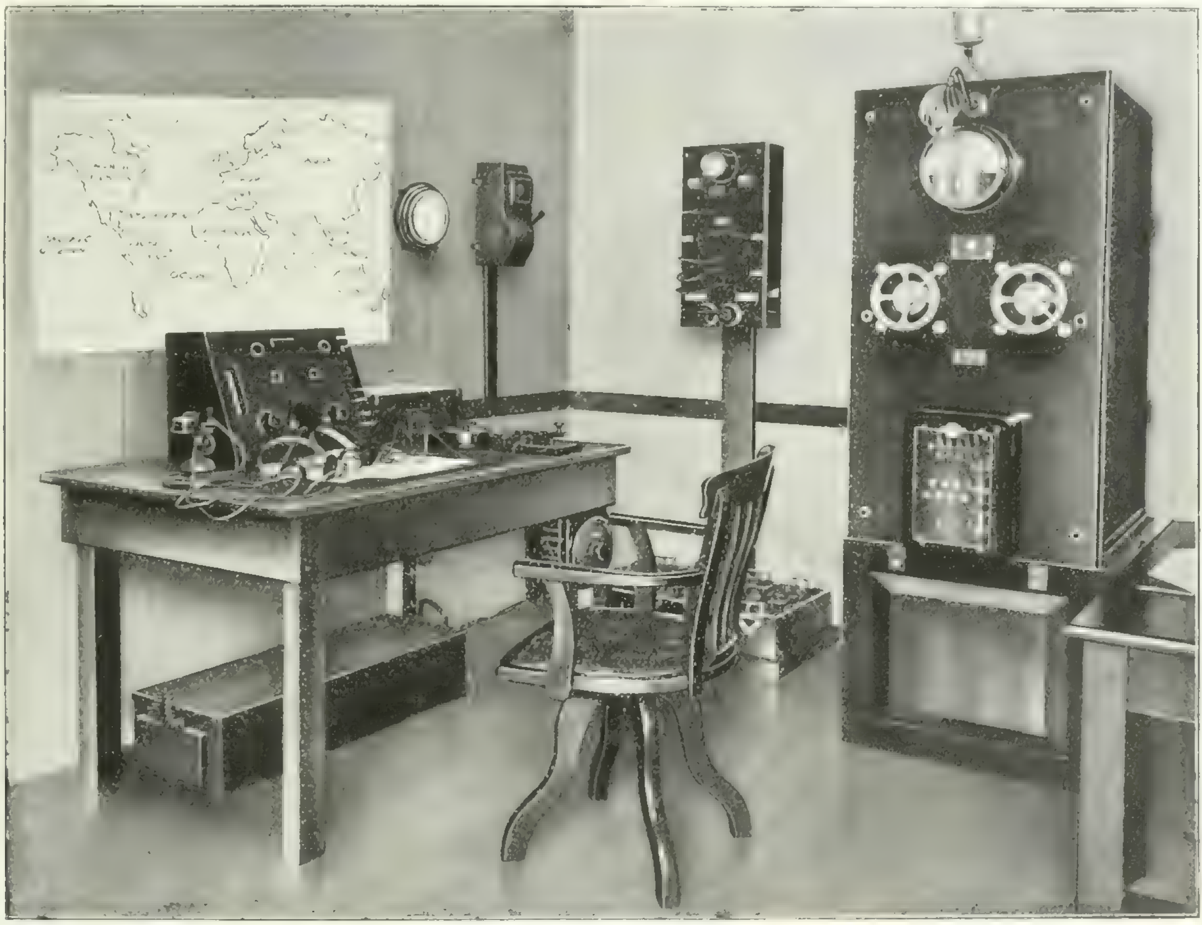


FIG. 1. –SHIP'S CABIN FITTED WITH "POLAR" $1\frac{1}{2}$ KW. SET.

A SHIP'S $1\frac{1}{2}$KW. INSTALLATION.

Fig. 1 illustrates the interior of a ship's cabin fitted with "Polar" $1\frac{1}{2}$ kw. standard ship's installation. At the right of the figure will be seen the transmitting apparatus, which is of the switchboard type, as is usual in the most modern practice. All the recording instruments, adjustment controls, &c., are placed on the front of the switchboard panel, which is of polished slate, whilst the various elements of the low frequency and high-frequency circuits, including those of the emergency gear, are arranged behind it. Below the switchboard panel there is a sound-proof wooden compartment, which encloses the motor alternator and synchronous discharger. Signals radiated by both main and emergency transmitters are sharply tuned, and have high and distinctive spark frequencies, as compared with the low notes produced by most other commercial types of installations. It is claimed that a combination of sharp tuning and spark frequency in the neighbourhood of 1,000 is a feature which places the "Polar" installation in a very distinct class. The high note obtainable has the great advantage of enabling longer ranges to be obtained, and is capable of being read through atmospherics.

Two control wheels are mounted on the panel of the transmitter. The right-hand one enables the operator to transmit on any of the four standard wave-lengths arranged for—namely, 300, 450 (D.F.), 600 (normal), and 800 metres. The set is adjusted at the time of installation on board ship, so that the wave-length changes may be quickly made by the movement of a single handle. In conformity with the regulations enjoining the use of the lowest power necessary for effective communication, provision has been made for obtaining quarter, half and full power by the simple operation of the left-hand control wheel.

DETAILS OF TRANSMITTING GEAR.

Entering into a more detailed description of the transmitting gear, the motor alternator is designed to give an A.C. output of $1\frac{1}{2}$ kw at 500 cycles and a pressure of 200 volts, and is run normally from the 110 volts D.C. supply, although it may sometimes be necessary to vary this to suit the voltage of the particular ship's dynamo. The D.C. armature and A.C. rotor are mounted on a common spindle between a single pair of ball bearings. The fields, however, are separate. This construction has the advantages of compactness and freedom from the mechanical trouble which is often involved in lining up two separate machines and the employment of a coupling between them. Brush gear for both the A.C. and D.C. systems is placed at one end of the machine and is readily accessible. The A.C. rotor has 20 poles, and the speed for 500 cycles is 3,000 revs. per min. The speed, and consequently the spark frequency, is capable of variation by adjustment of the motor field. This adjustment can readily be made by the operator, since the field resistance is placed on his right-hand side just below the operating table. (*See* Fig. 1.)

The Synchronous Spark Gap.

The synchronous spark gap is mounted at the outer end of the machine, and is normally completely enclosed in a strong aluminium-alloy case. A large inspection cover is provided which is held in position by wing nuts. The spark gap rotor is made of special aluminium alloy, and has 20 teeth, giving two sparks per cycle or 1,000 sparks per second at normal speed. The fixed electrodes have been designed with great care. They are easily adjusted, are self-locking and self-cooling, while the spark points themselves are made of copper strips which last a long time, but are easily renewable.

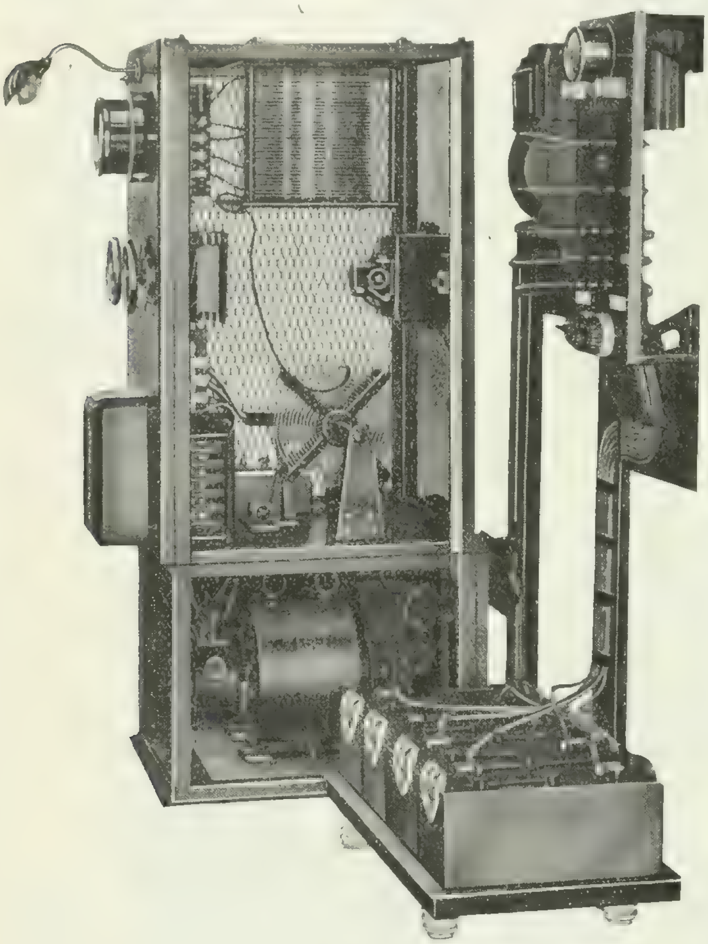


Fig. 2.—Detailed View of $1\frac{1}{2}$ kw. Transmitter.

The spark-gap casing, which, of course, carries the fixed electrodes, is made so that it can be rotated on the end plate of the machine through an angle just greater than that corresponding to the pitch of a tooth on the rotor. The timing of the spark can, therefore, be arranged at the most suitable part of the A.C. cycle.

Control Arrangements.

The motor alternator is controlled by a push button switch, which is fitted to the operator's table. Two buttons are provided, one for starting and the other for stopping the machine. The starter mechanism is entirely automatic, and is of the multiple finger type, resistance being cut out in four successive stages. The total time of starting is controlled by an adjustable air dashpot. In this way the machine is started quickly and smoothly, and the initial starting current is in no way dependent on the temper or mood of the operator, the dashpot being normally adjusted to allow full-speed to be reached in about 4 seconds. The field regulator is only altered if it is desired to change the spark frequency.

The operating key, which is of the latest design, has a breaking-in system which dispenses with a separate change-over switch for the aerial from transmitter to receiver, and enables an operator whilst receiving to call the attention of the transmitting operator in the manner of ordinary line telegraphy.

Condensers and Inductances.

The primary condenser is of 0·01 mfd. capacity, and is rated to stand 15,000 volts safely. The condenser is built up of mica sheets, and consists of a number of large condensers in series. It is mounted in a metal box, having an oil-tight lid of ebonite, and is fitted with a special cooling and insulating oil. Care has been taken in designing the condenser to ensure that there is no chance of mechanical movement of the plates taking place under the alternating forces imposed on them, which in badly-designed condensers gives rise to heating, loss of efficiency, and ultimate breakdown. A safety spark-gap is fitted.

The primary and secondary inductances are built up from thin copper strip in the form of flat spirals. This enables the wave to be continuously varied between the minimum and maximum limits, whereas in the case of a coil wound with stranded wire, only isolated tappings can be employed.

The wave-length selector switch is mounted behind the main slate panel and consists of a vertical bar of insulating material, which can be moved up or down by the control working through a rack and pinions. These details will best be understood by reference to Fig. 2, which shows a side view of the installation. The bar carries two contact blades, each being arranged to engage successively with four fixed contact pieces. One blade is fixed to the top end of the bar and selects one of four A.T.I. tappings, while the other, fixed to the bottom end, selects a primary inductance tapping to correspond. Any one of the four waves to which the set is being initially tuned can, therefore, without any further adjustment, be brought into use by the movement of one handle.

The aerial tuning inductance will be seen mounted at the top of the transmitter. In series with it is the flat spiral aerial coil, which is coupled to the closed circuit inductance. A graduated slide bar enables the coupling to be varied to obtain a pure radiation. Above the two control wheels on the panel is mounted the aerial ammeter, which is fitted in lieu of the usual glow lamp, since it gives a tangible indication of the actual current in the aerial circuit.

The Emergency Transmitter.

On the operator's table is mounted a change-over switch, enabling an emergency transmitter to be brought into action when required. This transmitter is rated at 500 watts, and has a spark frequency of 650 per second, giving a clear pure high note. It will be found that the range obtained with this transmitter is very much better than when a spark coil is used. The set is fitted with motor interrupter, and forms a single unit inside the switchboard cubicle. The terminals of its high-tension transformer are led to a special auxiliary spark-gap. A remote control switch automatically transfers the leads of the main oscillating circuit from the rotary spark-gap to the emergency gap without interfering with the tuning of the primary circuit. The emergency transmitter is operated by the same Morse key as the main set.

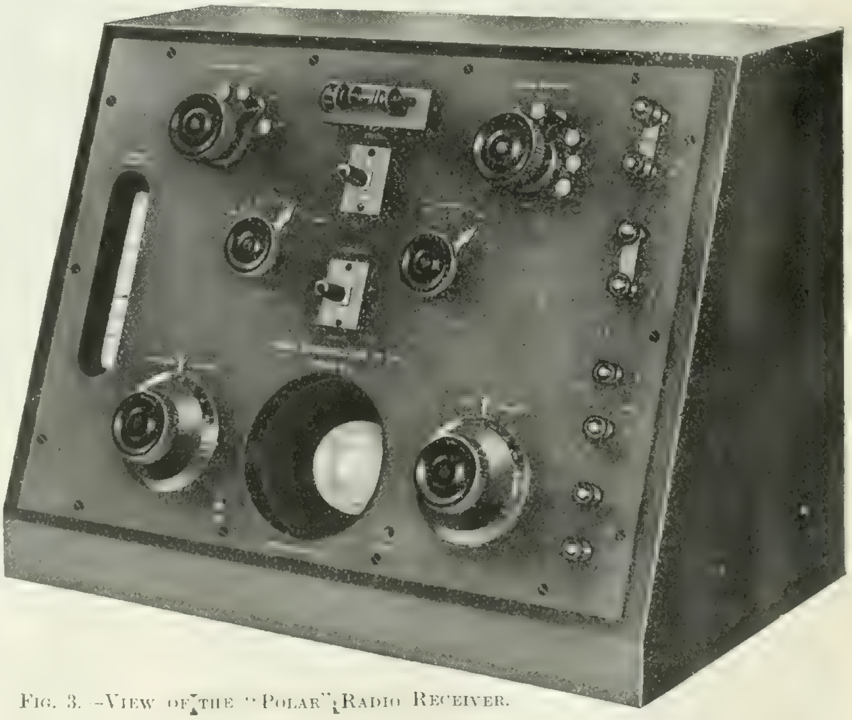


Fig. 3.—View of the "Polar" Radio Receiver.

Receiving Arrangement.

The receiving instrument supplied with the 1½ kw. installation is illustrated in Fig. 3. All its component parts are mounted on a single ebonite panel with controls on the face. The panel is recessed into strong polished teak case and is inclined at an angle to the operator's desk, thus enabling all controls to be easily manipulated while giving a clear view of the scales and indicators. The range lengths obtained with this set are normally from 250 to 9,000 metres. An increased range up to 20,000 metres may be obtained by the addition of a unit containing two inductances.

The aerial circuit is tuned by means of the right-hand adjusting handle, which varies the inductance on the lower right-hand variable condenser, which may be connected in series or parallel with the inductance by means of the lower switch in the centre of the panel. The closed circuit is tuned by the inductance switch shown at the right-hand top corner. A variable condenser is in the bottom corner.

By means of an ingenious wave indicator the wave-length to which the closed circuit is tuned may be read off directly. The indicator can be seen through a window situated on the left-hand side of the receiver; it consists of a rotary metal drum carrying a white scale and movable pointer. The drum is rotated by movement of the secondary tuning coil switch, which exposes at the window one of six calibrated scales corresponding to each stud of the switch. The secondary tuning condenser operates a pointer, which travels longitudinally over the exposed scale, indicating the wave-length. The six scales are made to overlap one another, and, for any given position of the secondary switch and condenser, the wave-length to which the secondary circuit is tuned may be seen by a glance at the pointer, without reference to chart or tables. A switch on both the series and parallel key enables either a crystal detector or three-electrode valve to be used. The crystal detector would only be used in an emergency.

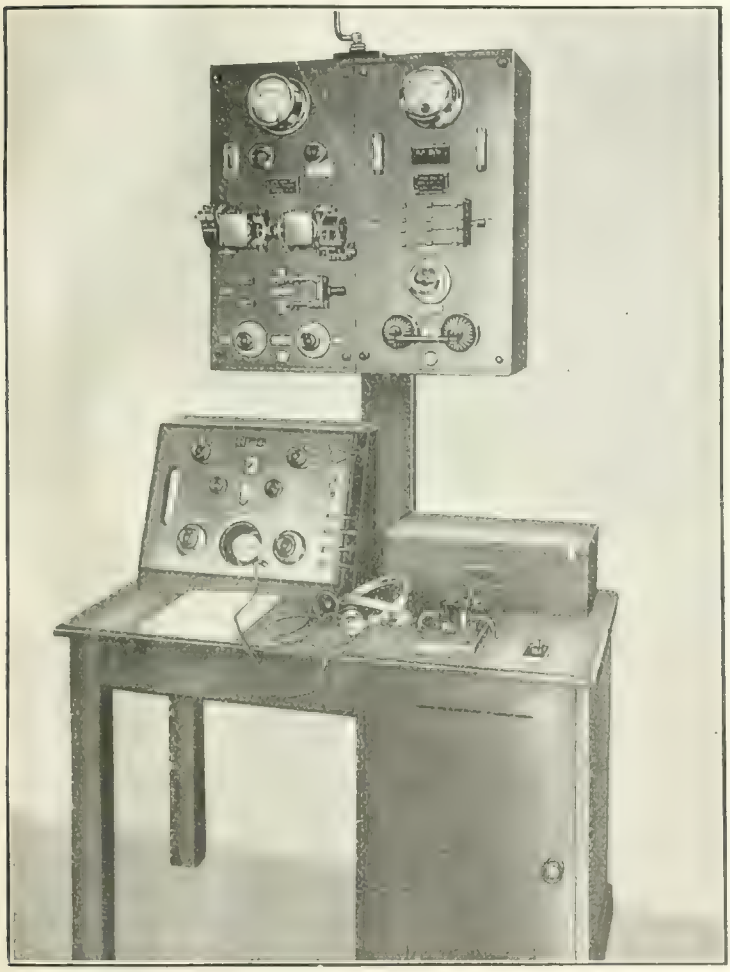


Fig. 4.—View of a 0·25 kw. Ship's Set.

The three-electrode valve detector is situated centrally between the two tuning condensers, and is well recessed into the instrument, thereby giving ample protection. The action of the valve is, of course, absolutely reliable, and, unlike any other form of detector, cannot be upset by atmospherics or induction from the transmitter. The valve filament is heated by current from accumulators, and normally takes 0·75 amps., the filament life being approximately 1,000 hours. At the side of the receiver is placed a "Kallirotron" oscillator unit, which supplies a local source of oscillations for the reception of continuous waves. This oscillator employs the same source of anode and filament voltage as the receiver. Its range of oscillation is from 600 to 20,000 metres.

A Short-range Ship's Set.

Fig. 4 shows another ship's installation rated at 0·25 kw. This set is intended primarily for use on board ships requiring a reliable wireless service at ranges up to 100 miles under normal conditions. Ranges far in excess of this figure may be obtained with this type of installation when working at night or under favourable conditions.

The transmitter is operated from an accumulator battery of 10 cells, which supplies current to a transformer through a high-speed rotary interrupter. The battery has more than sufficient capacity to operate the set at full power for a period of six hours, which fulfils all requirements under international regulations for emergency supply without the necessity of subsidiary apparatus. The battery of accumulators is normally kept charged by current from the main ship's supply. The complete transmitter is of the switchboard type, and is shown supported upon the wall of the cabin in the accompanying illustration. Upon the left-hand panel of the transmitter are mounted the units of the radio apparatus, all adjustments and controls being upon the face of the panel. Rotary motor interrupters are provided in duplicate with a double-pole throw-over switch to enable one or the other to be brought into action.

Below the change-over switch are two motor regulators, by which the speed of the interrupter may be varied. In this way the spark frequency of the set may be adjusted over a considerable range and a high musical note obtained, which greatly facilitates reliable communication during periods of atmospheric or other interference.

Other units upon the panel comprise aerial ammeter, geared adjustment for spark-gap, and wave change switch, enabling four changes of wave-length—namely, 300, 450, 600 and 800 metres—to be instantly made. Transformers, condensers and high-frequency circuits are mounted at the back of the panel. Since no high-tension portion is exposed on the face of the panel, all risk of accidental shock during manipulation is entirely eliminated.

The transmitting key is of the same robust pattern used in "Polar" 1½ kw. sets, and is fitted with an automatic switch, which enables the operator to receive external signals in between the dots and dashes during transmission. There is consequently no switch for changing from "send" to "receive." At the side of the transmitting key a push button master control switch is provided, which starts up or closes down the rotary interrupter and main supply circuits. The above arrangements give ease of control, and greatly facilitate the rapid handling of traffic. The right-hand panel comprises a charging board for use in conjunction with the large transmitter accumulators, and also the two batteries employed for heating the filament of the receiver valve. A voltmeter is provided for indicating the voltage of the accumulators. At the foot of the panel is a switch for reversing the polarity of the mains when necessary. Below the transmitter case will be seen the standard "Polar" receiver.

Ranges of Sets.

The range of the 1½ kw. set depends of course on various circumstances, but a day range of 800 miles and a night range of 1,200 miles has been so frequently obtained that such figures may be taken as indicating the average range under good conditions. A range of 500 miles may be taken as being normal.

The emergency set has frequently communicated 400 to 500 miles at night while its normal range may be taken as 200 miles. The ¼ kw. set has a comparable range.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Office on receipt of published price, plus postage.]

"Russia in the Shadows," by H. G. Wells. (London: Hodder & Stoughton.) Pp. 153. 6s. net.

"Properties of Steam and Thermodynamic Theory of Turbines," by H. L. Callendar, M.A., Ll.D., F.R.S. (London: Edward Arnold). Pp. xi.+531. 40s. net.

"Mathematical Theory of Electricity and Magnetism," by J. H. Jeans, M.A., F.R.S. (Cambridge: University Press.) Pp. vii+627, 4th Edition. 24s. net.

"Electric and Magnetic Circuits," by E. A. [illegible]. (London: Hill Publishing Company.) Pp. xi.+194. 16s. 6d.

"Mechanical World Year Book, 1921." (Manchester: Emmott & Company.) Pp. 310. [illegible] net.

"Scienza e Tecnica Dell 'Illuminazione Fotometria," by Ing. Guido Peri. (Turin: S. Lattes & Company.) Pp. vii.+479. Lire 26.

Mr. S. L. Pearce on American Electrical Practice.

The interim report of the Chairman of the Manchester Electricity Committee (Ald. W. T. Dagnall) and of the Chief Engineer and Manager of the Manchester Electricity Department (Mr. S. L. Pearce, C.B.E.) has now been prepared. As was to be expected, this report contains a great deal of interesting information, and we reproduce it practically *in extenso* below.

The object of the visit was manifold. First, to obtain information on the design and layout of power stations, generating plant, switchgear and auxiliaries, boiler-house equipment, automatic stokers and coal-and-ash-handling plants, on generating voltages, boiler pressures above 250 lb. per square inch, the use of pulverised coal, capital and operating costs and aids to economy in working. Second, to examine the extent to which overhead lines are used in place of underground cables, the limiting voltages and distributing systems employed, the use of pole-line transformers and the relative capital and operating costs of the two systems. Third, to consider the general layout and design of substation plant and equipment, especially that of the outdoor type. Fourth, to inspect public-heating supplies for central power stations, hydro-electric systems, showrooms, staff organisations, interconnection of systems, and to obtain details of certain legal questions.

With these exhaustive ends in view power stations were visited in New York, Newark, N.J., Boston, Philadelphia, Pittsburg, Wheeling, Cincinatti, Chicago, Milwaukee. Detroit and Niagara, while the electrical equipment of the New York Central Railway and typical railway sub-stations of the Chicago, Milwaukee and North Shore Electric Railway and of the Schenectady to Amsterdam Inter-Urban Railway were also inspected, as were the Central Heating Stations in Detroit and the works of the General Electric and Westinghouse Companies.

THE CONCLUSIONS REACHED.

The conclusions arrived at as the result of this visit are summarised as follows :—

(*a*) That, apart from size, the general design and layout of modern American power stations does not differ materially from the latest examples of British practice, and is not superior thereto. It follows from the foregoing that no fundamental alteration in the design of the Barton Station is considered necessary.

(*b*) That the American manufacturers are not so advanced in the development of steam-turbine engineering on sound lines as the British firms, nor (comparing the best plants of each) can the former show such high operating efficiencies as the latter.

(*c*) That the boiler-house practice in American stations—irrespective of the size of units—is to install plant capable of giving an output of 300 to 350 per cent. of the normal rating for short periods—such plant having its maximum efficiency at about 175 per cent. of normal rating. The short-period ratings are in excess of British practice, but are stated to be justified on the ground that to-day the effect of high investment costs predominates over lower operating efficiencies and higher maintenance charges.

(*d*) That there is a marked tendency to increase the working steam pressures up to 350 lb. per square inch, and even higher.

(*e*) That a standard periodicity of 60 cycles per second on alternating-current systems for mixed lighting and power supplies is adopted in America, instead of the more general figure of 50 for this country.

(*f*) That there are no standard voltages for generation—the American figures varying between 4,500 and 13,200 volts, as compared with the two standards of 6,600 and 11,000 volts for this country.

(*g*) That the adoption of pulverised fuel in conjunction with the existing types of water-tube boiler furnaces, or some modification thereof, is one method which offers strong possibilities for increasing the thermal efficiencies of boiler-house plants.

(*h*) That overhead lines—with a few exceptions—are used almost exclusively for transmission pressures of 20,000 volts and upwards to 220,000 volts.

(*i*) That the highest pressure adopted, so far, for 3-core underground cables is 23,000 volts, and there appears to be no tendency whatsoever to adopt higher pressures.

(*j*) That—with the exception of what may be termed the downtown sections of the large cities, where direct-current supplies are principally given—the greatest possible use is made of overhead distribution, mainly on alternating-current systems—the line poles being used for carrying the step-down service transformers.

(*k*) That the service pressures of supply—both alternating current and direct current—are approximately one half of those used in this country.

(*l*) That sub-stations for use on alternating-current systems are being increasingly planned for outdoor service, and that at least 75 per cent. of the apparatus (transformer and switchgear) being manufactured to-day is of the weatherproof type. The savings in building costs are very substantial.

(*m*) That two types of indoor converter sub-stations (direct current) are being developed : (1) The completely automatically operated, and (2) the remote controlled. The former, up to the present, is exclusively applied to railway systems, but the latter is used in conjunction with standard lighting and power-supply networks. In either case, the object is to reduce operating expenses by the elimination of attendants and idle running hours for the plant. This development opens up interesting possibilities.

(*n*) That stand-by batteries—capable of a high rate of discharge for intervals of time ranging from 20 minutes to 45 minutes—are almost exclusively used in conjunction with direct-current converter sub-stations.

(*o*) That public steam-heating supplies are best furnished from independent central stations, or, in other words, that it is not practicable to combine such supplies with the production of electrical energy.

(*p*) That the average price of all supplies of electrical energy for the fiscal year 1919, furnished by such undertakings as the Edison Companies, of New York, Boston, Chicago, Detroit and Philadelphia, varied from 2·15 cents to 5 cents per unit, as determined very largely by the cost of fuel. Broadly speaking, it may be inferred that the cost of electrical energy in the States is not only relatively, but in a good many instances actually, cheaper than in this country, which is due to the bigger scale of operation and the lower charges for distribution, owing to the very general adoption of the overhead system.

(*q*) That, whilst practically all the American undertakings possess very up-to-date and elaborate showrooms, and the business-getting methods are also highly organised, and the inducements held out to consumers very substantial, there appears to be, nevertheless, a tendency to delimit the spheres of business as between gas and electricity.

(*r*) That the staff organisation of the electricity-supply companies is on a very elaborate scale, and the principle of specialisation is carried out to a far greater extent than in this country. In this connection attention is drawn to the possession by many undertakings of a highly trained personnel in their technical and research departments.

(*s*) That practically the whole of the electricity supply industry is in the hands of public companies or public-service corporations, who are subject to the jurisdiction and control (mainly financial) of the Public Service State Commissioners.

(*t*) That the inter-connection and co-ordinated working of the large undertakings is being increasingly adopted in the States—in some cases over areas nearly as large as the whole of England—and these arrangements, for the most part, rest on a purely voluntary basis.

THE APPLICATION TO MANCHESTER.

Whilst a good deal of American practice is inapplicable to this country, and this district in particular, we do not doubt, the report concludes, that much of the information placed at our disposal, or gathered as a result of our many inspections and interviews, will be of great value in connection with the development of the Manchester Electricity Undertaking, and we feel sure that our visit has justified itself, and will well repay the Corporation.

In a report upon the present position of the DUNDEE electricity undertaking, the city electrical engineer (Mr. H. Richardson) states that he hopes to have new plant installed by the end of April at Carolina Port, which will see the city through next winter in a fairly comfortable manner. For the winter of 1922-23 further steam plant, estimated to cost half a million pounds, would be needed to meet the requirements of consumers, and this machinery will have to be ordered at once.

As to the possibility of a hydro-power scheme being developed to meet the city's requirements, Mr. Richardson thinks that, under the most favourable circumstances, such a scheme could not be ready for four or five years. Mr. Richardson is to submit a report on steam generation, and Prof. A. H. Gibson and Mr. Richardson are to be invited to report as to the best methods for future extension of the Grampians generating resources and also on the hydro-electric scheme. In the meantime a petition will be presented aginast the Order.

A Christmas Tragedy.

Futile Search for Electrical Presents.

By "ELECTROCYNIC."

Conformably with the widely-published injunction of the E.D.A., I tried to make this last Christmas an electrical one, in so far as my own present-giving was concerned. The phrase which urged me most to what I knew would be an expensive enterprise was this : "Fashion foretells an electrical Christmas this year." These words appeared at the bottom of the pre-Christmas E.D.A. poster. Of course, I, being a man, am not on confidential terms with the fickle dame who plays havoc with the habiliments of women and the bank balances of their husbands and am, therefore, unable to say whether her prophecy is mere guess-work or is based on information received. In any case, this particular decree of fashion touched a sympathetic chord within my usually unresponsive breast and, without waiting to test the authenticity of Mr. Beauchamp's revelation, I hastened to obey.

During the week preceding Christmas I spent many hours searching for electrical presents which should be at once purchasable and acceptable. As I am in the electrical business there is no need to say that my purse is not a long one ; but I thought I might be able to afford to buy three or four small devices for certain of my relations who have from time to time (probably from ulterior motives) expressed an interest in the subject of domestic electrification. A toaster for a maiden aunt ; a small fire for my mother-in-law ; and a boiling-ring for my wife : these comprised the extent of my ambition.

Touching a Toaster.

I very nearly ordered these articles on the strength of having seen illustrations in the catalogues of reputable firms. However, I concluded that it would, perhaps, be advisable to have a look at them before committing myself. I went, I saw, and I, regret to say, was disgusted. I found that the toaster, in spite of its relatively high price and wholly delightful catalogue representation, was badly-finished, poorly-made, and was in every respect totally unfit to stand in company with the irreproachable silver ware upon my aunt's snowy damask. The toaster was an unsubstantial and consumptive-looking affair, which chattered like castanets when you touched it ; while its nickel-plated surface had an unpleasantly scabby appearance. It looked cheap, but was as a matter of fact quite expensive.

However, I did not buy it, and my respected aunt still has to make her toast by the cosy, but inefficient, coal fire. Of course, I made more than this one attempt ; but I found that unless I was prepared to pay at least 50 per cent. more it was impossible to get anything better than the toaster I have described And even the most expensive ones were nothing to rave about.

Iron, Mica and Wire.

Why are things of this sort made so badly ? Surely, at the prices charged, it should be possible to sell small electrical devices which are at least as well made as other middle-class table appointments. I am not, of course, in the innermost councils of the manufacturers, and it may be that the retail prices are justified by production costs. This, however, does not seem credible, and one can only infer that intermediate profits are much too high. After all, what is there in these small table appliances, to account for their extraordinary prices? A few ounces of sheet iron, a yard or so of wire, and some pieces of porcelain or mica : these are the constituents of the average toaster, which may be priced at thirty shillings or so. I, for one, would not complain at the price, if in exchange I could get a strongly-constructed, carefully-finished and good-looking article ; but so far my efforts have not been very successful.

The toasters I have looked at may have been very efficient in the electrical sense, but in every other sense they were utter rubbish.

The Fire of My Wife's Mother.

I did not, however, allow this toaster fiasco to deter me in my attempt to convert Christmas into an electrical festival. The fact that my aunt would have to go without her toaster was no reason why my mother-in-law should not have an electric fire to provide a little (very little !) warmth in her declining years. I didn't want to run the old lady into bankruptcy by giving her a fire that would consume a great deal of current ; and I thought to myself that I might save both our pockets by getting one of those sweet little things that look like over-grown sunflowers. Such a fire would only use about half a unit an hour, and if she really desired to warm herself, my mother-in-law could hold it in her lap or put it under her chair.

Although I did not succeed in buying the fire after all, I was able to find the kind of thing I wanted. It was excellently made and finished and the price was reasonable. The trouble was that there was only a single specimen of this fire in the manufacturer's showroom, and that had already been sold. I went to other places and inspected fires of the same type, but invariably found that for one reason or another they were not worth buying.

The Inaccessible Element.

To take an instance : I was shown in a certain showroom a fire which had looked entirely delightful from the catalogue illustration. Actually, however, it was utterly contemptible in finish and construction. The whole thing couldn't have weighed more than a pound, including the 12-in. copper reflector. The metal work of the pedestal was so thin that you almost left a dent at every touch. It is obviously desirable that the elements of electric fires should be easily replaceable ; yet in this particular fire I could see no way of changing the element without using a pair of wire-cutting pliers, a tin opener and, subsequently, a soldering set.

There was no means of access at the back of the fire ; while the wire guard over the front was rivetted in about twelve places. (I suppose a dozen rivets *are* cheaper than three detachable fasteners). Not only did this arrangement prevent me from changing the element, but it also hindered any attempt at dusting the interior of the reflector, since the wire mesh would not permit the insertion of more than two fingers at a time. And even if one did succeed in forcing an entry, one could only replace the element by the slow process of unwinding the old wire, and rewinding the new, on the fragile mica structure which served as a former.

My One Success.

In the case of my wife's boiling-ring, I had to run the same gamut of flimsy rubbish, but fortunately was able at last to buy the thing I wanted. Certainly, and naturally, I gave more time and attention to this item than to the others, and perhaps had I begun my search somewhere back in the late summer I might have succeeded in all three affairs.

My experiences in this connection have at any rate convinced me that, although individual manufacturers are turning out articles of great utility and excellent finish, the general standard of quality is perniciously low. I think that this is indisputable. One has only to examine closely the variegated display of electrical devices in the average contractor's window to realise that there is something radically wrong with the manufacturing end of the business. It is not lack of ability, since obviously it has required a greater degree of ingenuity to devise and make the present unsubstantial rubbish than would be necessary for the production of more solidly-constructed articles.

The Vogue of Fragility.

Cast metal parts seem to be almost unknown nowadays in the electrical appliance business. Manufacturers have pinned their faith and reputation to fragile spinnings and stampings. Perhaps I am the kind of man for whom the Gillette people have designed their new "Big Fellow" razor—a man who prefers to handle things of weight and substance, and who would always rather use a sledge hammer than a tack hammer wherewith to drive the most diminutive nail. However this may be, I certainly dislike the present mania for lightness which is apparent in the manufacture of domestic electrical appliances. Stamped metal, of course, has its place, and a very important place, in the scheme of things electrical ; but its use has been carried altogether too far.

In many cases which have come under my notice, the metal has been so thin that it could be bent between the finger and thumb. Often this form of construction has quite definite disadvantages. For example, the connecting pins in most electric irons are protected by a thin strip of metal. The slightest knock will usually suffice to push this guard out of shape, and then, of course, it is impossible to insert the plug.

Next Christmas.

I am now looking forward to next Christmas, in the hope that by that time a change for the better will have taken place. I really *do* want to buy electrical presents, but I am not going to put myself and the industry to shame by giving away articles of obviously bad quality. No doubt Mr. Beauchamp will make another attempt to induce the public to adopt the habit of giving electrically. Well ! he has got a hard row to hoe so long as the present low standard of quality is maintained ; and he would do far better to address himself to the manufacturers, with the request that they make something worth the giving.

The Institution of Electrical Engineers.

DISCUSSION AT BIRMINGHAM.

The meeting of the South Midland centre of the Institution of Electrical Engineers, which was held on December 15, was devoted to a discussion on Mr. W. B. Woodhouse's Paper on "The Distribution of Electricity," an abstract of which appeared in our issue of December 3.

The discussion was opened by Mr. R. A. Chattock, who complained that the formulæ which Mr. Woodhouse used in his Paper were not easy of application, owing to the fact that the probable value of the constants adopted were not given. He agreed that in a large distribution system three pressures at least would have to be adopted, and probably four. This was due to the fact that a pressure of 30,000 volts, while suitable for large-capacity trunk mains, was too high for the smaller-capacity mains which would be required for supplying villages in the agricultural districts within, say, a radius of 10 or 15 miles of Birmingham, especially as 30,000-volt underground cables had for mechanical reasons to be limited to a capacity of about 7,000 kw. In Mr. Chattock's opinion interconnection of networks could be carried too far, and while the possibility of such interconnection should be provided for, it should not be permanently made. It would also be desirable to provide ample reactances in the distribution system between one generating station 'bus bars and each section of the distribution network, in order to keep the expenditure on switchgear within a reasonable figure. Mr. Chattock called attention to the possibility of supplying direct current on as economical a basis as alternating current to outlying districts by the employment of the mercury arc rectifier, a point which Mr. Woodhouse seemed to have overlooked. The use of this apparatus not only did away with the employment of very expensive low-tension feeders, but also saved the cost of operating rotary sub-stations.

Mr. W. Wilson said that, to his mind, the arguments in favour of bold planning where the provision of electricity supply was concerned were greater to-day than ever before. Electricity supply enterprise could be divided into two classes, the first of which was usually to be found in a district where purely local schemes had been inaugurated, and where the demand was generally a number of years in front of the supply. The second class was exemplified by most hydro-electric enterprises which, although often criticised as being undertaken on too large a scale, had never in his experience failed on account of too small a demand. He hoped that recent legislation would do much to counteract the unfortunate tendency to excessive caution which had been only too marked a feature of our electrical policy in the past.

Mr. A. M. Taylor gave a detailed account of some tests he had recently been undertaking, the principal points deducible from which were that with 3-phase current the total losses in armoured and unarmoured cables were practically equal. The losses in unarmoured cable were 62 per cent. greater than with continuous current. The losses in unarmoured cable with single-phase current were only 20 per cent. greater than with continuous current. It followed that of the 62½ per cent. given for 3-phase losses, no less than 50 per cent. were due to eddy-current losses caused by the rotating field, while only 12½ per cent. were due simply to the pulsation of the field. A very great saving in eddy-current losses in the lead sheathing could therefore be effected by using single-phase current for long-distance transmission, while for the same reason the desirability of employing a frequency of 25 for extremely long-distance transmission should be considered, as it was obviously not in the best interests of the maintenance of insulation of extra-high-tension cables that there should be an unnecessary loss in the lead envelope amounting to 50 per cent. of the copper losses. The practical equality of temperature rise in unarmoured and armoured cables with 3-phase current proved conclusively that the armouring did not materially affect the question as would have been expected.

DISCUSSION AT GLASGOW.

A discussion, of which we give an account below, took place at Glasgow on December 14th on Mr. W. B. Woodhouse's Paper.

Mr. Norman C. Bridge remarked on the difficulty of ascertaining the demand in advance in developing a power system. To secure sufficient flexibility sub-stations with switchgear units of a semi-portable type might be used, these being replaced from time to time as the distribution system grew. Such a policy, he thought, would be better than the gradual raising of pressures suggested by the author. On the question of interconnection it would be difficult to justify any large expenditure. The cable was idle copper for a large part of the time and suitable boilers and generating plant had to be maintained at both ends to enable it to function in emergency. The suggested benefit of the diversity of incidence of demands on stations running in parallel was gradually losing point.

Mr. D. S. McCall gave figures for a 33,000 volt transmission scheme, the total cost coming out about £0·53 per k.v.a. mile. Of these costs 62 per cent. were for cable and pilot wires, including the cost of laying; switchgear absorbed 4·7 per cent., jointing 2½ per cent., and transforming and boosting apparatus 21 per cent.

Mr. W. J. Cooper thought great consideration should be given to the use of overhead lines. The simplicity with which these could be used at different pressures was important.

Mr. R. B. Mitchell agreed with the last speaker that the use of overhead cables should be seriously considered. He had had entire satisfaction from 20,000-volt cables—in fact, cables were in his opinion the soundest part of the Glasgow system.

Mr. D. Berry wished to know how the equation for the safe rating of 11,000-volt cables was derived. As regards the size of sub-stations the sites available, especially in cities, was a factor. The cost of excavating was a serious item in cable laying.

Mr. A. P. Robertson said that in the case of switchgear doubling the pressure almost quadrupled the cost. A 6,000 k.v.a. sub-station could be put down at £6 per k.v.a., including buildings, and a 12,000 k.v.a. sub-station at £4 per k.v.a. He thought underground cables the most reliable and had had bitter experiences with overhead lines.

DISCUSSION AT CARDIFF.

A discussion, of which we give an account below, took place at Cardiff on Monday, December 6th on Mr. Woodhouse's Paper.

Mr. A. Nicholls Moore questioned whether it was desirable to have two different high-working pressure mains to consumers. He was sorry that the author did not enlarge on the cost of energy. The working costs were proportional to the load factor according to Mr. Woodhouse, but something must be taken into account for diversity factors and for stand-by charges apart from standing charges. The formulæ set down in the Paper would have been more useful had the author made it a little clearer how the different factors were arrived at.

Mr. J. W. Burr said that the cry for cheap electricity would involve the expenditure of vast sums on transmission lines and if those sums were expended he did not see how a cheap supply of electricity would be possible. Mr. Woodhouse had suggested that interlinking mains should be used to supply consumers *en route*. The speaker thought that they might also be used for taking a supply from waste heat stations.

Mr. A. Ellis pointed out that with transmission the question of cost of switchgear had also to be considered. This formed one of the most serious items in capital expenditure in any comprehensive scheme of bulk supply.

Mr. W. Nairn pointed out that the author gave two expressions for the rating of cables, one for the current density according to Kelvin's law, and the other for the maximum permissible density. As regards the first rating it would be interesting to know exactly what this current density was. Mr. Beard had investigated the subject a few years ago and had found that it was approximately 1,000 amperes per sq. inch. He would like to know whether Mr. Woodhouse confirmed this figure.

Mr. W. A. Chamen thought that the very high pressures necessary to obtain an economical supply in a large area would mean a tremendous expenditure in transformers, switchgear, &c., and he therefore felt that from this point of view these high pressures would not be required.

Major E. Ivor David did not agree with Mr. Woodhouse that the cost of overhead lines increased with pressure. In the colliery system with which he was connected their average load factor during the day shift was 96 per cent., and during the off-shift about 80 per cent. But when they came to the load factor per machine installed, the colliery gave very bad figures. He considered that until the prices of switchgear came down the extension of high-tension distribution in this country would be very much retarded.

Mr. W. B. Woodhouse in reply said that Mr. Ellis and other speakers had referred to the high cost of switchgear. He agreed that this was hampering development and that switchgear makers would have to produce something cheaper if long distance schemes were to be developed. In the application of Kelvin's law to a cable the cost, which varied with the size of a conductor, was roughly about four times the cost of the copper.

We regret that an error occurred in our report of Mr. B. Welbourne's remarks on the Heating of Buried Cables which appeared on page 741 of our December 24th issue. We stated that he had said the drawing of cables into ducts was a moribund system. This remark really applied to the solid system.

New District Railway Rolling Stock.

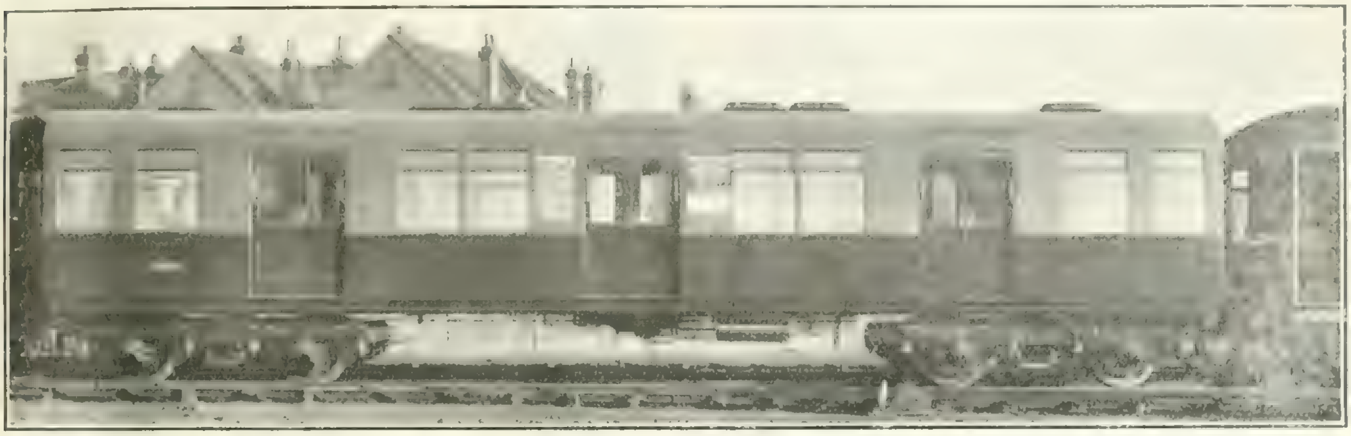


FIG. 1. GENERAL VIEW OF THE EXTERIOR OF THE NEW DISTRICT RAILWAY ROLLING STOCK.

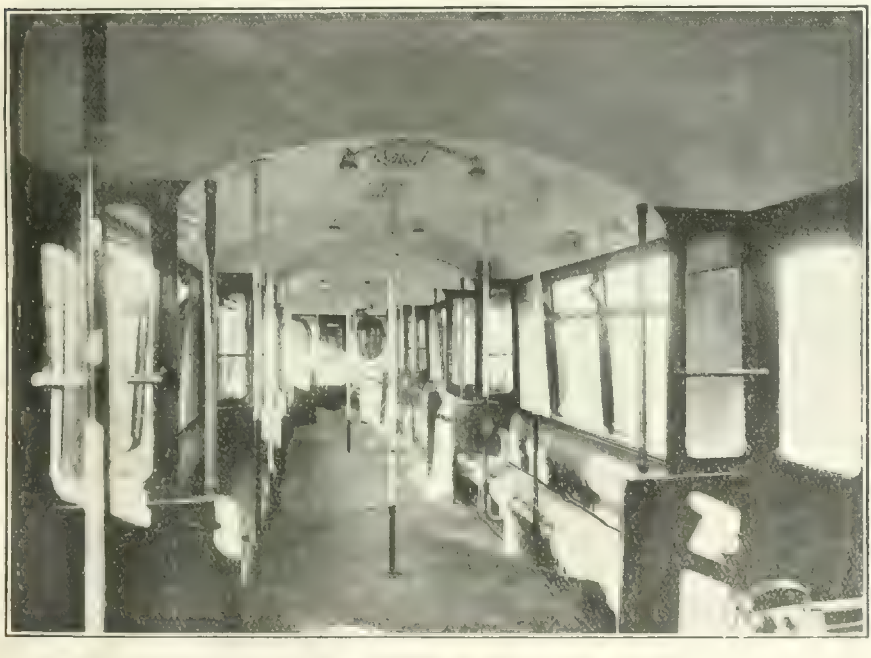


FIG. 2.—THE INTERIOR OF THE NEW STOCK.

With the object of establishing an eight car train service on certain sections of the Metropolitan District Railway, orders were placed some time ago for 100 cars of improved design. The Press were recently invited to take a trial trip on a train which forms the first instalment of this large order, the cost of which is estimated at £750,000. The builders of the 100 new District cars are the Metropolitan Amalgamated Carriage, Finance & Waggon Company, of Birmingham; and the electrical equipment is provided by the British Thomson-Houston Company, of Rugby. The width of the cars is 9 ft. 6 in., or a foot wider than the old District cars and the sides of the cars are slightly curved instead of straight, the roof is arched instead of clerestory, the exterior colouring is engine lake, a deeper shade of red than the old cars. The wheels are 36 in., compared with 30 in. on the old cars, and this, with improved springing arrangements and the large bogies with which the trailer cars are fitted, makes for silence and smooth running. The motors are of higher power than their predecessors. The new trains will be capable of running 45 miles per hour, and starting will be accelerated, while improved braking equipment will secure more rapid yet more even stopping.

Special attention has been paid to the lighting of the cars. The lamps are fitted in artistic brackets, and the light is evenly diffused by opal reflectors. There are no straps, but hand rails and vertical pillars are provided in convenient positions. On the floor wooden slats are replaced by linoleum. The arrangement of the doors is considered the most important feature. Each trailer car has three double sliding doors on either side. The old type of vestibule at either end of the car is dispensed with. On the motor cars and control trailer cars, in addition to the three double doors, single doors are fitted at the ends of the cars. An eight-car train of the new stock will give the equivalent of 52 single doors. The provision of these facilities for alighting and entering will reduce the time taken in loading and unloading, accelerate the operation of individual trains, and enable more trains to be run. It is the company's intention for the relief of rush hour congestion to set up a regular service of eight-car trains. There are indicators, one on either side of the centre doors, showing the stations at which the train does not stop.

Heating and Cooking Notes.

A REVIEW OF 1920 AND THE PROSPECT FOR 1921.

The opening of a new year finds the heating and cooking section of the electrical industry in a very productive state, though unfortunately war conditions have had and have still an adverse effect on the affairs of many of the electricity supply authorities. Consequently progress in heating and cooking is held back owing to inadequacy of electricity supply. It has taken many years of patient effort, and much expenditure of hard cash, to bring electrical heating and cooking apparatus to the reliable and efficient state that it is to-day, and it is distinctly unfortunate that at this time when the public are educated to the advantages such appliances possess, the use of the appliances has in many districts to be tabooed because the electricity supply system is overloaded And, what is more, there seems no prospect of an early alteration of these conditions.

THE ROLE OF THE DIVERSITY FACTOR.

This is the more unfortunate as the heavy plant side of the industry is incapable of dealing with the demand that exists, so that there will undoubtedly be several months of waiting before plant is delivered and put into operation to relieve the pressure on overloaded generating stations. Whilst we have every sympathy with the station chief and the mains engineer struggling against all these difficulties, we do feel that sufficient recognition is not always given to the wide diversity factor which many domestic electric appliances provide. It is not at all likely that serious peaks will arise from the use of irons, kettles, vacuum cleaners, toasters, milk boilers, &c., and all these articles do valuable missionary work on behalf of electric heating and cooking. They represent methods of peaceful penetration and often prove to be the forerunners of the employment of larger apparatus, such as radiators and cooking stoves.

To omit to encourage the use of small appliances now is to retard progress not only at the present time but probably for two to three years in the future, after which period it is probable that electric supply conditions will be much more normal.

Slow Progress.

Progress in the installation of electric lighting in housing schemes is slow, and in connection with heating or cooking still worse. Due consideration does not seem to be given to the advantages of cleanliness and convenience. Initial cost receives the main attention, a factor not to be wondered at considering the present high figure of taxation and rates, but to be regretted, because ultimately much of the difference in initial cost will be accounted for in annual white-washing and decorations and cleaning occasioned by the use of a combustible illuminant and heat agent. In other words, saving now will mean spending annually hereafter. Undoubtedly an urgent problem in domestic appliances calling for solution is that of hot water supply. At the moment the coke boiler seems to be the cheapest but it is not labour saving or particularly convenient. Given an economic system of electric water heating the progress of domestic electrification would undoubtedly be more rapid. The apparatus available, which offers a steady load throughout the day and night is on the right lines, but the supply authorities have not taken up the scheme with enthusiasm, neither, in many cases, have equitable rates been quoted for supplying electrical energy for this purpose. Such apparatus offers a 100 per cent. load factor, which should enable a very reasonable rate to be quoted.

Stimulating the Public Interest.

Commendable efforts have been made during the past year to stimulate public interest in the use of electrical appliances. The British Electrical Development Association has got into running order, and provided much useful publicity matter for distribution and has also organised publicity campaigns in the general press. Manufacturers have also realised the value of general press publicity as a means of stimulating demand and aiding sales through contractors and supply authorities. In addition, numerous articles have appeared in the press concerning domestic applications of electricity, all of which considerably aid progress.

Industrial Electric Heating.

On the industrial side, considerable developments have taken place in the use of electric heating for a number of manufacturing processes, for maintaining the temperature of store-rooms, and for the heat treatment of materials. Undoubtedly the advantages of easy and exact temperature regulation and control provide a means for wide development in the application of electric heating in manufacturing industries generally.

Many manufacturers of electric fires report that the export demands are steadily increasing. Compactness of apparatus and facilities for easy assembly are factors which have received considerable attention by firms catering for the export market. This has had an influence on the design of home apparatus as well, as it has been realised that it is a convenience to contractors to be able to quickly change elements from one fire to another, either to obtain a fire with a different finish or pattern frame, or to provide a fire with elements for a different voltage.

The successful experience with electric fires and cookers on board ship during the war has led to a wider use of this class of apparatus in peace time. A ship's galley is never roomy in the ordinary sense of the word and therefore the compactness of a marine electric cooker and the advantages gained by reducing the heat of the atmosphere due to the electric cooker as compared with a coal cooker provide a marked improvement in working conditions in the galley, especially on a vessel which passes through the tropics.

A start towards standardisation of designs has been made in connection with electric cookers, but we are still without the principle of elements of standard dimensions which can be fitted to any apparatus, and quickly changed in a similar manner to a lamp. Some points in the standard specification are quite good, but several are open to criticism, and a wide diversity of opinion.

The "Ideal Home" Exhibition

The "Ideal Home" Exhibition at Olympia last January provided a valuable means of showing the public the advantages of electrical appliances, an opportunity which was taken advantage of by many manufacturers. Many new pieces of apparatus have been introduced during the year, most of which have been described in these columns from time to time.

Correspondence.

A QUESTION OF NOMENCLATURE—WIRE RADIO.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to the letter of General Squier, published in your issue of December 17th (page 716), I think that the "Wire Radio" should be designated "High Frequency Telephony and Telegraphy."

As a matter of fact, that system of telephony and telegraphy was invented by M. Maurice Leblanc, and described in his French patents No. 215,901 of 1891, entitled, "Multiple Telephony," and No. 234,785 of 1893, even before radiotelegraphy was known. M. Leblanc made use of a special telephone receiver for high-frequency circuits.

Wire radio for power lines under the name of high frequency telegraphy has been described by L. Neu in his French patent No. 355,442 of 1905.

I beg to call the attention of your readers to the fact that the first description of multiple telephony and telegraphy with valve amplifiers at the receiving end and valve generators of reduced power at the transmitting end as actually used to-day has been given in my French patent No. 510,964, dated June 25, 1915.

I should say that the "High Frequency Telephony and Telegraphy" is a French invention.—I am, &c.,

Paris, Dec. 14. Marius Latour.

THE ENGINEERS' CLUB.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your current issue you mention my name in connection with the formation of an Engineers' Club, and I would like to confirm that I am strongly in favour of one being started if it be found practicable to do so. I have not so far heard of any definite proposals and may therefore be allowed to mention a few points that in my judgment are of importance.

First of all, I think it essential that the members should be drawn from every branch of engineering, and I would urge that membership of a recognised engineering institution should be one necessary qualification. I would include every class from students upwards, possibly grading the subscriptions. The next essential is that the club should be high class in regard to its amenities and appointments, and capable of competing in attractiveness on its merits with other West End clubs. The catering, while providing ordinary club fare, should also meet the requirements and purses of those who have to study economy. I am inclined to think that the members would benefit by a contract with an experienced restaurateur, amateur catering often being extravagant and indifferent. Bedrooms would be a great boon to members, and should be provided, if possible. The locality should be as near as practicable to the Institutions, and it is possible that premises might be found on the South side of the river, a neighbourhood which is likely to improve in character with the erection of the L.C.C. palace.

It will be noted that my suggestions involve a club on democratic lines, and it is on these only that it is likely to succeed, but success requires that there shall be an unwritten rule, strictly observed, that there shall be no order seeking practised within the club; every member must feel assured that he will be not be met with inconvenient questions as to work in progress or contemplation. I imagine that the only way in which the club can be established is by means of a limited liability company, with its shareholders drawn chiefly from among the club members. The capital required for buildings, furniture and appointments will necessarily be large, and it is only on this score that I feel any doubt as to the project being practicable.

The advantages to be anticipated from an Engineers' Club in London are manifold. The salient ones are the affording of opportunities for meeting brother engineers in other branches as well as in one's own; the provision of a central rallying point common to all branches and all grades; facilities for gatherings of a social character; opportunities of welcoming engineers and others from overseas and a permanent headquarters for all non-Londoner engineers at which they can be communicated with.

The Engineers' Club in Manchester has been a conspicuous success and has wrought much good; there is every prospect of one being established in Birmingham in the immediate future, and it may be hoped that others will follow in other important industrial centres. All such clubs should be linked together, and it ought to be found possible to make arrangements by the payment of an additional subscription to any one to make a member free of all. It will be more difficult to start a club in London than in the provinces, because the cost of premises will be higher, the standard of comfort higher, the counter-attractions are greater and the homogeneity of possible members less. That there is a desire for such a club and for more social intercouse is quite certain. The popularity of the informal little dinners after the I.E.E. meetings held for a time during my presidency are enough to show this. I have long been convinced that the social side of the Institution ought to be developed, and I think the club would afford the readiest means of doing this.

Already sporadic and successful efforts have been made to bring engineers together—the Smeatonian Club, the 25 Club, the Dynamicables, the Electro-Harmonic, the Electrical Engineers' Ball, the Batti-Wallahs would all identify themselves naturally with the club. I trust that an influential committee may be formed and that the various problems involved may be fully considered.—I am, &c.,

London, Dec. 22. C. H. Wordingham.

[We regret that owing to extreme pressure on our space, we were not able to include the above letters in our last issue. Ed. *E.*]

"FREAK MESSAGES" AND MAGNETIC STORMS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In the "Radio News" for December, 1920, is an account of the receipt in Scotland by a wireless amateur, Mr. George W. Benzie, of wirelessly transmitted speech from the station of Mr. Hugh Robinson, at Keyport, New Jersey, 200 watts being used; and Mr. Gernsbeck suggests in an editorial that "all such freak messages take place only during magnetic disturbances of the earth."

This suggestion is of interest because I had already pointed out in my Paper on wireless telephony, "Transactions" of American Institute of Electrical Engineers, July, 1908, that super-positions of curves of magnetic disturbances furnished me by the U.S. Weather Bureau with the curves taken by me of relative intensity of trans-atlantic transmission showed that the curves had the same character and that therefore the two phenomena were related to each other. A little over a year ago I published in the "Scientific American" an account of the first transmission of speech across the Atlantic on several occasions in the spring of 1908 between Brant Rock, Mass., and Macrihenish, Scotland.

It would be very interesting if some one in a position to obtain access to the records of magnetic storms would ascertain if there were not strong magnetic storms in the spring of 1908 about the time these first telephonic transmissions took place.

Of course, the transmissions referred to, since they were carried out with professional apparatus and towers 420 ft. high and 1 kw. of energy at 17,000 cycles, are not by any means comparable as a feat with the receipt by Mr. Benzie from Mr. Robinson's station, but it would nevertheless be a matter of scientific interest to know if the transmission on the two dates referred to occurred during magnetic storms, as, if so, it would tend to confirm Mr. Gernsbeck's theory and the relation of the curves for trans-atlantic transmission and magnetic disturbances referred to in my 1908 Paper. I am, &c.,

Boston, Mass., Dec. 13. Reginald A. Fessenden.

THE CRAWLING OF INDUCTION MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In reply to Dr. Chapman's letter on p. 747 of your issue of December 24, the first queries he raises are dealt with in the original article, but the following additional description may be added.

The article explains that, owing to the saturation of the stator tooth lips with leakage flux, the main airgap flux is "ragged," that is to say, for about one half the slot pitch (under the tooth) flux crosses the airgap, while over the other half of the slot pitch, under the slot, practically no flux crosses the gap, owing to the high reluctance. The crawling speed is found by observation to be such that the rotor moves exactly one stator-slot pitch during one period of the supply, and a rotor conductor is considered which moves under a tooth while the north-pole half-wave is passing over that tooth, and then moves past the slot while the south pole passes. That is to say, this conductor cuts north-pole flux only, and the E.M.F., due to rotation, is a positive half-wave followed by zero for half a cycle. If the rotor coil spans a pole-pitch, then 180 electrical degrees away from the first conductor is another conductor which cuts south-pole flux only. These two conductors form a turn which carries a current which consists of only one lobe of an alternating current, the remaining half-cycle having zero current. This is mathematically equivalent to an alternating current of half-magnitude, plus a direct current of half-magnitude, plus higher harmonics.

The E.M.F. produced by any other rotor conductor may be represented by a sine wave of which 180 deg. has been wiped out and replaced by zero. Progressing round the rotor, the varnished portion occupies a position gradually moving relatively to the sine wave. In a conductor exactly midway between the conductors previously described, the E.M.F. exists as a sine wave from 90 deg. to 270 deg., the remainder being zero, and this has obviously no direct component. These varying E.M.Fs. may easily be shown to be made up of three terms (neglecting higher harmonics), which consist of a direct term, an alternating term (varying with the slip frequency), and a double-periodicity term. The two alternating E.M.Fs. are constant in magnitude, but differ in relative phase round the periphery, while the direct component varies from a maximum in the position shown in Fig. 1, p. 440 (October 15, 1920), to zero at a point half a pole-pitch away from it.

I cannot agree that the variation of the permeance when brought into the transformer E.M.F. equation will affect the conclusions reached. It will certainly bring in an additional double-frequency term, just as the other irregularities in the stator (stepping and grouping of coils, saturation, &c.) will bring in a whole series of harmonics, but since the transformer E.M.F. must be proportional to a *time* rate of change, it is impossible for a direct E.M.F. to be generated, so as to destroy the direct component generated by the rotation. The difference between time rate of change and space rate of change must be emphasised. A direct current cannot be produced by a time rate of change of a flux. That is, there is no such thing as a homopolar transformer, but the existence of the homopolar generator proves the possibility of generating a direct current by a space rate of change of flux.

The difference between the ordinary rotating-field theory and the theory outlined in the article criticised may be roughly summarised as follows: The irregularity in the main field may be in imagination, or mathematically, split up into two oppositely rotating fields, with one of which the rotor moves. The field apparently rotating backwards produces currents in the rotor of approximately double frequency. The outstanding difference lies in the consideration of the field apparently rotating with the rotor. The pure rotating-field theory states that as this moves synchronously with the rotor no E.M.F. is produced.

The crawling-motor theory states that as this field is always of the same strength relative to any individual rotor conductor, a direct E.M.F. is produced in a similar manner to the E.M.F. produced in a homopolar machine.

The final proof of the inadequacy of the rotating-field theory is the behaviour of the machines themselves, as with low-resistance rotors, firstly, the loss of torque observed on test is far greater than can be explained by the harmonic field acting as a superposed induction motor, and, secondly, the crawling speed is exactly a sub-synchronous speed, without allowing for any negative slip, as is required by the rotating-field theory.—I am, &c.

Hale, Cheshire. Laurence H. A. Carr.

THE BRITISH COMMITTEE FOR AIDING MEN OF LETTERS AND SCIENCE IN RUSSIA.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: We have recently been able to get some direct communication from men of science and men of letters in North Russia. Their condition is one of great privation and limitation. They share in the consequences of the almost complete economic exhaustion of Russia; like most people in that country, they are ill-clad, underfed and short of such physical necessities as make life tolerable.

Nevertheless, a certain amount of scientific research and some literary work still goes on. The Bolsheviks were at first regardless, and even in some cases hostile, to these intellectual workers, but the Bolshevik Government has apparently come to realise something of the importance of scientific and literary work to the community, and the remnant—for deaths among them have been very numerous—the remnant of these people, the flower of the mental life of Russia, has now been gathered together into two special rationing organisations, which ensure at least the bare necessities of life for them.

These organisations have their headquarters in two buildings, known as the House of Science and the House of Literature and Art. Under the former we note such great names as those of Pavlov the physiologist and Nobel prizeman, Karpinsky the geologist, Borodin the botanist, Belopolsky the astronomer, Tagantzev the criminologist, Oldenburg the orientalist and permanent secretary of the Petrograd Academy of Science, Koni, Bechterev, Latishev, Morozov and many others familiar to the whole scientific world.

Several of these scientific men have been interviewed and affairs discussed with them, particularly as to whether anything could be done to help them. There were many matters in which it would be possible to assist them, but upon one in particular they laid stress. Their thought and work is greatly impeded by the fact that they have seen practically no European books or publications since the Revolution. This is an inconvenience amounting to real intellectual distress. In the hope that this condition may be relieved by an appeal to British scientific workers, Prof. Oldenburg formed a small committee and made a comprehensive list of books and publications needed by the intellectual community in Russia if it is to keep alive and abreast of the rest of the world.

It is, of course, necessary to be assured that any aid of this kind provided for literary and scientific men in Russia would reach its destination. The Bolshevik Government in Moscow, the Russian trade delegations in Reval and London, and our own authorities have therefore been consulted, and it would appear that there will be no obstacles to the transmission of this needed material to the House of Science and the House of Literature and Art. It can be got through by special facilities even under present conditions.

Many of the publications named in the Oldenburg list will have to be bought, the costs of transmission will be considerable, and accordingly the undersigned have formed themselves into a small committee for the collection and administration of a fund for the supply of scientific and literary publications, and possibly, if the amount subscribed permits it, of other necessities, to these Russian savants and men of letters.

We hope to work in close association with the Royal Society and other leading learned societies in this matter. The British Science Guild has kindly granted the Committee permission to use its address.

We appeal for subscriptions, and ask that cheques should be made out to The Treasurer, C. Hagberg Wright, LL.D., and sent to

The British Committee for aiding Men of
Letters and Science in Russia,
British Science Guild Offices,
6, John-street, Adelphi, London, W.C.2.

We are, &c.,

Montagu of Beaulieu
Ernest Barker
E. P. Cathcart
A. S. Eddington
I. Gollancz
R. A. Gregory
P. Chalmers Mitchell
Bernard Pares
Arthur Schuster
C. S. Sherrington
A. E. Shipley
H. G. Wells
A. Smith Woodward
C. Hagberg Wright.

THE ENGINEERS' CLUB AND MR. PURSE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: There are two matters discussed in your issue of December 17 which, although apparently disconnected, have, to my mind, an important bearing on each other. I refer first to the proposal to form an Engineers' Club in London, and secondly to the lonely fight which Mr. Purse has valiantly put up in contesting the Electrical Engineers' Council's proposals in regard to increased subscriptions. In reference to the latter I belong to that indifferent class of members which really takes no interest in the work of the Council beyond the purely technical work of the Institution, and am only too glad that I do not have to take any positive part in the Institution's activities. (If I were to express an opinion on the debate I should say that Mr. Purse's opposition was amply justified if only in calling attention to the way in which the proposals were rushed on the members). The point is, however, that my attitude which I am sure is typical of about 80 per cent. of the members, arises chiefly from a complete lack of corporate feeling in the engineering profession and, from the accepted scientific society aspect, I see no likelihood of any such feeling being developed.

What is chiefly required to improve the status, shall I say, even the self-respect, of members of the engineering profession today, is an honest appreciation by the members of the profession of each other's abilities and personal qualities, and I can conceive of no better means of bringing this about than by the formation of a Home of Engineering in London. Daily informal meetings would occur automatically, and it might even happen that the ordinary member of the Institution would discover friends in the Council instead of regarding the latter as almost unapproachable.

There are many other pressing reasons for the formation of such a Club, and in common with many of my friends, I shall be happy to give my support and take a keen interest if a concrete scheme is enunciated.—I am, &c.,

London, Dec. 29th. S. Murphy.

Labour Movements.

By ARTIFEX.

One thousand patent fuel workers in Swansea are idle through depression in trade.

The dispute between the Electrical Power Engineers' Association and private companies and municipalities owning electricity undertakings is now practically settled, though in South Wales and other districts a few undertakings have not conceded the demands made.

Mr. Philip Snowden, speaking at Leicester last week, said that although the capitalist system had failed to justify its existence, they could not change it by some great catastrophic act.

The Admiralty Industrial Council are considering a proposal to close the dockyard and civil establishments on Saturdays, and to start one hour later on each of the five days of the week.

Owing to the high cost of production and falling markets for tin plates, the firm of Richard Thomas & Company has closed down its rolling mills at Lyndley and Lydbrook, Glos.

Mr. Tom Mann, secretary of the Amalgamated Engineering Union, says that the new conditions governing night shifts in engineering workshops are, generally speaking, advantageous. Substantial increase of wages is provided for, and 460,000 workers are affected.

A ballot of the members of the Amalgamated Engineering Union for a new secretary is in progress. The candidate heading the vote must possess a clear majority over the rest going to the poll. Otherwise a second ballot will be taken.

Consett steel workers' wages, calculated upon the average net selling price of steel plates during the last three months, will be advanced a further 10 per cent. in the current quarter. This will be 207 per cent. above pre war basis.

Under the sliding scale in the Welsh tin-plate trade, wages are to be reduced by nearly 6s. in the pound. The scale is dependent on the selling price of steel bars. Over 27,000 workpeople will be affected.

"By its aggressive and dishonest methods, trade unionism has exacted from the Government privileges over free labour which could only be obtained through the grossest political jobbery and corruption," says the report of the National Free Labour Association for the present year.

The Rt. Hon. J. R. Clynes, M.P., referring to the Government's proposal to establish short time in order to provide employment for the greatest possible number of workpeople, says that it is not a policy, but a desperate makeshift, and thinks the unions will be hostile to it.

Demands for immediate work or unemployment grants at the rate of £2 a week for a householder, 25s. for a single man or woman, and allowances for dependants, were made by the Labour Party Conference held at Westminster last week. Mr. Tom Shaw, M.P., and other speakers said that the only solution of unemployment was Socialism.

The whole of the Transport Workers' Unions have decided to form themselves into one big Union, affecting the whole of the industry. Mr. Ernest Bevin says that the estimated membership of the Union will be half a million.

Rating of Electricity Undertakings.

At a meeting of the Surveyors' Institution, Mr. H. Stewart Logsdon, discussed the subject of "Rating, as affected by Recent Legislation," and referred to the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, which empowered the appropriate Government department to authorise local authorities carrying on statutory undertakings to increase their charges by such amount, not exceeding 50 per cent. of their statutory maximum charge, as would enable the undertaking to be carried on without loss. Charges could be increased in the case of other statutory undertakings by such amount as would enable the payment of three-quarters of the standard or maximum rate of dividend (if any) on the ordinary stocks or shares, or three-quarters of the pre-war rate of dividend, whichever was lower. The value of the properties to which the Act applied (with tramway and gas undertakings, which had been specially dealt with in other Acts of Parliament) had been more directly affected by the war than any others, and where no order under the Act was in force, their rateable values being based upon the accounts, usually proved so low as to result in a large decrease in the assessments; indeed, in many cases the rateable value was reduced to a minus quantity. The chief factors which contributed to such a result were (a) The enormous increase in the tenant's working expenses, due mainly to the great advance in the cost of coal and all management expenses; (b) the larger share given to the hypothetical tenant as his remuneration. This was based upon a percentage of the capital which it would be necessary for him to invest to equip the undertaking to enable him to work it satisfactorily. He did not think any convincing argument could be raised in support of the view that the tenant's share should not be increased, it being obvious that a tenant contemplating renting, say, an electricity undertaking, would find that the equipment constituting the tenant's property had risen enormously in cost. The consequent result of taking the usually accepted percentage upon that greatly increased capital expenditure was to give the tenant a larger proportion of the net receipts than in pre-war days. In the third place, the cost of the repairs, insurance and renewals of the landlord's part of the property also far exceeded any estimate based on pre-war prices. The balance of the net receipts (if any), after providing for the tenant's share and the cost of the repairs, &c. (statutable deductions), provided the fund out of which the rent and rates had to be paid, unless the latter had been previously deducted among the working expenses.

Reforms Needed.

It would be seen that if the usual method of valuation was adopted in future—unless the gross receipts were substantially increased—the hypothetical tenant would obtain an increased share at the expense of the landlord. In his opinion that was unreasonable assessment. The effect of an "Order" under the Act modified this position by partially maintaining the rateable value, but his experience was that the increased charges authorised had not been more than sufficient to meet the increased working expenses, which left little, if any, of the increased receipts to affect the rateable value. If the rateable value of such undertakings was in future to be calculated on the hitherto accepted principles, and produced a satisfactory result, a permanent increase in the statutory charges must be authorised. The post-war conditions had produced many anomalies in our existing rating system, and the time had arrived when the whole subject should be reviewed and the law and practice amended to meet the requirements of present-day and prospective conditions. The method of valuing for rating purposes public undertakings such as electric tramways, railways, &c., which were not in existence at the time of the passing of the Acts which govern the present-day practice, led to many difficulties and unsatisfactory results.

The present system of leaving the assessments in the hands of the overseers, who were not compelled to make a regular and periodic revaluation (except in the Metropolis) was very unsatisfactory. It would lead to equity of assessment, if it were made compulsory on the authorities outside London to make a complete and periodic revaluation, similar to the quinquennial valuation in London; indeed, there did not seem to be any valid reason why the two parts of the country should be differently treated. Any revision of the rating system would be incomplete which did not provide for a uniform method of dealing with machinery in valuing rateable hereditaments.

Birmingham Electricity Supply.

Owing to the difficulty in raising fresh capital, there will be delay in carrying out the proposed extensions at the Nechells generating station, Birmingham. In a report by the Electric Supply Committee the Corporation is reminded that in June last it approved an extension of the permanent station at a cost of £1,757,800, doubling its capacity, subject to the general financial reservation which provided that no new contracts were to be placed for works not already begun until the Finance Committee could state that new capital was available or in sight. The Committee feel it is impossible to defer action, but it is perturbed to learn that the Finance Committee cannot see its way to allow the extension scheme to proceed, though fully impressed with its urgency. Since June strong representations have been made to the Committee by their consulting engineers and the electricity commissioners, and by local manufacturers, all urging the necessity of further provision of electric power without delay.

Reasons for Urgency.

The Committee think, therefore, on a review of the whole of the facts, that it is necessary to place before the Council a brief statement of the position, and to urge the imperative necessity of authorising, without further delay, the putting in hand of the extension scheme. The erection of the first portion of the Nechells works, with a plant capacity of 30,000 kw., was authorised on July 31, 1918, but despite the efforts made to press forward with the work, the plant will not be ready for service until the autumn or winter of 1921, and then only partly so. Thus, allowing for the initial delay through the arrangements that had to be made with the Ministry of Munitions, a period of three years has to be allowed as the minimum within which large extention works of the present character can be started and finished. At present the department has had to impose certain restrictions on user by existing consumers; it has on its books about 3,500 applications for supply, including large and small works, business premises and private houses, notwithstanding that it was common knowledge that the department could not, with its present limited plant capacity, deal with new business. Various measures have been taken by the Committee to alleviate the difficulty by temporarily supplementing their sources of supply, but it has proved to be impossible to provide adequate facilities to meet the requirements. The existing plant is working to its full capacity, with no spare machinery, and when any breakdown has occurred the remaining plant has had to be overloaded or the supply curtailed. In addition to actual consumers' demands, the provision of a certain proportion of reserve plant is vital to maintain continuity of full supply, and the margin of this must tend to increase as larger units of plant are installed. The plant now being provided will quickly be absorbed, and long before the winter of 1923-24 the department will again be in a similar difficult position as regards shortage of supply as it is in to-day. If the preliminary steps were taken in hand forthwith the extension works could not be ready until the end of 1923 at the earliest.

The Electricity Commissioners have already consented to the extensions and concur in the view that unless immediate steps are taken to install further plant a grave situation will arise in the course of the next few years, and they express the hope that the City Council will authorise the carrying out of the works. The scheme would involve raising approximately £100,000 in the next financial year, but the bulk of the payments to contractors would not fall due until 1922 and 1923, chiefly in the latter year. The Committee urge that an adequate supply of power to the city is of first importance and that it is reproductive in the fullest sense. Without it, industry will not only not be attracted to the city, but will be driven from it. In the best interests of the city the Council should authorise the extension to proceed, or take the responsibility for the serious shortage of power that will result.

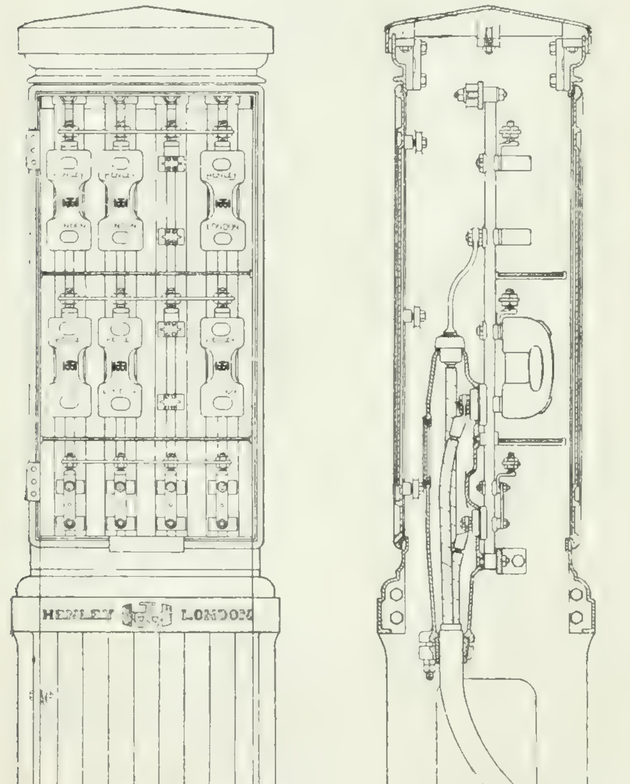
We regret to learn that the City Council decided at its meeting on Tuesday to uphold the view of its Finance Committee, thus involving postponement of the electricity extensions.

On New Year's Day the various CANADIAN TELEGRAPH SYSTEMS were MERGED into one undertaking. The new merger comprises the Great North Western, Grand Trunk, Grand Trunk Pacific, Canadian Northern, Inter-Colonial Railway and Commercial systems, with a number of smaller companies. The title of the new organisation will be the Canadian National Telegraphs, and it will be conducted on similar lines to the national railway system, but with the merger a number of changes of methods are announced which will tend to economy and efficiency.

Henley Distribution Pillars.

The new patent unit type of distribution pillar which Messrs. W. T. Henley's Telegraph Works, Company, Ltd., have just placed upon the market represents a distinct advance in design and construction of apparatus of this class. Whilst it is evident that the greatest care has been taken to ensure the highest standard of reliability, the outstanding feature is the absence of non-essentials, which indicates true engineering principles. The Henley pillar unit itself has been reduced to its simplest form and consists of two parallel micanite-covered steel tubes coupled together at top and bottom, the copper fittings carrying the fuse clips and 'bus bars being clamped on the front of the frame thus formed.

The sealing chamber for the incoming cable is secured immediately behind the fuse terminals at the back of the unit, of which it forms an integral part. This arrangement obviates all rubber tails, and therefore eliminates one source of possible failure; it also enables the units to be finally assembled at the works and greatly facilitates jointing. The insulation provided is particularly good, and another feature which commends itself to engineers is the accessibility of all parts from the front of the pillar. As a matter of fact only one door is provided, with the result that these pillars may be erected against a wall or building, or even built into the brickwork, quite secure from damage by collision in busy thoroughfares, dockyards, &c.



The Henley Unit Pillar.

The units are interchangeable, and may be added to or removed from the pillar as desired without interrupting the supply for more than a few minutes, whilst fuse clips may be replaced, in the unlikely event of this being necessary, without removing anything but the damaged clip. We notice the fuse clips are of the well-known Henley shielded type, completely protected by porcelain and fitted with self-aligning contacts. The illustration shows a Henley unit pillar, arranged for four three-wire distributors, and showing the method of jointing cable in the direct connection type of unit.

Messrs. Henley's engineering department have just issued a very comprehensive list, illustrated in colours, which will be of assistance to engineers who contemplate extensions of mains or the installation of up-to-date distribution pillars. The catalogue has been arranged to enable customers to make up any desired arrangement of units required in a pillar. Very clear and simple instructions for ordering are given, with a specimen form as a guide. Specimen specifications are also worked out in detail. Blank forms are provided at the end of the list for the use of customers, and a further supply may be obtained when required from the company's head office in London, or from any of their home, colonial or foreign branches, where all inquiries will be promptly dealt with. The reference number of the new list is W.A. 1

The Lighting of a Large Drapery Store.

Whenever improved methods of lighting have been devised the large London stores have always been among the first to take advantage of them, drapers being early in realising the cleanliness and safety of the electric lamp even in the days of carbon-filament lamps. Later on, both the arc lamp and the vacuum-type metal-filament lamp were eagerly adopted. It is not surprising, therefore, to find that the big drapery and outfitting houses are to-day installing high-candle-power gas-filled lamps wherever possible, and are revising their lighting arrangements in order to reap the full benefit of modern knowledge and progress.

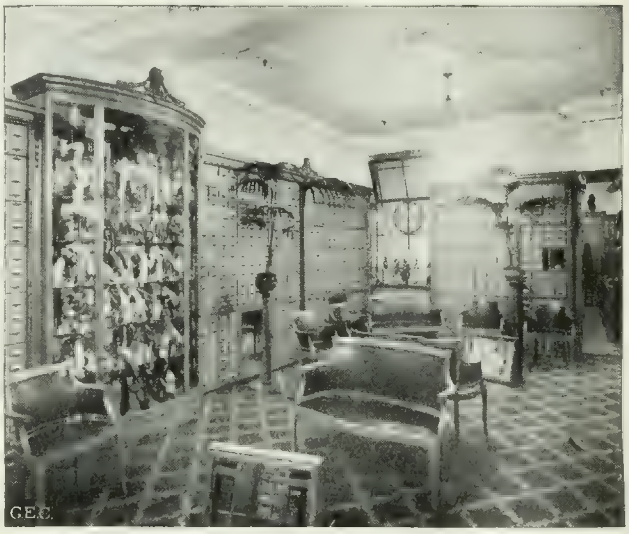


Fig. 1.—View in Messrs. Stagg & Mantle's Foot-wear Department.

An excellent example of this progressive policy is furnished by Messrs. Stagg & Mantle, of Leicester Square, who have kindly consented to allow us to publish some photographs of their showrooms. Practically the whole of these premises are lighted by Osram gas-filled lamps in conjunction with either diffusing spheres or semi-indirect bowl fittings equipped with "Equiluxo" glassware supplied by the General Electric Company, Ltd. This beautiful glass has been produced to meet the demand for reflectors and bowls having a more artistic appearance than ordinary opal glass. It is a soft white glass of uniform density which, when illuminated, transmits a perfectly diffused light. "Equiluxo" glassware can be supplied in the form of bowls, dishes, spheres and reflectors, and in several styles of ornamentation, so that fittings can always be selected which harmonise with the existing decorative scheme.

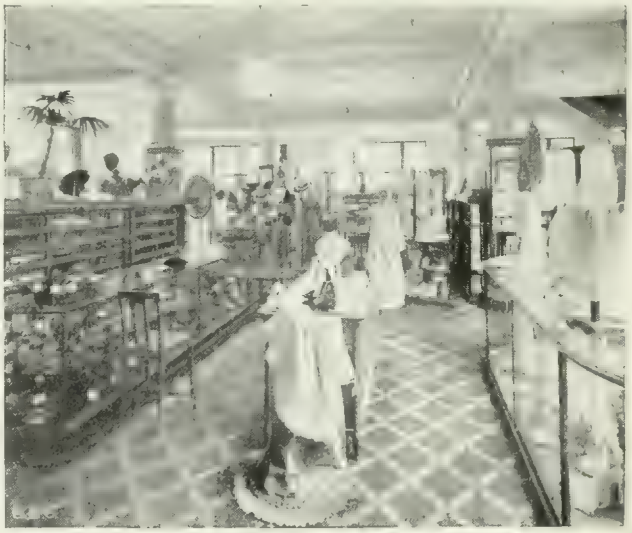


Fig. 2.—The Millinery Department at the Same "Ladies Paradise."

Commercial Topics.

Abolition of German Export Duty.

It is reported that the German Engineering and Machinery Industries are suffering from depression, and a lack of orders. A decree has, therefore, been issued abolishing the export duties on a large number of engineering and metal products, including: Steam engines, gas turbines, water-power machines, internal combustion engines for motor cars, steam engines in connection with dynamos, pumps, hammers, &c. machines of most kinds used in preparation of textiles, dredgers, washing-machines, and plant for chemical cleaning, fire extinguishers, machines for preparing metal and wood, steam and hydraulic presses, riveting machines, power ploughs, milling paper-making and refrigerating machinery, lifts, &c. The export duties on used machines of the same kinds are in most cases fixed at 6 per cent.

* * * *

Fuel Economy and Low Temperature Carbonisation.

Col. Sir Henry Goold-Adams, K.B.E., claimed at the meeting of the Low Temperature Carbonisation, Ltd., last week that the low temperature carbonisation of coal might now be regarded as an accomplished fact, and if this be so then the company has made important progress. On the recent visit of himself and his colleagues to their works at Barnsley, he said the new plant was working smoothly and smokelessly, and the results obtained from the crude coal, which took an average of eight hours to carbonise, were in every respect satisfactory. The solid resultant fuel was good; it contained a minimum of "breeze," was sufficiently hard to be easily transportable and was absolutely smokeless. As far as it was possible to ascertain, the gas was rich in quality and high in volume, and the oils and ammonia were all they had ever claimed alike as to quality and quantity. The Barnsley plant consisted of 20 retorts with a capacity for treating some 25,000 tons of coal per annum. The by-product portion of the plant was completed to deal with four times that quantity.

Sir Henry also stated that they were satisfied that they had now in operation a successful working commercial plant, and the figures would be sufficiently convincing to determine every colliery of importance, as well as the leading towns in the country, to adopt their method and arrange for the installation of plants for the treatment of the raw coal that was now so largely burnt to waste. Nothing indeed was more obvious than that the burning of raw coal was a criminal waste of the nation's greatest asset, and now that their process might be regarded as proved, the Government could not remain blind to the economic necessity for compulsorily carbonising all coal before use. That would mean that no longer would a dense smoke pall hang over all our engineering and manufacturing districts and large towns, and no longer should we be almost entirely dependent upon foreign countries for supplies of motor spirit, while in addition to the heavy oils required for such purposes as Diesel engines and lubrication, or for distillation into dyestuffs, they would be producing, for every ton of coal carbonised, something like 7,000 cubic ft. of rich gas and some 20 lb. of sulphate of ammonia.

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British Trade Prospects in China.

An article on the prospects of British trade in China, by Mr. H. H. Fox H.M. Commercial Counsellor, appears in the current issue of the "Board of Trade Journal," and in view of the great possibilities of engineering development in China and the Far East, we produce a few extracts from it. Mr. Fox hopes that British merchant firms will continue the practice of sending out travellers who, where possible, carry their clients' samples with them. He is of opinion that the best channel for selling British goods in China is through the British merchant firms who have their own house in London or Manchester and branches at least in Shanghai and Hongkong, and preferably in Tientsin and Hankow as well.

ENGINEERING TRADE.

In the engineering business, more particularly in that concerned with the supply of electrical plant, Mr. Fox has found a most gratifying activity among many of the largest manufacturers. Some are opening their own offices in China and rightly selecting Shanghai as their headquarters; others are joining with non-competing firms to maintain representatives in China, who in many cases work with merchant firms; others, whose business does not warrant the expense of sending out special representatives, are appointing merchant firms, preferably those provided with engineering departments, as their agents.

FUTURE PROSPECTS.

In the case of a vast and partially developed country such as China, immediate results must not be looked for, and manufacturers must be prepared to "pay for their footing," but there is no question that the foreign trade of China, in spite of frequent setbacks, is steadily growing in volume, and may show extraordinary expansion during the next few years, if the efforts now being made to settle the country's internal affairs prove successful and China accepts the means now offered of making the much-needed extensions of her railway system. British manufacturers seeking fresh outlets for their products are urged to turn their attention to China and make arrangements for representation in that country now before our trade rivals consolidate the positions they have won during the war. Cheapness has been in the past the determining factor in the sale of foreign goods in China, and our trade has been handicapped to a great extent by the comparatively high prices of our wares, but it is certain that, as the industrial development of the country proceeds and the export trade in raw and semi-manufactured materials increases, the Chinese will want and be able to purchase a better class of goods.

Electricity Supply.

BARNES Urban Council is to apply for sanction to borrow £10,000 for mains and services required for three years.

Councillor R. J. Wilson has been elected chairman of the SUNDERLAND Electricity Committee, with Councillor Speeding as vice-chairman.

Sanction has been received by WEST HAM Corporation to a loan of £18,000 for linking up with the Ilford and Barking electricity works.

WREXHAM Corporation has applied to the Electricity Commissioners for sanction to borrow £14,700 for extending electric supply mains to the 800 houses at Acton Park. The Council has referred back a proposal to increase the salaries of the station superintendent and four charge engineers, so as to comply with the demands of the E.P.E.A.

There are at present 524 electricity consumers at MALVERN, an increase of 52 compared with last year. In view of the largely increased load, it has been found necessary to overhaul the sub-stations, and a 100 kw. transformer is to be installed at the Church-street sub-station.

MANSFIELD Corporation has applied to the Electricity Commissioners for authority to increase the maximum charge for electricity allowed by its Provisional Order. It is proposed to obtain power to make a charge not exceeding 1s. per unit, but at present the maximum will be 10d.

DORCHESTER Corporation is applying to the Electricity Commissioners for a Special Order to authorise the Corporation to purchase the undertaking of the County of Dorset Electric Supply Company, Ltd., and to generate and distribute electrical energy in the borough.

The BOLTON General Purposes Committee has decided not to grant applications made by Corporate officials in the Electricity, Tramways and other departments for increases of salary, on the ground that the position was sufficiently met by the grant of the Civil Services war bonus.

DERBY Electricity Committee has rejected a proposal to employ direct labour on the extension of the electricity station buildings, and a tender has been accepted, at £45,970, for the work. It has also been decided to seek sanction to borrow a further sum of £10,000 to cover the estimated additional cost of the machinery and buildings.

Unlike most electric supply undertakings STOKE-ON-TRENT Corporation is happy in being able to reduce the price of electric current. It has been decided that as from the September quarter meter readings the charges for power supply, heating, cooking, and apparatus used in conjunction therewith, are to be reduced by 25 per cent., and the private lighting charges by 35 per cent.

At a meeting of the HOME COUNTIES (No. 9 AREA) DISTRICT JOINT BOARD, on the 22nd ult., it was reported that the following members had been nominated by the E.P.E.A. to sit on the employees side: Messrs. H. M. Bowman and A. T. Bullen (Bedford), F. Chignell (Colchester), H. A. Kell (Luton) and E. E. Pope and H. Wilson (Maidstone). Mr. Wilson has been elected vice-chairman of the joint board, and Mr. Bullen will act as secretary for the staff members side.

A conference of local authorities, representing the City of WORCESTER and the Southern part of the County, was held last week to consider the formation of a joint Electricity Authority, but the conference was adjourned in order to obtain information as to the capital outlay involved, and the anticipated revenue, and how it is proposed that the new board should be constituted. It was decided to object to the districts being included in the South-West Midlands area.

Extensions of plant, involving an expenditure of £150,000, are proposed by ACCRINGTON Electricity Committee, and the Council are asked to apply for sanction to the scheme. The new plant, which is required to meet the growing demand, includes a 5,000-kw. turbo-generator, condenser and auxiliaries; switchgear and cables; two 1,000-kw. rotary converters and switchgear; four 25,000 lb. water-tube boilers, superheaters, economisers, stokers and coal-handling plant.

Notices of INCREASES IN THE CHARGES FOR ELECTRICITY in Newcastle-on-Tyne and Gateshead have been given. The Newcastle-upon-Tyne Electric Supply Company will charge 6d. per unit net for lighting, and for heating 2¼d. per unit, but the office tariff (for business premises only) will be a fixed charge of £1 for each winter quarter and 5s. for each summer quarter, plus 1¼d. per unit. A discount of 5 per cent. will be allowed for electricity supplied for heating purposes, provided prompt payment is made. In Gateshead the County of Durham Electrical Power Distribution Company will charge 6½d. per unit for lighting, and 2¼d. for heating. The office tariff for heating (business premises only) is a fixed charge of £1 for each winter quarter and 5s. for each summer quarter, plus 1¼d. per unit, with a discount of 5 per cent. for lighting and heating, provided prompt payment is made.

On the presentation to EDINBURGH Corporation of the report of Mr Alex. Kennedy on the Portobello power station and sub-stations last week, Bailie Robertson called attention to the enormous increase in the cost of the works. Two years ago the estimated cost of the machinery and plant was £490,000, and the actual cost or estimate at present was £633,000, an increase of £143,000, and the total cost of the work apparently came to £1,750,000.

Mr. Bruce Lindsay, Convener of the Electricity Committee, said he was not in a position to go into the matter in detail. The report spoke for itself in pointing out that the increased cost on the items referred to was a little under 30 per cent., which was considerably less than might have been anticipated in view of the advances in rates paid to labour and the increased cost of materials, coal and railway transport. He thought they had reached the extreme point in the matter of prices.

Ultimately it was decided to receive the report, and tenders, to the amount of £53,488 for coal and ash handling plant were accepted.

Electric Traction.

Newcastle-on-Tyne Tramways Committee have dealt leniently with the men whom they suspended for refusing to work on Christmas Day. The Committee, after hearing a deputation who asked for clemency stating that the men realised that they had put themselves in a wrong position, decided to re-instate the men.

An inquiry was recently held into the application of Blackpool Corporation for sanction to borrow £18,000 for alterations at the Corporation's Rigby-road stables, in order to provide a new tramway depot. The Corporation recently acquired the Blackpool & Fleetwood Tramroad Company, and more accommodation is required for cars and engineering works.

The Industrial Court has issued its award on the claim of the Liverpool Corporation tramway employés for increased wages, &c. The men are to receive an advance of 4s. 6d. per full ordinary week, but the demand for a rearrangement of the 48 hours' week has been rejected, and no alteration is made in the practice with regard to payment for work done on Bank holidays, &c. Shed workers receive an allowance of 1s. a night for each night worked, and pro rata for part thereof. The award takes effect as from the beginning of the first day period following Dec. 2 last.

Taunton Corporation has declined an offer of the Taunton Electric Traction Company to sell the local tramways for £7,000. The Corporation is demanding an increased charge for current which the company is unable to pay. At the last meeting of the Council Mr. Kingsbury said that the offer might be thought a tempting one as the capital outlay on the undertaking had been £35,000, but after going into the matter the Tramway Committee could not see any prospect of making the undertaking pay. If the company gave them the undertaking it would be unwise to accept it, as they could not work at a profit with the present high cost of electricity. The committee would prefer motor 'busses.

In a recent interview Sir Thomas Williams, who has retired from the general managership of the London & North-Western Railway Company, and has become a director, stated that the most far-reaching change on the Company's system during the past 50 years was the electrification of the line to Watford. There had been and still existed difficulties affecting the development of the electrical service between Euston and Queen's Park stations arising from the high cost of materials, but within reasonable time the linking up of that part of the system would be completed. The effect of railways in 50 years had been greatly to increase the value of suburban property, and with the development of the suburban service had grown up the great residential districts round London pouring their thousands of workers into the City daily.

Institution Notes.

The annual dinner of the Electrical Contractors Association (Incorp.) is to be held on Wednesday, January 19th, at the Connaught Rooms, Great Queen Street, London.

A Paper on "The manufacture of Thermionic Valves" was read on the 16th ult. by Mr. E. S. B. Staines, of the Edison Swan Electric Company, before the Birmingham Wireless Society at the Midland Institute, Birmingham. The author dealt fully with the subject, and at the conclusion of the Paper great attention was attracted by the comprehensive exhibit of valves and parts on view.

An additional Informal Meeting of the Institution of Electrical Engineers will be held on January 24th for the purpose of discussing in what ways the Institution can be made more useful to its members. This will give an opportunity to members who made suggestions at the recent meetings in connection with the increase of subscriptions to put forward their views on the subject. As it is expected that the attendance at this meeting will be larger than usual, arrangements have been made for it to be held at the Institution of Civil Engineers, at 6 *p.m.* (instead of at the Chartered Institute of Patent Agents, 7 p.m.).

At the December meeting of the Diesel Engine Users' Association Mr. C. O. Milton, A.M.I.E.E., Borough Electrical Engineer of Maidenhead, was elected President for the ensuing year, and Mr. Percy Still, M.I.E.E., M.I.Pet.Tech., Chief Engineer to the Chelsea Electricity Supply Company, was re-elected hon. secretary. Messrs. Napier Prentice, M.I.E.E., and A. E. Farrow, A.M.I.E.E., were elected members of the general committee in place of the two members who retire at the end of their term of office. The present members of the standing committee on insurance were all re-elected.

The honorary Secretary's annual statement showed that the Association had further considerably increased its membership since the beginning of the year. The standing committee on Insurance Against Breakdown held several meetings, and an amended form of the standard policy was adopted. The provisional committee of the Research Association for Liquid Fuels has been approved by the Privy Council for Scientific and Industrial Research, and the Memorandum and Articles of Association have been submitted to the Department of Scientific and Industrial Research with a view to making application to the Board of Trade for a license to register the Association.

During the year Mr. Geoffrey Perter's "Notes on the Wear of Diesel Engines" were published, together with a report of the instructive discussion which followed. Other subjects on which Papers were read and discussed were "Obturators," by Mr. W. Fennell, and "The Recovery of Lubricating Oil," by Mr. A. J. Wilson. Several meetings were taken up with discussions on Connecting Rod Bolts, their life and periodic renewal or heat treatment. These discussions have been summarised and published as a Report.

Imperial and Foreign Notes.

It is stated that the Mysore Government is considering a suggestion to further utilise the waters of the Cauvery by erecting power stations at the Shimisha Falls and the Makadatu Falls.

In a recent report the manager of the water works and electric-lighting department at Valletta (Malta) states that the present generating plant is inadequate and there is an increasing demand for current, not only from localities where mains are laid, but also from outlying centres such as Rabato, Zebbug, Curmi, Hamrun, Zeitun and Paula, from which over 600 applications have been received. In view, however, of the risk of breakdowns and the suspension of the service for indefinite periods, mains extensions will not be undertaken before the generating station can meet the heavier demand. A new generator must be provided, and it is hoped that it will be found possible to place the order very soon, so as to enable the department to put the new plant in service during 1921.

H.M. Consul at Vienna reports a start was made on the 23rd ult. with the construction of the Strubklamn power-station. It is anticipated that the work will be completed by Dec., 1921. The total cost will be 54 million crowns, which will be covered by a loan of 80 million crowns from the municipality of Salzburg.

A visit has recently been made to Switzerland by the Director-General of the Finnish Railways (M. B. Wuolle) in order to study the electrification of railways, and he has announced that proposals are being considered for converting the Finnish State Railways to electric traction. Plans and estimates for the work will be prepared during the year.

The Sociedad Hidro-Electrica Espanola has been granted permission to supply current from the Albacete power station to the Sierra Almagrera (Province of Almeria) for use in silver lead mines. Mr. A. W. Harrison, British Vice-Consul at Garruch, anticipates that electric mining plant will be required in connection with this scheme, and he is desirous of receiving catalogues from British makers of such plant.

The shareholders of the Siemens & Halske Elektricitäts-Gesellschaft, of Berlin, have approved the arrangements for amalgamating the company and the other Siemens' interests with the Rhine-Elbe Union, one of Hugo Stinnes' trust creations. The Siemens & Halske one will increase its capital to 260,000,000 marks by the issue of 130,000,000 preferred and 4,000,000 ordinary shares. The fusion is expected to make the company independent of market fluctuations in raw materials and to increase the company's technical and commercial efficiency.

It is reported that Herr Hugo Stinnes, the German industrial magnate, has accepted the offer by the Soviet Government of a monopoly for the "Electrification" of Russia. Herr Stinnes is associated in the matter with the Borsig-Siemens-Schuckert Company and Krupps, and he will send a commission to Russia to study the immense project.

It is also announced that the Soviet Government has prepared a big programme of economic development which will involve the extensive use of electric power. It is proposed to construct electricity stations in the peat bogs, and to transmit the energy within a radius of 200 km. It is expected that a greater use of electric power will minimise the use of oil and permit Russia to export its superfluous stock in exchange for machines. The regions suffering from drought will be irrigated, and the land suffering from too much water drained by means of electric pumps. It is in reconstruction of transport that electricity will play the leading role, as the railway system will be converted to electric traction. Electricity will also be used extensively in the refining of metals and other purposes. The work of "electrification" is estimated to take 10 years, and it is proposed to construct 27 electric stations, the first station being in the Don basin. The programme is an ambitious and interesting one, and it remains to be seen how far it can be realised under present conditions.

Bankruptcies and Liquidations.

Chas. Carlisle Thompson, electrician, &c., formerly trading at 78, Salisbury-street, Hull, has been adjudicated bankrupt.

A petition presented by Messrs R. Johnston & Company, Ltd., for the winding up of Electrical Industries, Ltd. (electrical engineers) will be heard in the High Court of Justice, London, on Jan. 18.

The estates of Alex. Stewart Fraser, electrician, Olive Cottage, Viewmount-road, Banchory, Kincardineshire, have been sequestrated. Meeting to elect trustee and commissioners will be held on Jan. 7 at the Imperial Hotel, Aberdeen.

A meeting of creditors of Pritchett & Gold and Electrical Power Storage Company, Ltd. (in vol. liq.), will be held at 50, Grosvenor-gardens, London, S.W., on Jan. 19. The Company is in voluntary liquidation for the purpose of the sale of its undertaking to Pritchett & Gold and E.P.S. Company, Ltd. All creditors will be paid in full.

The public examination of Thos. McClelland De Bingham, engineer, 3, Longridge-road, Earl's Court, London, took place recently at the London Court of Bankruptcy. Debtor said since a previous failure in the year 1906, and until the outbreak of war in 1914, he was engaged in experimenting and perfecting his own system of wireless telegraphy and telephony. His apparatus was removed as part of a general measure, under the Defence of the Realm Act. He carried on his operations under the style of the De Bingham Wireless Telegraph Company, and later as the De Bingham Submarine Syndicate. The patents on his inventions had all expired. His activities practically ceased when the Postmaster-General took away his apparatus and licence.

Miscellaneous.

On account of the increased land line rates in this country and in North America Marconi's Wireless Telegraph Company has raised its charges for ordinary full rate Transatlantic wireless telegrams by one penny per word as from the 1st inst.

A recent issue of "The Graphic" contains an interesting illustrated account by Mr. George R. Sims of the works of Messrs. John Brown & Company, of Sheffield. This system of educating the public in the details of our great industrial processes is one that we should like to see extended.

Wireless telephony is to be introduced by the Mersey Dock and Harbour Board in order to provide means of communication between the Board's headquarters at Liverpool and the Bar Lightship (14 miles distant) at the entrance to the Mersey channel. The installation will supersede wireless telegraphy and permit of much quicker transmission of messages and instructions to pilots and ships.

The annual reunion of the Penzance Staff of the Western Union Telegraph Company took place on Saturday, when 45 dined, under the chairmanship of Mr. T. O'Donoghue, superintendent of the station. A number of guests were invited to the musical evening which followed. A long and a good musical programme was performed, and at the close the visitors drank the health of the superintendent and his staff.

The girls of the staff of the Edison Swan Electric Company, Ltd., gave a New Year's Eve supper, concert and dance on Friday last in the staff café at Ponders End. A merry company of about eighty sat down to an excellent repast under the chairmanship of Mr. J. W. Elliott, joint sales manager. A concert followed, and at its conclusion an adjournment was made to the boys' canteen for dancing, and a programme of 10 dances was gone through to the music of the Ediswan Orchestra (Mr. S. Dean, conducting), Mr. R. Swallow acting as M.C.

On the 23rd ult. Messrs. Jonas & Colver, Ltd., pleaded guilty at the Sheffield Police Court to a charge of having work done on a h.t. switchboard, the whole of the board not having been made "dead," or the portion on which work was being done was not "dead" or screened. A man named Booth, who was cleaning the cage of the board, fell and came into contact with the live portion and was rendered unconscious. The defence was that the man acted irregularly in cleaning the inside of the cage without first speaking to his superiors. The firm were fined £30.

An inquest was held at Carnarvon on Tuesday upon Hugh Roberts, who was recently killed at Cefndu Wireless Station. The jury found that his death was caused by coming into contact with a live wire, and added a rider recommending that the Board of Trade or some other Government department should see that every possible protection was given to workmen at wireless stations.

Mr. Quick, engineer, said he found Roberts on his back in the gallery of the station, close to the high-tension wire, but he had no right to go there without instructions. Mr. Woodward, engineer in charge, said they were not supposed to report any accident to any Government department.

The Coroner expressed a hope that further inquiries would be made into the matter to see if anything could be done to prevent similar accidents in future.

It is announced that the new Telephone Rates and Charges will be introduced on April 1 next. No fresh legislation is required, the sanction of the Treasury only being necessary. As the Commons Select Committee endorsed the Departmental Committee's recommendations, no delay in obtaining this sanction is likely. It has been suggested that those who use an instrument up to 10,000 calls per annum (5,000 each way) and thus overload their line and impair its efficiency, will be compelled to take a second instrument. There is no intention of interfering with a subscriber's use of his telephone to the full extent of its capacity, but where 25 per cent. of the calls put through to subscribers are "engaged" such subscribers will be required to have a second instrument. It is also understood that the recommendations of the Select Committee that some modification in the proposed new tariff for private telephone wires should be made and a rebate given to large users will be complied with before the new scheme comes into operation.

In the meantime there is growing opposition from business and commercial houses to the proposed increase of charges, and the F.B.I., The London Chamber of Commerce, and other organisations are joining in the opposition.

Obituary.

The death occurred on the 29th ult. of Mr. C. J. Gale, Secretary of the Topsham Electric Light Company, Ltd.

The death occurred on the 19th ult. of Ald. Richard Irvin, Chairman of the Tynemouth Electricity Committee.

Mr. Frederick Wm. Cross, electrical engineer of the Tamworth Co-operative Society, has been killed as the result of an accident. His head was severely crushed between two motor lorries.

The death is announced of Mr. Robert McLean, manager of the States of Guernsey telephone department, which took place somewhat suddenly on the 30th ult. Mr. McLean was born in Musselburgh, in 1869, and in 1885 he joined the staff of the National Telephone Company in Edinburgh. Subsequently he was engaged on telephone work at Manchester. Later he went to London as chief inspector to the Mutual & New Telephone Companies, and then to Birmingham, Cardiff and Nottingham as local manager in each town. Mr. McLean while local manager at Birmingham was associated with Mr. K. Munro, who was chief electrician there, and was instrumental in getting the latter appointed to Guernsey, where they have worked together for 23 years. Deceased was appointed manager and engineer to the Guernsey States telephones in May, 1900.

Personal and Appointments.

Halifax Tramways Committee again recommend the Town Council to confirm the appointment of Mr. J. W. Galloway, tramways engineer, as general manager of the tramways, for one year, at £700 per annum.

Lieut.-Col. F. A. Cortez-Leigh, chief electrical engineer of the L. & N.W. Railway Company, has been added to the committee which has been formed in connection with the establishment of a Chair of Hydro-Electrics at the University College of North Wales.

In the published list of New Year Honours we notice the following recipients who are connected with the electrical engineering and allied industries :—

Baron.—Sir Wm. Beardmore, Bart., chairman and managing director of Wm. Beardmore & Company, Ltd., and a director of Vickers, Ltd., and other companies.

Privy Councillor.—Ald. Sir Andrew Beattie, D.L., chairman of the Provincial Tramways Company and its subsidiary companies.

Baronet.—Fredk. Mills, D.L., J.P., chairman of Ebbw Vale Steel & Iron Company.

Knights.—Andrew Rae Duncan, Coal Controller; Harry Vernon Kilvert, J.P., Director of Lancashire Dynamo and Motor Company; Ernest Fitzjohn Oldham, deputy chairman, and Wm. Peter Rylands, President of Federation of British Industries; Prof. Jas. Walker, Professor of Chemistry, University of Edinburgh.

C.S.I.—Geoffrey Rothe Clarke, O.B.E., Director General of Indian Posts and Telegraphs.

Business Items, &c.

The new address of the Ebonestos Insulators, Ltd., is Excelsior Works, Rollins-street, Canterbury-road, S.E.15. The telegraphic address and telephone number are unchanged.

The London offices of the Chloride Electrical Storage Company, Ltd., have been removed to 57, Victoria-street, S.W. 1. The telephone numbers (442 and 445 Victoria) remain unaltered.

As the Electrical Engineering & Equipment Company are moving their stores to larger premises, they announce that they are selling the whole of their stock at enormously reduced prices. They have a large quantity of lamps, cable, switch gear, motors, &c.

Messrs. Donovan & Company, of Birmingham, notify that, owing to increased business, they have been obliged to take additional premises at 16, Cornwall-street, which will be used for bulk stores of electrical accessories—cable, conduit and "Safuse" switchgear. The offices and sales department will remain at 47, Cornwall-street.

The London Electric Firm, makers of searchlight projectors, lamp lowering gear, &c., Brighton-road, Croydon, ask us to publish a request that all communications for them shall be sent to that address, and not to an address in High Holborn, which appeared in their entry in the last edition of our "Electrical Trades' Directory and Handbook."

Messrs. Alfred Herbert, Ltd., of Coventry, have recently been appointed sole distributors for the Cataract line of precision lathes manufactured by Messrs. Hardinge Bros. (Inc.) of Chicago, U.S.A. In Bulletin No. 18, illustrated details are given of the various designs of lathes manufactured by the company which enjoy a high reputation.

Messrs Alfred Herbert, Limited, have also been appointed sole distributors for Great Britain and Ireland for the sale of the fine precision measuring instruments manufactured by the Soc. Anon. des Etablissements P. Roch, of Rolle, Switzerland. The goods include Vernier calipers, sliding gauges for measuring depths, gear-tooth Verniers and special combination Vernier-caliper-and-height gauges. These tools have long borne a reputation for their quality and high precision of accuracy. Large stocks are being placed in all the depots of Messrs. Alfred Herbert, Ltd., throughout Great Britain.

Catalogues, Price Lists, &c.

Their January list of d.c. and a.c. motors in stock has been issued by Messrs. Higgs Bros., of Sand Pits, Birmingham.

Messrs. R. B. Hand & Company, Ltd., 63, High Holborn, W.C.1, have issued a price list of electrical fittings, cables, conduits and accessories.

A pamphlet published by Messrs. Holz & Company, Inc., of New York, is devoted to a history and illustrated description of the Burrows Defectoscope and Magnetic Analyser for the inspection of steel rails, rods, cable and other steel and iron stock of uniform section.

A variety of domestic electric appliances, including cookers, boilers, bed-warmers, heating pads, irons, &c., is listed and priced in the catalogue of the Photector Company, Ltd., Central Hall, Southall. Copies will be sent to the trade on application.

Messrs. Alfred Herbert, Ltd., of Coventry, who are agents in Great Britain for the Lodge & Shipley Lathes, have issued an interesting brochure giving examples of turning on the manufacturing lathe. The Lodge & Shipley Machine Tool Company, of Cincinnati, O., claim to be the largest exclusive lathe manufacturers in the world, and in the pamphlet various samples are illustrated by line drawings, particulars of the material, and the time taken being indicated in each case.

The Sun Electrical Company, Ltd., 118-120, Charing Cross-road, W.C.2, have issued their catalogue of domestic electrical apparatus. Full particulars and prices are given of a complete range of electrically operated articles for household use, including irons, kettles, tea-pots, coffee-urns and percolators, electric heating utilities, boiling and warming plates, cooking stoves, &c., also electric glue-pots and soldering-irons for industrial use. Copies of the catalogue may be obtained on application to the company.

Tenders Invited and Accepted.

Camberwell (London) Council require tenders by Feb. 7 for the supply of stores, including electric lamps and fittings. Forms of tender from the Borough Engineer.

Leyton Urban Council require tenders by Jan. 11 for electric wiring in 142 houses on the Barclay estate. Specifications from Mr. J. H. Jacques, 2, Fen-court, Fenchurch-street, London, E.C.3.

Manchester Tramways Committee want tenders by Jan. 11 for the supply of electric welding equipment for welding rail joints. Specifications, &c., from the General Manager, 55, Piccadilly, Manchester.

Tenders are invited for a 5,000 kw. three-phase turbo-alternator for the Commune of Ixellis (Brussels). Specification (in French) at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

Tenders will be received until the end of February for six electric cranes and coal-handling plant for the Loubet Bassin, Boulogne. Specifications (in French) at the Department of Overseas Trade, 35, Old Queen-street, Westminster, S.W.1.

Tenders are required by Feb. 3 for 12 months' supply of lighting fittings, lamps, switches, cables, meters, tubes, &c., to Halifax Electricity Department. Forms of tender from the offices,

Tenders are also wanted by February 3 for 12 months' supply of stores to Halifax Tramways Department, including lighting fittings, insulating materials, cable, wires, trolly and overhead line material, castings, oils, &c. Forms of tender from the Tramways Engineer, Skircoat-road, Halifax.

Antwerp Municipal Council invite tenders for supply and erection of rotary converters with switchboard for Wharf No. 77 of the Bassin Canal. Tenders by noon Feb. 1. Specifications (in French) may be seen at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

Tenders are invited by Jan. 26, 1921, for the supply and delivery to the Postmaster-General's Department, State of Queensland, of telephone apparatus and parts (schedule 509). Tender forms at office of High Commissioner for Australia, 406, Australia House, Strand, W.C.2.

Amongst requirements of the Bulgarian State Railways Department are telephone and telegraph materials, electrical installation material for coal mines, machine tools and railway stores. List can be seen at the Department of Overseas Trade, 35, Old Queen Street, S.W.1.

Pretoria (Transvaal) municipality require tenders by March 10 for one 20 ton overhead crane, six boilers to evaporate 18,000 lb. an hour each at 350 lb. pressure ; three 3,000 kw. steam turbo-generators, with condensing plants ; and five 750 kw. converters. Specification from the Town Clerk.

Tenders are invited up to March 2 for the supply and delivery to the Australian Postmaster-General's Department, State of South Australia, of (a) telephone parts (Schedules 558 and 559); and (b) telegraph and telephone materials (Schedule 560). Tender forms from the High Commissioner for Australia, 406, Australia House, Strand, London, W.C.2.

Durban (Natal) Corporation require tenders by Jan. 26 for telephone cable (air-space and paper insulated type), paper sleeves, pipes and other electrical accessories. The Corporation also want tenders by Feb. 16, for a 1,000 kw. rotary converter, with transformers. Specifications at the Department of Overseas Trade, 35, Old Queen street, S.W.1.

The City of Auckland (N.Z.) invite tenders for the supply and erection of one 3,000 kw. and one 5,000 kw. turbo-alternator, rotary converters (1,500 kw. and 500 kw.) switchgear and transformers, also water tube boilers, conveyor pumps, pipework and h.t. and l.t. cables. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew & Rider, 8, Queen Anne's-gate, S.W. 1, and tenders by noon, February 22, 1921, to Mr. Alex. Wyllie, C/o. Messrs. Preece, Cardew & Rider.

The Electricity Commissioners of Victoria (Australia) invite tenders for the supply of plant and material required for the Morwell Power Scheme, including 25,000–12,500 kw. turbo-alternators, 600 kw. turbo-alternators, transformers, switchgear, cables, transmission steel towers, steel telephone poles, &c. Tender forms and specifications can be obtained from the Agent-General for Victoria, Victoria House, Melbourne-place, Strand, London, W.C.2, and drawings can be seen at the offices of Messrs. John Coates, & Company, Ltd., consulting engineers, at the same address. Tenders by noon, Feb. 24, to Mr. R. Liddelow, secretary, Electricity Commissioners, 673, Bourke-street West, Melbourne.

Stepney (London) Electricity Supply Committee has accepted the tenders of W. T. Henley's Telegraph Works Company for (*a*) ¼-mile 0.007 sq. in. lead-covered cable, £74 10s., and (*b*) ½ mile each twin and 3-core armoured cable and ¼ mile 0.04 sq. in. 3-core armoured cable, £829.

Hammersmith (London) Council is recommended to accept the tender of the Western Electric Company, amounnting to £635 for 375 yards of 0.075 sq. in. six-core e.h.t. cable for connectiong up from the Council's present main to the generating station of the Chiswick Electric Supply Corporation. The Council is also recommended to accept the tender of the Westinghouse,Cooper Hewitt Company, (at £748)for three mercury vapour rectifiers, with switchgear, for charging electric vehicles.

Bradford Electricity Committee has accepted the following tenders : T. Broadbent & Sons, 40-ton lifting beam ; J. Blakeborough & Sons, one 48 in. retaining valve for water circulating system ; Herbert Morris, Ltd., runway for riddling hoppers to three boilers ; Ferguson, Pailin, Ltd., two e.h.t. transformer switchgear cubicles, and e.h.t. switchgear for two feeders ; Davenport Engineering Company, two cooling towers ; Metropolitan-Vickers Electrical Company and Landis & Gyr, year's supply of a.c. meters.

Patent Record.

SPECIFICATIONS PUBLISHED

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

1920 Specifications.

139,485 Benjamin Electric Manufacturing Co. Electric circuit closers. (3,3/15.)
140,811 Siemens-Schukertwerke. Alternating current dynamo-electric machines (29/3/16.)
148,748 Siemens-Schuckertwerke. Field magneto for dynamo-electric machines.
152,447 Huguniot. Electric musical instruments. (30/4/19.)
152,556 Scott's Shipbuilding & Engineering Co. & Caparn. Magnetic clutches. (7/1/20.)
152,572 Hope. Cord-grips for electric lamp holders. (10/6/19. Divided Application on 14,614/19.)

1915 Specifications.

130,329 Western Electric Co. Telephone exchange system. (22/7/18.)
132,499 Scintilla. Interruptors for the magneto-electric ignition machines of internal-combustion engines. (13/9/18.)
132,799 Lorenz Akt.-Ges. Means for producing electric oscillations by an electric arc. (5/6/18.)

A self-induction of comparatively large size is connected in series with the electric arc, and another self-induction of similar magnitude is connected in parallel to the first self-induction and the arc. The resultant self-induction opposed to the currents which flow through the self-inductions in parallel is considerably lowered by the parallel connection and may be reduced to a very small figure if the two fields are intimately coupled with each other, but all the currents that pass through the two self-induction coils in series are opposed by the total value of these self-inductances.

5,684 B. T.-H. Co. (G. E. Co.) Devices for controlling electric discharges through vapours, and methods of operating said devices. (15/4/15.)

Relates to a signalling system in which a source of alternating current is connected to a vapour electric arc device provided with means for continuously ionising gas therein and with a conducting member the potential of which is adapted to be varied in accordance with the signals to be sent in order to time the starting of successive arcs in the device by the alternating current, the energy of the variable current conducted by the device being utilised for the transmission of signals.

1919 Specifications.

153,038 Frecheville. Electrically-operated horns for motor-vehicles. (23/6/19.)
153,058 Smith & Powell. Method of and means for automatic electric control of the electric energy employed upon vehicles with electric transmission. (21/7/19.)
153,076 Miller. Alternating current motors and rectifiers. (28/7/19.)
153,112 Rutherford. Electric lamp holders. (8/8/19.)
153,136 Western Electric Co. (Western Electric Co.) Electric telegraph system (27/8/19.)
153,146 English Sewing Cotton Co. & Bennett. Devices for cutting off the current of electric lifts or hoists when the gates or doors are open. (11/9/19.)
153,153 Mascarenhas. Electric lamps. (3/10/19.)
153,158 Lewis. Trolley head for electrically-propelled vehicles. (11/10/19.)
153,160 Speck. Electrically-operated hoisting-devices. (13/10/19.)
153,167 Lenaghan. Telephone systems. (23/4/19.) (Divided Application on 152,702.)
153,168 Lenaghan. Automatic telephone systems. 23/4/19.) (Divided Application on 152,702.)
153,179 Nobuhara. Rotary electric machines. (17/11/19.)

APPLICATIONS FOR PATENTS.

Note.—*Names within parentheses are those of communicators of inventions.*

July 7, 1920.

19,686 Gesellschaft fur Drahtlose Telegraphie. Wireless telegraph transmitters. (12/9/18, Germany.)
19,687 Ges. fur Drahtlose Telegraphie. Wave telephone systems. (17/1/19, Germany.)
19.688 Ges. fur Drahtlose Telegraphie. Receivers of electric waves. (3/6/18, Germany.)
19,689 Ges. fur Drahtlose Telegraphie. Reception of electric oscillations. (2/5/16, Germany.)
19.690 Ges. fur Drahtlose Telegraphie. Production of high-frequency currents in static transformers. (26/2/14, Germany.)
19,702 Jackson. Detecting presence of magnetic bodies.
19,756 Ges. fur Drahtlose Telegraphie. Electro-magnetic wave navigational or direction-finding systems. (23/10/18, Germany.)
19,757 Ges. fur Drahtlose Telegraphie. Electrical high-frequency current transformers. (29/7/15, Germany.)
19,758 Ges. fur Drahtlose Telegraphie. Electro-magnetic wave navigational or direction-finding systems. (3/6/18, Germany.)
19,759 Latour. Telephone, &c., systems. (23/5/19, France.)
19,760 Latour. Continuous electro-magnetic wave-transmitting system. (16,8/15, France.)
19,761 Latour. Thermionic tube amplifying-devices. (30/11/18, France)
19,762 & 19,763 Latour. Telephone, &c., systems. (25/6/15, France.)
19,789 Gross. Incandescent lamps. (19/2/19, Germany.)
19,792 & 19,793 Tucker. Apparatus for assembling switches.
19,799 Apple. Armatures. (19/11/14, U.S.)
19,801 Apple. Armatures, &c. (30/12/16, U.S.)
19,802, 19,803 and 19,804 Apple. Commutators. (22/1/17, U.S.)
19,805 Apple. Armatures. (29/1/17, U.S.)
19,806 Apple. Armatures. (22/1/17, U.S.)
19,808 Apple. Commutators. (14/2/18, U.S.)
19,809 Apple. Armatures. (14/2/18, U.S.)
19,811 Apple. Conductor members for vibrating-current controlling regulators (14/2/18, U.S.)
19,812 and 19,813 Apple. Electric machines. (14,2/18, U.S.)
19,814 Apple. Armature cores. (8/3/18, U.S.)
19,815 Apple. Electric machines. (21/3/18, U.S.)
19,816 Apple Armatures. (27/4/18, U.S.)
19,817 Apple. Armatures. (7/5/18, U.S.)
19,818 Apple. Inductor elements for electric machines. (20/5/18, U.S.
19,819 Apple. Armatures. (20/5/19, U.S.)
19,821 Apple. Current-controlling devices. (17/1, 19, U.S.)
19,822 Apple. Armatures. (15/9/19, U.S.)
19,886 Ges. fur Drahtlose Telegraphie. Multiplex telephony. (14/12/18, Germany.)
19,899 Ges. fur Drahtlose Telegraphie. Apparatus for generating high-frequency currents for wireless telegraphy &c. (19/1/15, Germany.)
19,900 Ges. fur Drahtlose Telegraphie. Arrangement for operating relays by electrical oscillations. (8/2/16, Germany.)
19,901 Ges. fur Drahtlose Telegraphie. Generation of electric oscillations. (28/9/17, Germany.)
19,902 Ges. fur Drahtlose Telegraphie. Wireless telegraph transmitters. (22 12/17, Germany.)
19,903 Ges. fur Drahtlose Telegraphie. Cathode-ray tubes. (9/1/18, Germany.)
19,904 Ges. fur Drahtlose Telegraphie. Wireless telegraph receivers. (9/4/14, Germany.)
19,905 Ges. fur Drahtlose Telegraphie. Cascade high-frequency amplifiers. (22/7/18 Germany.)
19,906 Ges. fur Drahtlose Telegraphie. Cathode-tube generators. (25/10/18, Germany.)

Companies' Reports, &c.

EDISON SWAN ELECTRIC COMPANY, LTD.

The profit of the Edison Swan Electric Company, Ltd., for the year ended June 30 last was £111,569 16s. 6d. Adding balance from previous year (£61,711 10s. 1d.) and deducting interest on both classes of debenture stock (£17,689 18s. 8d.), the 7 per cent. dividend on the participating preference shares (£7,000) and the excess profits duty to June 30, 1918 (£16,615), the balance is £131,976 7s. 11d. It is proposed to appropriate £2,843 18s. 6d. as depreciation on special munitions plant, £10,000 for expenses of issue of ordinary shares, to transfer £5,000 to reserve, to pay a further 3 per cent. dividend on the participating preference shares, making 10 per cent. for the year (£3,000), and to appropriate £5,977 17s. 4d. for debenture stock sinking fund, leaving to be carried forward (subject to excess profits duty from June 30, 1918, and corporation profits tax) £105,154 12s. 1d.

During the year £127,550 was expended upon capital account, of which £460 is in respect of additional land adjoining the works, which has been purchased, and £78,268 on buildings and £48,822 on plant and machinery. Extensive additions have been made to the lamp works, mainly to provide for the manufacture of gasfilled half-watt lamps, which are now being turned out by the company in large quantities and of excellent quality. These works have been equipped with the most up-to-date machinery and plant, thereby enabling this type of lamp and standard lamps to be produced at the lowest possible cost. The expenditure upon these buildings and their equipment is £91,169.

Lamp and Meter Developments.

In the early part of the year the board entered into an arrangement with Messrs. Philips' Glowlampworks, Ltd., of Eindhoven, whereby the company, has been able to obtain the co-operation of that firm at the company's works at Ponders End in the manufacture of all classes of electric lamps. The Philips' Company is acknowledged to be the premier lamp manufacturing concern in Europe, possessing processes, plant and machinery which have hitherto enabled it to manufacture lamps on, the most economical basis and of the highest quality. Similar plant machinery and processes have now been installed for some months at the Ponders End works of the Edison Swan Company. The directors are satisfied that the arrangement will prove beneficial to the company, and under the terms of the agreement a separate company will be formed for the entire manufacture of electric lamps for the Edison Swan Company, the necessary capital being equally contributed by the Edison Swan Company and the Philips' Company. The heavy rise in wages has increased manufacturing costs and thereby reduced profits, but this should be met in the future by increased production.

Arrangements have also been entered into with the Sangamo Electric Company of the United States, manufacturers of high class electric meters, which command a ready sale in all parts of the world. Under this arrangement a company is being formed, in conjunction with the American firm, the capital being subscribed by that firm and the Edison Swan Company, to manufacture similar meters at the Ponders End works, buildings having been erected for the purpose at a cost of £25,000. The Edison Swan Company has already disposed of considerable quantities of these meters made in the United States, but it is anticipated that when it is in a position to manufacture here, there will be no difficulty in disposing of the whole output at remunerative prices.

During the war and for some considerable time after the cessation of hostilities the stocks of raw materials and manufactured goods had fallen very low, and in order to carry on the company's operations efficiently it has been found necessary to increase these largely. For this reason, coupled with the heavy expenditure on new buildings, plant, &c., the prospective employment of further large sums in lamps, electric meters and other stocks, it is necessary that additional capital should be provided, and an extraordinary meeting will be held to pass the necesary resolution. The position of the money market, however, is not sufficiently favourable to allow of an immediate issue, but so soon as it is possible it will be made. In the meantime it is necessary that the cash resources of the Company should be conserved, and under these circumstances the directors regret that they are not able to recommend the payment of a dividend upon the ordinary shares, and therefore they propose to carry forward £105,154 12s. 1d., subject to excess profits duty and corporation profits tax. Should the financial position become more liquid, the directors may be in a position to declare a compensating interim dividend before the termination of the financial year.

VICKERS, LTD.

Mr. Douglas Vickers, M.P., who presided over the extraordinary general meeting of Vickers, Ltd., last week, gave an analysis of the report and accounts (abstracted in our last issue) and dealt with at some length with the position and prospects of the company. The dividends paid during the four years 1915-19 amounted to £3,967,112. In addition, income-tax, amounting to over one and a quarter millions, was paid on those dividends on the shareholders' behalf. The latter figure did not include the whole of the income-tax paid, for allocations of profits to reserve, even if kept within the company, were also subject to the tax. The wages paid during the war, a period of about four years, amounted to 46 millions, compared with the 5¼ millions of dividends and income-tax thereon, so that the workmen received about nine times as much as the shareholders. An allocation of £3,200,000 had been made to "works reserve," or at rate of £800,000 a year, compared with about £250,000 a year in pre-war times.

Prevailing Conditions.

At the meeting in April last, after pointing out that during 1919 output had been low in many of the branches, and that the year had ended with the moulders' strike lasting many weeks, and throwing many of the firm's workmen in other branches out of employment, he had expressed the opinion that there was a marked improvement in the spirit of the workmen, and that it appeared as if 1920 was likely to proceed under more satisfactory conditions than 1919. Unfortunately, the good indications did not last long. Wages and raw materials, and consequently selling prices, still rose, the difficulty of quoting fixed prices continued, and relatively the financial position of foreign buying countries grew worse and worse. Those combined influences brought about in the summer a decline in trade which had culminated in the present financial crisis. At the close of the war it was clear that a very large amount of waste and destruction would have to be made good. That had been done in shipping, where the available tonnage was already in excess of that existing before the war, and partly done on the transport services and manufacturing branches, but as the absolutely necessary work approached completion the buyer became much more careful. His liquid cash having been absorbed in stocks and work in progress, or paid away in taxes, he had to consisder most closely the prospects of his getting an adequate return on the price paid for his purchases and the cost of raising capital to pay for them. They found companies of good standing making issues of notes and debentures which the investing public would hardly touch even at prices giving a return 50 per cent. greater than would have been expected on ordinary shares before the war. Preference shares found hardly any market at all, and ordinaries were impossible to issue since E.P.D. had kept down dividends on them till they returned little more than the new trust securities. In the impossibility of raising new capital, buying had come at home nearly to a standstill. Abroad the low relative value of currencies of buying countries, compared even with the pound sterling, had put a stop to buying and customers were even seeking to cancel contracts.

Engineering Works.

Their engineering interests covered many branches, and some were affected differently from others. The shipbuilding and engineering works at Barrow had been very successful in changing over from war to peace work. Their Erith works had also developed some new trades that they hoped would have justified themselves when the accounts for 1920 were made up. The old Sheffield works had been affected by the diminished output due to the cessation of war work, but they had good hopes for next year. The Crayford factory, which was built for repetition work on a large scale, had found conditions very difficult, and at their Dartford works they had come to the conclusion that they must abandon some of the wood-working trades started after the war. With regard to the subsidiary companies, their old branch, the Wolseley Company, had their output programme spoilt by the moulders' strike and difficulties of delivery of outside supplies. Their weekly output was, however, about 50 per cent. more than they ever reached before, and the demand for their cars continued. Of the interests acquired with the Metropolitan Carriage Company, the Carriage Works and the Patent Shaft & Axle Tree Company, their steel section had done well, but the wagon trade has been unsatisfactory. The electrical interests of the firm, now centred in the Metropolitan-Vickers Electrical Company, had been well employed, and had a very large order book. Of course, it must be understood that they did not own outright the electrical interests now worked under the name of the Metropolitan-Vickers, but they owned, either directly or indirectly through their subsidiary companies, about two-thirds of the preference, two-thirds of the ordinary, all the deferred ordinary and half the 4 per cent. prior lien debentures.

Dividend Position.

Though the balance-sheet showed a very strong position and a large "carry-forward" from last year, the outlook was so unfavourable that they could not have risked denuding the company's cash resources even by the amount of an interim dividend. They knew now how they started in 1920, but as far as trade and the general financial situation was concerned there was no improvement yet. Much as the directors would like to pay an interim dividend they felt it absolutely necessary to follow the only safe policy, and that was to defer the question of any dividend for 1920 till the accounts for the year were out in next April. They were more predominantly an armament company, and the change from armaments to peace had therefore been more difficult for them than for any other company.

An interim dividend of 5 per cent. has been declared by Messrs. Benn Brothers, Ltd.

The accounts of the North Wales Power & Traction Company for the year ended June 30 last show a credit balance of £413.

The directors of the Victoria Falls & Transvaal Power Company, Ltd., have declared a half-yearly dividend at rate of 6 per cent. per annum on the preference shares.

The profit of the British Electric Transformer Company, Ltd., for half-year ended June 30, 1920, was £35,344, compared with £21,419 for same period of 1919. Since Jan. 1920, the works have been quadrupled in size and the output is steadily increasing.

The gross receipts of the Manx Electric Railway Company for the year to Sept. 30 last were £89,780, and expenditure was £48,870, leaving £40,910. Deducting debit balance brought forward (£8,910), interest on debenture stock and on second mortgage debentures, &c., the balance is £15,712. The preference share dividend for two years ended Sept. 30, 1915, is recommended, carrying forward £1,390.

New Companies.

BRITISH INDUSTRIES FAIR (BIRMINGHAM), INCORPORATED. (172,127).—Reg. Dec. 20, as a company limited by guarantee, without share capital. The company is not formed for profit, and the word "Limited" is omitted from the title by licence. To organise and promote the British Industries Fair, Birmingham. The names of 50 more gentlemen (all in Birmingham and district) are given as first members. The management is vested in a Council, to be appointed by a majority of the members. Reg. Office: 95, New-street, Birmingham.

GLOBE ENGINEERING COMPANY, LTD. (172,285).—Private company. Reg. Dec. 28. Capital £5,000 in £1 shares. To take over the business of electrical engineers carried on by Barraclough Brothers, Ltd., at Brighouse. First directors are: R. M. Brooke, A. Dean and A. M. Lawry. Reg. office: Perseverance Works, Huddersfield-road, Brighouse.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics": "Aviation Companies Plans for 1921"; "German Wind Tunnels"; and "The Zeppelin Airships L64 and L7L," by Major George Whale (late R.A.F.).

"Cabinet Maker": "Re-furnishing of the Hotel Cecil"; "The Arts in XVIIIth Century London"; and "The Present Position of Furnishing Textiles."

"Chemical Age": (Special Number) "Mechanical Handling of Material in Chemical Works."

"Farm and Home": The Agriculture Bill Passed; "Rye and Its History"; and "Sugar Beet in Norfolk."

"The Fruit-Grower": "Research Station for Eastern Counties", "Revision of Railway Rates"; and "Marketing Methods in Glasshouse Industry."

"Gardening Illustrated": "The Blue Garden at Earlham Hall"; "Rose Courtney Page"; and "Vegetables in 1920."

"Gas World": "Board of Trade Returns relating to Gas Companies"; and "Analyses of Some Municipal Gas Accounts."

"Hardware Trade Journal": "Enamels for Sheet Iron and Steel"; "Hardware in the Making (IV.): Knives"; and "Progress in Lighting (II.)."

"Transport World": (First Issue) "The Return Load Problem"; "Opposition? The Attitude of the Railways"; and "Practical Page—Help for The Novice."

Prices of Metals, Chemicals, &c.

TUESDAY, Jan. 4.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£82 0 0	—	—
Electro Wirebars ...	,,	£83 10 0	—	£0 10 0
H.C. wire, basis ...	per lb.	1s. 0$\frac{5}{8}$d.	—	$\frac{1}{16}$d.
Sheet	,,	1s. 2d.	—	$\frac{3}{16}$d.
Phosphor-bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	..	1s. 4$\frac{5}{8}$d.	—	$\frac{1}{16}$d.
Brass 60/40—				
Rod, basis	..	0s. 9$\frac{1}{2}$d.	—	—
Sheet, basis	..	1s. 2$\frac{1}{4}$d.	—	$\frac{1}{4}$d.
Wire, basis	..	1s. 1$\frac{3}{4}$d.	-	$\frac{1}{4}$d.
Pig Iron –				
Cleveland Warrants	per ton	£11 17 6	—	—
Galvanised steel wire, basis 8 SWG	..	£37 0 0	—	—
Lead Pig -				—
English	..	£26 5 0	£2 5 0	—
Foreign or Colonial	,,	£24 5 0	£2 15 0	—
Tin—				
Ingot	,,	£207 0 0	£8 0 0	-
Wire, basis	per lb.	2s. 9$\frac{1}{4}$d.	1$\frac{1}{4}$d.	

Salammoniac.—Per cwt. 110s.-105s.

Sulphur (Flowers).—Ton £16 15s.

,, (Roll-Brimstone).—Per ton £16 15s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £39.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 10$\frac{1}{2}$d.

Sodium Chlorate.—Per lb. 5d.

Rubber.—Para fine, 1s. 1d.; plantation 1st lutex, 10$\frac{1}{2}$d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Company, Ltd.

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Forty Years Ago.

(THE ELECTRICIAN, JANUARY 8, 1881.)

THE POST OFFICE AND TELEPHONY.—We believe that the applications from the public for telephonic facilities under Government control are exceedingly numerous.

IN MEMORIAM.—A tablet has been erected in the Shooter's Hill Cemetery, by the staff of the Eastern Extension Company, in the memory of H. T. Fisher, Esq., for some years the electrician of the Company.

ROYAL INSTITUTION OF GREAT BRITAIN.—At the Friday evening meeting on January 21, Warren de la Rue, Esq., D.C.L., F.R.S., Sec.R.I., will lecture on "The Phenomena of the Electric Discharge with 14,400 chloride of silver cells."

SOCIETY OF ARTS.—Among the papers to be read during the remainder of the session, we notice the following:—"Recent Advances in Electric Lighting," by W. H. Preece, Pres. Soc. Tel. Eng., on Feb. 23: "Flashing Signals for Lighthouses," by Sir W. Thomson, F.R.S., on March 2; "Deep Sea Investigation and the Apparatus used in it," by J. G. Buchanan, F.R.S.E., on Feb. 24; "The Future Development of Electrical Appliances," by Prof. J. Perry, on March 24.

COLLEGE OF PRECEPTORS.—A few words concerning the examinations held by the College may not be amiss. We shall refer only to the paper on "Electricity and Magnetism," set by O. J. Lodge, D.Sc., the examiner. Is an examination paper of any real value which contains only fair questions? As a rule a candidate passes if he obtains half marks. In this case, if the value of each of the questions is the same, the answer to two questions means a certificate indicating knowledge in electricity and magnetism.

Arrangements for the Week.

ROYAL INSTITUTION.

At Albemarle-street, Piccadilly, London, W. Christmas Lectures for Juveniles, on "The Haunts of Life," by Prof. J. A. Thomson,

Saturday, January 8th.

3 p.m. The Conquest of the Land.

Tuesday, January 11th.

3 p.m. The Mastery of the Air.

SATURDAY, January 8th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7.30 p.m. At the Grand Hotel, Colmore Row, Birmingham. Presidential Address by Mr. A. C. Wynne.

MONDAY, January 10th.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

5.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Paper on "Four-wire Telephonic Repeater Systems," by Mr. C. Robinson.

INSTITUTION OF ELECTRICAL ENGINEERS, DUNDEE SUB-CENTRE.

7.30 p.m. At University College, Dundee. Lecture on "Electric Driving of Jute Factories," by Mr. W. Sutcliffe.

TUESDAY, January 11th.

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH MIDLAND CENTRE.

7 p.m. At Hotel Metropole, Leeds. Visit of the President, Mr. Ll. B. Atkinson.

INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH CENTRE.

7 p.m. At North British Station Hotel, Edinburgh. Paper on "Automatic Protective Devices for Alternating Current Systems," by Mr. A. E. McColl.

INSTITUTE OF METALS, BIRMINGHAM LOCAL SECTION.

7.30 p.m. At the Imperial Hotel, Temple-street, Paper on "Segregation in Non-Ferrous Alloys," by Mr. E. A. Smith.

INSTITUTE OF METALS, SCOTTISH LOCAL SECTION.

8 p.m. At the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow. A Paper on "Rolling and Extrusion," by Mr. S. E. Flack.

WEDNESDAY, January 12th.

INSTITUTION OF AUTOMOBILE ENGINEERS.

8 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Paper on "Recent Developments in Transmission," by Capt. S. Bramley-Moore.

THURSDAY, January 13th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Twelfth Kelvin Lecture on "Electrons," by Sir William Bragg, K.B.E., F.R.S.

FRIDAY, January 14th.

N. EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "Advantages of Water-tube Boilers in Merchant Ships," by Sir James Kemnal.

INSTITUTION OF ELECTRICAL ENGINEERS: STUDENTS, SECTION OF THE SCOTTISH CENTRE.

7.30 p.m. At The Royal Technical College, Glasgow. Paper on "Alternating Current compared to Direct Current for Distribution and Supply," by Mr. R. R. Birch.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At Caxton Hall, London, S.W. Chairman's Address: "The Tides, their Cause, Effect and Use," by Mr. B. E. Dunbar Kilburn.

THE ELECTRICIAN

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Notes.

The West of England Inquiry.

THE inquiry into the organisation of electricity supply in the West of England area, which was opened at Bristol on Tuesday by the Electricity Commissioners, inaugurates a new and, we believe, a more prosperous era for the supply industry in this country. It begins the movement for the standardisation of methods of generation and supply; it implies greater coordination, an extension of the principle of linking up, and the gradual transformation into sub-stations, or the disappearance altogether, of those numerous kennels, euphemistically termed generating stations, which are dotted over the country as a monument to that short-sighted policy which, until recently, forbade any association with one another of adjacent electricity authorities. The task of the Commissioners is by no means an easy one. To restore order and system out of the present disorganised state of affairs would be in itself difficult, but when the conflicting interests of municipalities and companies have to be reconciled, the jealousy and petty parochialism of some local authorities resisted for the common good, financial and other problems to be solved, their labours become colossal, and skill, tact and patience will all be required. Nevertheless we feel certain that they possess the necessary capacity and mental qualities for the accomplishment of their great undertaking, and we wish them great success in their efforts, for only thus can come an electricity supply system capable of meeting the country's needs. Unfortunately there is still delay. For, as we go to press, we learn the enquiry has been adjourned until March 1st, to enable the parties interested to make themselves acquainted with the engineering details of the proposed scheme. It is only fair to add that the organising committee are not to blame for this state of affairs, but that like all pioneers they are suffering for the benefit of others.

A New System of Multiplex Telegraphy.

THOSE who think that telegraphy is too old and well established a science to produce for our delectation any startling technical improvements will be pleasantly disappointed when they read the description of the Western Electric Company's new system of multiplex telegraphy, which we publish on another page of this issue. We do not like to use the words "revolution" or "astounding" in such a connection, but to do so would not be by any means a misdescription when applied to the system we have mentioned. Its genesis is mainly due to the increasing demands on the world's means of telegraph communications, the ever-increasing traffic on which has meant an ever-increasing exercise of ingenuity to provide apparatus to deal with that traffic. The improvements thus produced have generally been along what may be called direct lines, but in the Western Electric Company's system for the first time indirect high-speed methods are employed. By this we mean that each line is fed by a number of transmitting instruments up to a maximum of six, the traffic so provided being dealt with by a corresponding number of instruments at the receiving end. This has the great advantage that all instruments work at a low speed, while at the same time the total amount of traffic that can be dealt with on any one line is greatly increased. As, moreover, the instruments supplying such a line need not be in one office, or even in one town, high speed working is made available in places where this would not otherwise be possible. The one drawback to the system seems to be the increased capital cost, but this is probably more than counter-balanced by the lower maintenance charges and by the elimination of highly skilled labour, which are really most important points. We deal at some length elsewhere with the ingenious devices which have been designed for bringing this advance in telegraph science to the commercial stage, but we may say here the more the details of the system are studied the more it will be realised what a vast amount of care, patience and enterprise must have been necessary to ensure success in the performance of so complicated a mechanism, or, in other words, that human skill has brought to the highest pitch the elimination of the human element from the operation of the apparatus.

Telephone Charges.

THE outcry which has broken out in the daily Press on the subject of the increased telephone charges is remarkable both for its unanimity and its virulence. The objections are, first, that the new charges are unconstitutional, and, second, that they would not be necessary but for the inefficient management of the Post Office. As a remedy for this state of things it is suggested that the telephone system should be boycotted, until those responsible for its operation see the error of their ways. The futility of such a course should be obvious. It would simply mean that the present deficit, and more also, would be met by the taxpayers instead of by those who use the telephones, and it would prevent that development which, though small at present, will, we hope, soon be increased and bring about those improvements which are necessary for the well-being of the communications of the country. Nevertheless, we can sympathise with those who object to the increases. They are mainly newspapers and commercial undertakings which have so far garnered the benefits of the unlimited rate. It is, therefore, hard, after years of enjoyment of a beneficial, though uneconomical tariff, to be suddenly faced with a change to an arrangement which, though economically sound, is bad for their balance sheets. Our sympathy, however, is tempered by the fact that we still feel that all this agitation is *vieux jeu*. Had the telephone system of the country been still in the hands of a private concern we can conceive no scorn acid enough to deride the suggestion that it should be handed over to the State, for we now know what State ownership and control mean, but, unfortunately, those who criticise our government are not blessed with second sight, with a result that some years ago they viewed with indifference, and even welcomed, the transfer of a fairly efficient system to a department that, whatever its history, has never been distinguished either for its enlightened outlook or its business-like operations. That they should now be reaping the harvest they have sown, though it may be bitter, is only poetic justice. Nevertheless, we are sorry that these changes should have been made at the present time. We feel that the same end might have been obtained by developing the telephone system on money borrowed under Government security coupled with a determination that the administration should be conducted on more business-like lines.

Electricity in Gas Works.

The subject matter of the Paper by Mr. H. C. Widlake on "Electricity in Gas Works," of which we give an abstract on another page of this issue, will perhaps come as a surprise to some readers of The Electrician who do not realise what wide opportunities exist for the use of electricity by gas undertakings, and the extent to which these opportunities have been seized. Mr. Widlake mentions, for example, one case—that of the Plymouth and Stonehouse Gas Light and Coke Company—where it is expected that the consumption of electricity will shortly exceed a million units per annum. The fact that steam is necessary for so many operations in a gas works doubtless explains the natural tendency to use steam engines. But the loss of heat and the inefficiency of such plant are apt to become a tax on the existing boiler power, and in many cases the introduction of electrical generating plant and the ensuing convenience of distribution and special advantages of the electric drive have proved well worth while. It is pointed out, however, that the fact of steam being in any case necessary for many operations, and also the presence of a supply of breeze as fuel, tends to favour the use of steam driven plant, though gas-driven generators may prove useful as a stand-by. Finally, it should not be overlooked that a large gas works making extensive use of electricity needs to take many of the precautions against possible breakdown that are necessary by an electrical supply company, though the possibility of storage does not make these so important. It seems likely that the applications of electricity in gas works will continually extend so that ultimately we may expect that a class of engineer, equally conversant with the problems of gas and electricity generation will arise, which will not be a bad thing.

Hydro-Electric Progress in India.

According to the Second Report on the Water-Power Resources of India, an abstract of which appears on another page of this issue, steady progress is being made with the survey of the water-power available in that Empire. Prior to the war, several water-power schemes were developed or projected, and one of the results of the war has been to increase the demand for a complete survey of the whole of the water-power and natural resources of the country. The work involved is immense, and will take several years to complete, but when completed it should prove of the greatest value from the reconstruction point of view. Hitherto the work on these problems, for which Mr. J. W. Meares, the electrical adviser to the Government of India, has been mainly responsible, has been carried on at a disadvantage. The organisation is not yet perfect; there has been a shortage of engineers to make surveys of sites; there has been a lack of self-recording rain gauges; and much of the territory is yet unexplored. However, these defects will, no doubt, be remedied in good time by the present chief engineer of the survey, Mr. F. E. Bull, who took over the direction of the work in December, 1919.

The Control of Water Power.

The important question of the control of the water-power, however, remains unsettled. There are advocates of State control or nationalisation, who demand the creation of an Imperial Water Board; some favour a combination of State and company ownership; while others urge the claims of the Provincial Governments to control the falls in their districts. Already a number of leases have been granted by the Local Governments, and it is most important to have a definite policy in regard to these concessions, for some concessionaires simply obtain rights in order to sell them later on to a company. In other cases the local authorities wait until a lease for a site is applied for by a company, and then oppose the application. This obstructive attitude militates against progress, and it is to be hoped that legislation will be passed in order to regularise the situation and to remove the power of the obstructionists. At all events, it would appear from the present report that there are large "blocks of power" capable of development, and if only one-fourth of the suggested sites are utilised there should be a large demand for turbines, electric generators, transforming plant, transmission lines, cables, &c. Our electrical manufacturers would, therefore, be well advised to keep themselves acquainted with developments in India in order to be ready when orders are given out.

North Wales and Chester Electricity District.

In a recent issue we gave a brief outline of the scheme prepared by the Chester Corporation for re-organising the supply of electricity in North Wales and Chester, and for the formation of a Joint Electricity Authority in that area. The proposals, which are somewhat similar to those suggested for the Mersey and West Lancashire Districts, provide for the representation of the various authorised undertakers and local interests on the Authority, for the standardisation of the generation and supply of electricity in bulk, and also for conferring powers for raising capital and for carrying on the general work of administration. The scheme was considered at a local conference last week, and has been referred to a committee for examination and report. From the discussion it appears there is jealousy regarding the leading part taken by Chester in the evolution of the scheme, and the rival proposals made by North Wales Power & Traction Company also find a good deal of favour. It is interesting to see that while the Chester scheme proposes to utilise the water power of the Dee in conjunction with a steam driven station, the Company's proposals are based entirely on the development of hydro-electric power

The Present Position of the Company.

At present the Company has hydro-electric stations at Cwm Dyll, near Beddgelert, and at Dolgarrog, near Llanrwst, about 60,000,000 units being generated per annum. It is, however, anticipated that in a short time there will be available water power capable of generating 130,000,000 units. A new station is being erected at Maentwrog and this will be linked up with the existing stations. From these three stations it is proposed that high-pressure trunk transmission lines should supply power throughout North Wales and the industrial centres on the Welsh border, while the existing transmission lines will be extended into Anglesey and South Carnarvonshire. Lattice girder masts on which the coastal line will be carried from Dolgarrog across the Conway valley have already been erected and the line will thence proceed, on wooden poles, to a point near Colwyn Bay, whence a tapping will be made to Llandudno. The line will then follow the coast line over the Clywd, will go along the Flintshire uplands to Chester, and thence to Northwich and Crewe, returning via Wrexham. The second main transmission line will run from the station at Maentwrog, via Bala, across the country to Wrexham. A third main trunk line will run, via Denbigh, to Chester. On the coastal main energy will be transmitted at a pressure of 54,000 volts and on the others at 66,000 volts.

Bulk Supply to Twenty-Six Districts.

It is further suggested that the Company should supply electricity in bulk to 26 sub-districts in the area defined by the Electricity Commissioners, the local authorities in these districts retailing the supply much as the present authorised undertakers do at present. The Company states that it can supply sufficient energy to meet the requirements of the whole of North Wales and of the industrial areas on the border for power and traction for many years, with a possible surplus for Liverpool, Birkenhead, Warrington, and the Potteries, so that it is nothing if not optimistic. Already the Company has agreed to supply Colwyn Bay Council with current in bulk at 1¼d. a unit, and it is hoped that similar arrangements will be made with the Llandudno and other Councils. As regards finance, Colwyn Bay Council is borrowing the capital required to construct the overhead mains from Dolgarrog to its boundary and will have a charge upon the mains until the principal has been repaid by the Company. Llandudno Council will provide its own lines from the connection with the trunk main at Colwyn Bay. It is understood that further sources of hydro-electric power are available, which would bring the total output up to 250,000,000 units per annum, but it is estimated that, excluding existing customers of the Power Company, an additional 15,000,000 units per annum will cover the requirements of the western area. It is in the eastern part of the area—Crewe, Northwich, Wrexham, Chester and along the Dee estuary—where the demand for power will increase and where there is, incidentally, already a shortage.

Electric Traction in America.

The United States is rather in the foreground at the present time, though, of course, that is not an unusual place to be. For, Mr. Pearce having told us about electricity supply conditions in that country, we now have Sir Vincent Raven giving us his views on electric traction as coloured by what he saw during a recent visit to America. The object of his visit was to obtain information regarding the electrification of railways and to discover whether the experience in America with this form of traction would warrant its development to a greater extent in this country. We should have thought that a visit to America was hardly necessary to find this out, and we are not therefore surprised that, his many thousand miles of travel by rail and the data regarding the costs of working and repairs he was able to collect, only confirm opinions which are held by British engineers on this question. What we should now like to know is how all this information is to be applied to solving the problems which the North-Eastern Railway, and, indeed, most of our railways, have to face and overcome somehow, yet that is where Sir Vincent Raven seems inclined to be reticent, though in a recent interview he did let out, not only that from the operating point of view electrification has been a complete success, but that it is inevitable, especially on new lines. Inevitability, however, is a plant of slow growth, and we should like to see the wheels of fate accelerated a little in order that the improvements which are urgently required may take place with the least possible delay. We are glad to see Sir Vincent Raven thinks that it is better equally for financial and technical reasons that the necessary energy for operating electrified railways should be obtained from a public source rather than that the railway companies should build their own generating stations. With that conclusion we are in hearty agreement.

Housing and Smoke Abatement.

The fallacy that electricity is so expensive is one which must obviously be exploded before any real advance can be made with the development of the domestic load. Given proper presentation, this should not be difficult, despite the unfortunate fact, the significance of which can hardly be exaggerated, that while the price of many commodities is beginning to drop, that of electricity is still rising. This, indeed, is a point to which those concerned with the supply side of the industry must give their careful consideration, for on it the prosperity or otherwise of our future must depend. At the same time, we are sorry to see that the Ministry of Health is among those who imply that electricity should only be used for purposes other than lighting when gas, or even coal, cannot be conveniently employed. In one of the Housing Memoranda which they issue from time to time the Ministry, quite rightly, points out the injury to life and the damage to vegetation and buildings which are caused by the smoke-laden atmosphere resulting from the use of coal in domestic grates, and, equally rightly, recommend that in every case where it is at all practicable, gas, anthracite or electricity be used for cooking and heating purposes. Unfortunately, however, they add a rider that electricity should only be used where the supply of current is obtainable "at a low rate," irrespective, that is, of the relative prices of gas or coal in the area. They quite overlook the fact that in dealing with this important question the total cost must in every case be considered, and not simply either the capital costs or the working expenses of installing or using any particular heat agent as separate items.

Peter and Paul.

This is all the more important, for at the present moment the employment of electricity in many of the new housing colonies is being hampered by the fact that the gas authorities are quoting such low installation costs that electricity cannot economically compete. This is, of course, excellent from the housing authorities point of view, but it should be obvious that those supplying gas must recoup themselves somehow, and will do so by charging the tenants an excessive price for the gas consumed; in other words, what the building authority saves the tenant will lose. While, of course, there is no objection to this policy as a matter of business, we cannot allow it to be ignored when comparisons between the costs of gas and electricity, such as we have mentioned above, are being made. Apart from any question of cost, however, it cannot be too often insisted that the cleanliness, convenience and general adaptability of electricity for domestic purposes offers greater advantages than any other form of heat or lighting agent can hope to show. Unfortunately, this is far from being generally realised, and it would, therefore, be an advantage if the electricity authorities concerned could obtain the sympathetic collaboration of the architects responsible for the various housing schemes from the very beginning, and by securing a large saving on the structural costs which would be possible by omitting most of the fireplaces help to offset the necessary cost of electrical apparatus and wiring, and so at least show that electricity has some advantages. This, we are glad to learn, has been done with great success at Billingham and elsewhere, but it is an idea capable of wider application.

A German Electric Proving House.

THOSE concerned in the establishment of an electric proving house in this country will be interested to learn that the Verband Deutscher Elektrotechniker has completed arrangements by which manufactured articles can be submitted to them for test. These articles, if they pass the test, will be approved and will be suitably marked with a registered mark, consisting of an equilateral triangle, written in the three corners of which are the letters V, D, E. The names of those who are to serve on the committee of supervision have already been issued. At the head of them stands Dr. KLINGENBERG, and he is supported by a number of electrical engineers, nominated by a variety of associations interested in the matter. The interests of manufacturers and consumers are represented on the committee. It is proposed at the start to limit the tests to certain types of device, including fuses and switches, capable of carrying up to 60 amperes, hand lamps, wall plugs of various kinds, cooking and heating appliances, electro-medical apparatus, and toys. The testing station is to start work at once, and will be in charge of Herr von ZIMMERMANN. The present intention is to start by testing apparatus, which might, if defective, be dangerous to life cr cause fires; with this object in view, the above selection was made, and it will be noticed that most of the things on the list fall within the category of articles which will be used in everyday life by unskilled persons. We hope that the establishment of some similar authority in this country will not be long delayed.

British Electrical Development Association.

THE enthusiasm which is generally expressed, and to a large extent also felt, for the aims and objects of the British Electrical Development Association obscures the fact that this useful body is not receiving that support from the various branches of the electrical industry which it requires, and to which its activities up to the present certainly entitle it. Now, while those responsible for the work of the Association and those who are using all their efforts to help it in every way, among whom we may be permitted to enrol ourselves, will not rest until it receives practically universal support from the whole of the electrical industry, that condition does not exist at the present time, and a good deal of energy of those responsible for its management which might be expended on more useful objects is, therefore, being taken up in persuading those who ought to belong to the Association to take up the responsibilities of membership. The beginning of the New Year is a time when good resolutions are made and broken. And we therefore hope that the various supply undertakings and manufacturing concerns who still remain outside the ranks of the B.E.D.A. will make without delay a resolution to remain in darkness no longer, and will take the necessary steps to assume membership at the earliest possible moment. We need hardly add that if there be any who are not fully acquainted with the objects of the Association, or who are inclined to be critical of what it has so far done, the best way to help their unbelief is to apply to Mr. BEAUCHAMP for a copy of the last report, which describes the activities of the past 18 months. They will there find much that is informative and sufficient to persuade them to take the course we have just suggested.

Scottish Water Power Schemes.

Though the Private Bill programme of the 1921 Session of Parliament is a comparatively lean one, there are two interesting Scottish hydro-electric schemes which deserve more than passing notice. In the first place, there are signs that both will encounter opposition from æsthetists in general and from those who desire to preserve the primitive grandeur of the Highlands in particular. On the other hand, there is evidence that the attitude of some of the local authorities interested will not be unfriendly.

ENLIGHTENED LOCAL INTERESTS.

For instance, the Inverness County Council has decided to support the Lochaber Water Power Provisional Order, because it is a local scheme and it is "primarily for the benefit of the Highlands," but the Grampian Electricity Supply Provisional Order is to be opposed because it is said to be "only for the benefit of the manufacturers of Dundee and Perth." Again, it is considered that the "Highlands should be developed for the benefit of the Highlands," and as the British Aluminium Company's project implies the development of industries in the County of Inverness, the County Council's support is already assured. Though this view is narrow and is determined by psychological rather than engineering considerations, it is a welcome change from the attitude taken up towards a similar scheme which was rejected two years ago. And even this is not an isolated case. For though the Perth County Council is going to enter opposition to the Grampian Order, it is understood that this is only done to ensure that the county's interests shall not be neglected.

Opposition is, however, being organised by other local authorities who are jealous of anything in the nature of the monopoly being obtained by a company. Representatives of authorities in Stirlingshire and Linlithgowshire have met and have decided to communicate with the Electricity Commissioners to point out that "if there is any benefit to be obtained the local authorities would like to participate, even though they are outside the area schedules in the Order." This is a very candid, though hardly a creditable, attitude for public bodies to assume towards a measure of first-class importance involving an expenditure, according to the estimates of the engineers (Messrs. MOTT, HAY & ANDERSON), of £4,060,000 and appearing to be a project eminently suitable on account of its nature and magnitude for carrying out by private enterprise.

DUNDEE'S OPPOSITION.

We are rather surprised to see that one of the principal opponents will be the Dundee Corporation, whose electric-generating plant is overloaded. The extensions in hand at the Corporation's own stations will only suffice for next winter, and it has therefore become necessary to order more plant for the winter of 1922-23. At first it was thought the Corporation might make an arrangement to take a supply in bulk from the promoters of the Grampian scheme, but as the result of reports from the Town Clerk and the city electrical engineer it has been decided to present a petition against the Order. It is thought that the Grampians Company could not give a supply for at least four years, and that the Company might compete unfairly with the municipal undertaking. Major Richardson also thinks that the Company could erect a steam-driven station near the city boundary, and might endeavour to supply in the existing municipal area. If this be so then Dundee can easily protect itself by getting a protective clause inserted in the Grampians Order. But we think this possibility so remote, especially as no new station can now be erected without the consent of the Electricity Commissioners, that we hesitate to believe it can be the real reason for the attitude of the Corporation. We are inclined to think that this attitude is partly due to a fear of a private monopoly and partly to a desire to revive last year's Tummel Valley hydro-electric scheme, because Major Richardson and Prof. Gibson have been instructed to report upon the possibility of developing the project in order to meet the future electricity requirements of the Corporation. We hope, however, that the Grampian scheme will be considered on its merits, and that it will ultimately receive Parliamentary sanction.

The Lochaber Scheme.

Turning to the details of the various schemes, the British Aluminium Company's Order is similar to that promoted two years ago. It seeks authority to construct works for the generation of electrical energy at Fort William. The water required is to come from the Spean, a tributary of the river Lochy. The main reservoir is to be an enlargement of Loch Treig and will be constructed by building a dam some 39 ft. high at its outlet. Loch Laggan, which is at the head of the Spean and a reservoir which is to be formed just below it, will supplement the main storage; while the supply from Loch Laggan is to be reinforced by water conveyed from the Spey through a pipe line about 15 miles long, extending to near the scource of the river. The main supply conduit from Loch Treig to the power house at Fort William will follow the contour line to round the foot hills of the Ben Nevis range, and practically every stream en route will be laid under contribution for the augmentation of the supply of water power. The estimates of the engineers, Messrs. C. S. Meik & Buchanan and Messrs. Alex. Binnie, Son & Deacon, put the cost of the scheme at £2,962,000, and as there is likely to be little opposition it will probably receive Parliamentary sanction.

The Grampian Scheme.

The Provisional Order for the incorporation of the Grampian Electricity Supply Company deals with a much more extensive and important scheme, and as the proposed works are in the counties of Inverness and Perth it is, to a certain extent, a rival of the Lochaber project. The promoters are Sir H. Babington Smith, Sir Wm. Guy Granet, Sir Austin E. Harris and Mr. E. Cox, and the capital is fixed at £1,000,000, with power to increase it to £4,000,000. There are extensive powers for the acquisition of lands and for the construction of reservoirs, dams, weirs, conduits, &c., and five generating stations are scheduled as follows: In Tortingall, on the North Shore of Loch Rannoch; in Laggan, near Chamb and Loch Ericht; in Kingussie and Inch, on Loch Cuaich; in Blair Atholl, on the Bruar water, and also in the same parish near the main road from Blair Atholl to Dalnacardoch.

Water Power to be Used.

Authority is sought to use the waters of 15 specified lochs (including Lochs Ericht and Rannoch) and 99 lochs, rivers and streams (including the Ericht, Garry, Tarf and Banvie), and all streams flowing into or from these lochs and rivers. The complete scheme will involve the construction of several large dams, reservoirs, &c. For instance, the storage for the Loch Rannoch power station will be provided by damming and raising Loch Ericht 57 ft., and to ensure a sufficient supply for the area, Loch Pattack will also be raised 29 ft., and the head waters of the Truim, as well as Lochs Bhaadain and an t'Sellich will be placed under contribution. It is proposed to feed the power station at Blair Atholl from Loch Garry, whose level will be raised for the purpose by 71 ft. From the loch the water is to be led by an aqueduct on the east side of the river to a reservoir to be formed by a dam across the Bruar water, some 117 ft. high, and three miles or so above the junction of that tributary with the Garry at Struan. On the way down, subsidiary dams are to be formed on most of the tributaries, and the waters therefrom led into the main aqueduct as well as a supply from Loch an Duin, at the top of the Tromie. The Bruar water is to be further strengthened by an artificial loch to be formed about Loch Mhaire and the head waters of the Tilt, and it is from this Bruar reservoir that the final aqueduct will lead the water direct to the power station.

Area of Supply and Powers.

The Company seeks powers to supply electricity within the counties of Perth, Kinross and Forfar and parts of Argyle, Inverness, Stirling and Dumbarton, but they will not be able to give a supply to those areas (except for power, to authorised undertakers or to any company owning railways, tramways, water-works, &c.), where authorised distributors are operating without the consent of those distributors, though in the case of unreasonable refusal an appeal lies to the Electricity Commissioners. A section of the Order compels the Company to give a supply of electricity to any authorised undertakers, &c., provided they contract to pay, for at least seven years, 25 per cent. on the outlay (excluding generating plant) incurred in providing such supply. Provision is made against the preferential treatment of consumers in similar circumstances and for dealing with cases of standby supply. If authorised distributors desire to cease taking supply they must give 12 months' notice, and the Company is empowered to enter into agreements for the supply and receipt of electricity in bulk, for the acquisition of electricity undertakings, &c., and it may "manufacture, acquire, maintain and sell, let on hire and dispose of" all electrical plant and apparatus. If a substantial commencement of the works has not been made within five years the powers lapse, and the works must be completed within ten years. Interest, not exceeding 8 per cent., may be paid out of capital until the expiration of the time for the completion of the works, but no interest accrues until two-thirds of the capital of £1,000,000 has been issued, and only one-fifth can be applied in paying interest.

Price of Energy.

The maximum prices to be charged are as follows: To authorised distributors, or to railway or tramway undertakings whose maximum demand exceeds 250 kw., 3d. per unit for any quantity not exceeding the equivalent of 400 hours of supply at the maximum demand, and to ordinary consumers 13s. 4d. for the first 20 units with 8d. a unit afterwards. Such in brief outline is the interesting and ambitious scheme of the Grampian Electricity Supply Company. Conceived in bold and somewhat original lines it deserves the sympathetic support of all who believe in electrical progress, and we wish the promoters success in their venture. Already one or two local authorities in the proposed area of supply are considering the question of taking a supply of electricity in bulk from the Company, and if they succeed in starting out with a few substantial consumers of this character there is no reason why it should not prove a financial success.

The Capacitance of Flat Top Antennae.

By W. H. ECCLES, D-Sc.

In a recent Paper* a new formula for antenna capacitance was given by L. W. Austin. It is an empirical formula, and is shown by experiment to be applicable with considerable accuracy to all flat-top antennæ of any reasonable shape. It may be written

$$C=(4\sqrt{a}+0{\cdot}885a/h)(1+0{\cdot}015l/b)\ .\ 10^{-5}.$$

where C is the required capacitance in microfarads, a is the area of the plan of the flat top in square metres, h is the height in metres, and l and b represent the length and breadth of a more or less rectangular flat top. The second factor becomes appreciable only when the length is more than eight times the breadth. The remarkable feature of this simple empirical formula is its applicability to any shape of flat top and its virtual independence of the number of wires.

For many years I have used a different formula for making trial designs of antennæ. It is even simpler than that of Austin, but is, perhaps, not of such wide application, being intended for use with long antennæ formed of a number of relatively close parallel wires. Let l be the length of the flat top, n the number of wires, c the capacitance per unit length of a single wire of the same gauge as each of the wires of the antenna and placed at the same height, then the capacitance of the actual antenna may be written

$$C=cl\sqrt{(n-1)}$$

in electrostatic units.

The value of c is given by the well-known formula

$$c=1\div 2\log_\epsilon(2h/r),$$

where h is the height and r the radius of the wire. When h and r are known, the values of c may be read from an abac; but for rough purposes we may usually take $c=0{\cdot}05$ electrostatic units, since it varies very slowly with change of the ratio h/r.

A great advantage of this formula is the possibility of applying it to obtain a direct solution of the problem of designing an **L** antenna of desired capacitance, the gauge of the wire being given. Suppose an **L** antenna of capacitance 5,000 cm. is to be made with wires of 5 mm. diameter, the height being 100 metres. The value of h/r is $2\times10^4\div0{\cdot}5=4\times10^4$, and therefore $c=0{\cdot}047$. Hence we must take

$$l\sqrt{(n-1)}=5{,}000\div0{\cdot}047$$
$$=94{,}000 \text{ cm.}$$

Thus, if $n=5$, $l=470$ metres; if $n=10$, $l=313$ metres; and if $n=17$, $l=235$ metres. Results such as these are quite trustworthy, provided that the spacing between the wires is not more than about a fiftieth of the length of the flat top. But the limitations of the formula have not been adequately determined. I have used it tolerably successfully even for a square flat top, made by stretching grids of parallel wires between four poles, the length being then regarded as the perimeter of the square.

Dr. Austin's Paper contains a number of examples of the application of his formula, in which, fortunately, there is sufficient detail to permit of trial applications of the formula just given. I have therefore prepared the following table from the data he gives for four **L** antennæ, numbered 1, 2, 3, 4. The lengths are in metres, the capacitances in billifarads, and wire diameters in millimetres.

It will be seen that in these examples the ratio of length to breadth varies between the extremes 10 and 45, the ratio of height to breadth from 0·65 to 7·9, and the ratio of breadth to diameter of wire from 162 to 16,000. The largest error in the calculated capacitance is about 4½ per cent.

It remains to be pointed out that the formula does not make any kind of allowance for the capacity of the down lead. A separate estimate has to be made of this if it is considered to be of importance. For nearly every purpose it may be calculated by the above formula with ½l substituted for l, if it is of fan shape.

Sometimes a logarithm table is not handy and then an approximation to the logarithm in the above formula is convenient. The final result is

$$C=\frac{4{,}200\ l\sqrt{(n-1)}}{7{\cdot}31\times10^4+h/r}$$

in electrostatic units when l is in centimetres.

—	Length.	Breadth.	Height.	No. of wires.	Diam. of wire.	Observed capacitance.	Calculated capacitance.
1	1830·0	160·0	104·0	32	10·0	53·0	53·2
2	91·5	9·15	49·0	11	3·0	1·4	1·44
3	25·9	1·52	12·0	6	3·0	0·34	0·33
4	18·3	0·406	1·52	6	2·5	0·28	0·29

Q_m-Operators and Hysteresis Harmonics.

By A. PRESS.

The problem of hysteresis and eddy currents in alternating-current theory is sufficiently important to warrant the attention of mathematical engineers and physicists. Thus, a notable recent application of advanced mathematical reasoning in connection with iron transformers for radio frequencies is to be ascribed to M. Marius Latour.† The above problem and also that of the resistance and reactance of iron wires as dealt with by the writer (*loc. cit.*) have been solved on the basis of elliptical hysteresis only. A later problem, "Harmonic Reactance and Resistance of Iron Supported End Connections" (*loc. cit.*, pp. 188-197), was attacked from the standpoint of the general harmonic relation subsisting between **B** and **H**. The basis of such solution was the operator Q_m defined by the equation

$$Q_m \sin pt=\sin mpt. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In this relationship Q_m is not to be looked upon as a numeric, but as a mathematical operator very much like the differential (or integral) operator $t_1=\frac{d}{dt}$ employed so successfully by Oliver Heaviside.

It will be observed that in developing the algebra of the Q_m operators a tacit assumption was made (*loc. cit.* Appendix II., pp. 200-204) that adding current harmonics on the primary side of a transformer was equivalent (effectively) to superposing linearly the corresponding voltage harmonics on the secondary side obtained independently by means of the **B-H** curve. To what extent this step is justified is the object of the present article, for on it rests not only the mathematical theory of the more general type of hysteresis problem, but that of elliptical hysteresis as well.

In the case of iron, at least where uniform magnetic distributions are assumed we are entitled to write the equation

$$B=f(H) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

quite independently of the manner in which H may be varied, provided, however, that no re-entrances shall occur. In order to express therefore the required relation for a nest of similar loops the scale of Fig. 1 will be assumed standard, on the basis of some maximum value H for which the corresponding value is B. For a loop in which the maximum value of H will be aH (*see* Fig. 2.) we are then justified in writing

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* "Proc." I.R.E., p. 164, April, 1920. THE ELECTRICIAN, Vol. LXXXV., p. 200.

† See also a Paper by the writer, "Treatment of Harmonics in Alternating-current Theory by Means of a Harmonic Algebra," University of California, September, 1919, pp. 167-174.

$$aB = f(aH). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The quantity a can then be looked upon as an amplitude parameter.

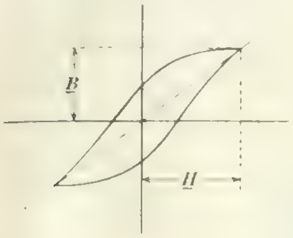

FIG. 1.

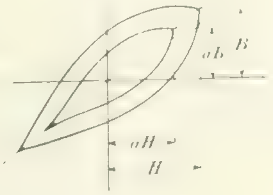

FIG. 2.

Turning now to the question of linear superposition of harmonics, let us assume a transformer given Fig. 3. On the primary or H side an arbitrary time relationship will be assumed according to the expression

$$H = T, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

when T is some function of the time t. In view of (2) we are then entitled to write

$$B = f(T), \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

since the amplitude of T in (4) is the amplitude of H, and *vice versa*. For the general case, however, we will assume two test curves to have been taken according to which we will have

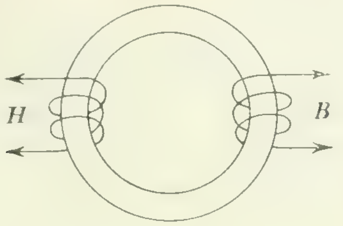

FIG. 3.

$$a_1B_1 = f(a_1H) = f(H_1) = f(a_1T_1) \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$a_2B_2 = f(a_2H) = f(H_2) = f(a_2T_2) \quad . \quad . \quad . \quad . \quad (7)$$

with the T's quite arbitrary, except for the possibility of reentrances. It is now clear according to the equation (2), that if instead of H we take the function

$$aH = H_1 + H_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

to be impressed on the left hand side of the transformer, Fig. 3, we ought to have in reality a resultant magnetic density function given by the expression

$$B_3 = aB = f(aH) = f(H_1 + H_2) = f(a_1T_1 + a_2T_2). \quad . \quad . \quad . \quad (9)$$

whereas, if we were at liberty merely to add (superpose) the two resultant expressions (6) and (7), we would have

$$B_3' = a_1B_1 + a_2B_2 = f(H_1) + f(H_2) = f(a_1T_1) + f(a_2T_2). \quad . \quad (10)$$

Clearly B_3 of (9) will not in general be the same as the B_3' of (10), and the question arises, which has important consequences so far as the proposed harmonic algebra is concerned, to what extent is (9) replaceable by (10). The error, in so far as there will be any, is given by

$$B_3 - B_3' = \Delta B = f(H_1 + H_2) - f(H_1) - f(H_2). \quad . \quad . \quad . \quad . \quad (11)$$

For the ideal case, that is, with

$$\Delta B = O \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

it would be necessary to equate

$$f(H_1 + H_2) = f(H_1) + f(H_2). \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

The above functional equation when solved for the functional form of f would indicate the all-sufficient condition to exist.

To solve for (13), differentiation with regard to H_1 and H_2 respectively can be resorted to. Thus we have

$$\frac{d}{dH_1} f(H_1 + H_2) = f'(H_1)\,; \quad \frac{d}{dH_2} f(H_1 + H_2) = f'(H_2). \quad . \quad . \quad (14)$$

But it follows quite simply from the symmetrical nature of $f(H_1 + H_2)$ that differentiation of this latter expression with regard to either H_1 or H_2 must eventuate in the same resultant expression. We therefore have

$$\frac{d}{dH_1} f(H_1 + H_2) = \frac{d}{dH_2} f(H_1 + H_2). \quad . \quad . \quad . \quad . \quad . \quad (15)$$

so that it is seen

$$f'(H_1) = f'(H_2). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (16)$$

Since by (6) and (7) both expressions of (16) are independent of each other they must both equal the same constant μ, so that integrating, we have

$$f(H_1) = \mu H_1\,; \quad f(H_2) = \mu H_2, \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

and on adding and taking note of (13) it follows

$$f(H_1) + f(H_2) = \mu(H_1 + H_2) = f(H_1 + H_2). \quad . \quad . \quad . \quad . \quad . \quad (18)$$

In other words, the form of $f(H_1 + H_2)$ is given by

$$f(H_1 + H_2) = \mu(H_1 + H_2). \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

A consequence of the above is that

$$f(H) = \mu H\,; \quad B = \mu H, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

and μ must be a mere numeric.

The above result (20) implies therefore that in order for condition (12) to apply *exactly* quite independently of what the arbitrary functions T_1 and T_2 may be, the real B-H locus *ideally* should be of the nature of a straight line only. For those practical cases, however, where the width of the hysteresis loop is not too great a proper approximation will result by adopting the Q_m-harmonic algebra suggested.

Bolshevism and Electricity Supply.

That so constructive an industry as electricity supply and the benefits which are obtainable by those using this commodity should have been seized by a Bolshevik leader as a way out of the difficulties which, even he seems to realise, now surround the future of Russia, is perhaps not so surprising as might appear at first sight. All revolutionaries are idealists. In fact, this is sometimes the worst thing about them, so that Lenin though, being a Marxist, he is theoretically opposed to Utopias of every sort, is only complying with the fitness of things in suggesting the building of great power stations and the development of electricity supply to serve Russia with light, with transport and industrial power, and in seeing in such a scheme a real chance of returning to something like sound methods of administration and existence.

According to Mr. H. G. WELLS' recent book on "Russia in the Shadows," Lenin has stated that two experimental districts had already been electrified. The project is one which Mr. Wells rightly describes as courageous, for it has to take place in a vast land of forests and illiterate peasants where no water power is available, technical skill is wanting and trade and industry are almost at their last gasp. We should be the last to decry any scheme for the development of electricity supply, but we cannot help feeling that in this particular case something more is wanted than just thought and talk about the matter. To develop such a scheme and to get it into the condition where it can really help Russia in her present struggle, almost unlimited work and constructive enterprise will be necessary, yet the one lesson which is derivable from Mr. WELLS' book would seem to be that Lenin and his followers, though well equipped with the bump of destructiveness, have not yet shown an aptitude for the more desirable and harder task of building up anything to take the place of what they have destroyed.

The Western Electric Company's Multiplex Telegraph System.

The needs of present day civilisation require an ever-increasing improvement in speedy and accurate means of communication. In a Leading Article published in our issue of February 13, 1920, we gave an account of what had been done in this direction, so far as "wire telegraphy" was concerned during the 50 years which had elapsed since 1870. Speaking broadly, it may be said that these improvements consist in the development of multiplex systems, and in the close attention to design and manufacture of apparatus, so that the two desirable factors of low maintenance cost and a minimum of breakdown are achieved as these both tend to keep the number of words sent and received to as high a figure as is humanly possible.

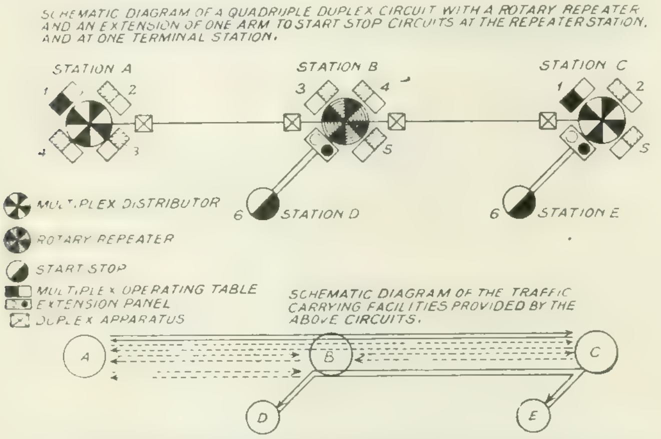
SCHEMATIC DIAGRAM OF A QUADRUPLE DUPLEX CIRCUIT WITH A ROTARY REPEATER AND AN EXTENSION OF ONE ARM TO START STOP CIRCUITS AT THE REPEATER STATION, AND AT ONE TERMINAL STATION.
STATION A
STATION B
STATION C
STATION D
STATION E
1
2
3
4
5
6
MULTIPLEX DISTRIBUTOR
ROTARY REPEATER
START STOP
MULTIPLEX OPERATING TABLE
EXTENSION PANEL
DUPLEX APPARATUS
SCHEMATIC DIAGRAM OF THE TRAFFIC CARRYING FACILITIES PROVIDED BY THE ABOVE CIRCUITS.
A
B
C
D
E

FIG. 1.—DIAGRAM OF THE WIRES REQUIRED AND TRAFFIC FACILITIES PROVIDED BY THE WESTERN ELECTRIC COMPANY APPARATUS SHOWN IN A RECENT DEMONSTRATION.

We recently had the opportunity of inspecting an interesting advance that has been made on these lines by the WESTERN ELECTRIC COMPANY, who have placed on the market in the States and have had under experimental test in this country, a new design of multiplex printing telegraph apparatus.

THE CONDITIONS OF MULTIPLEX TELEGRAPHY.

Before describing the details of this apparatus it may be interesting to recall the conditions demanded by multiplex telegraphy. It may be broadly said that these are accuracy, speed of service, flexibility to meet the varying traffic and operating requirements, line economy so that the system should be capable of handling a maximum of traffic over a given line, operator output which should be as high as possible without overtaxing the human element, low maintenance, and low fixed charges. All these desiderata it is claimed are obtained by the use of the Western system, principally by a sub-division of the transmitting and receiving apparatus, so that the operators who need not be of the highly-skilled variety that is necessary in some other systems, can work at a relatively low speed. The flexibility thus obtainable, as will be seen later, allows all the advantages of high-speed telegraphy to be employed in offices where the volume of traffic is not large enough to make it economical to employ certain types of such apparatus under ordinary conditions.

The fact that the apparatus itself works at relatively low speed is also responsible for low maintenance charges and freedom from breakdown, though against this must be offset to some extent the higher capital costs necessitated by the need of greater amount of apparatus. This slower speed also allows errors to be detected and corrected with greater ease than is often possible, and this is the more important as 95 per cent. of these errors are operator and line disturbance errors, rather than being due to anything faulty in the telegraph system.

DETAILS OF THE SYSTEM.

The Western Electric printing telegraph system may be broadly said to be a group of systems each of which is particularly suited to a given set of traffic and operating conditions. These various subsystems provide facilities which can be used to handle traffic loads varying from 600 words per minute, 300 in each direction, to as low as 30 words per minute in either direction. This variety makes it possible to arrange for all sets to operate at a speed which it is found best secures the maximum efficiency of the operating staff. To allow for this two systems the multiplex and the start-stop are used, the former of which is particularly designed for handling heavy and moderate loads for long circuits, the latter being intended primarily for short line and light work.

LINE EQUIPMENT.

We may take as an example apparatus required to provide a traffic carrying capacity of 400 words per minute, 200 in each direction, between two towns X and Y. The equipment at each end consists of four printers and transmitters, all of which are connected to the segments of a distributor, the two distributors being maintained in synchronism, the one with the other. During each revolution of the distributor brushes, the signals which correspond to one letter of four messages in the four transmitters are sent to the line At the receiving end these signals operate a relay which repeats them to the distributor, whence they are passed to four printers. The operation in the opposite direction is accomplished in exactly the same manner, two way transmission being obtained by means of a duplex balance.

Referring to the sending arrangement the operator works before what is practically an ordinary typewriter mechanism, with the following modifications. When the carriage is nearly at the end of its run, a red lamp lights which is a signal to the operator to press a key which automatically restores the carriage to its initial position. In addition a back space key is fitted which allows any errors that the operator discovers in the course of transmission to be corrected. The operation of these keys causes the perforation of holes in a paper strip which is passed out on the left side of the machine. This tape then passes through the transmitter which translates the perforations into positive and negative impulses, and through the distributor which, as already mentioned, sends the signals to the line. These signals when received in the way we have just described pass to a printer, which translates the combination of positive and negative impulses into the corresponding letter, and prints it on a paper in the machine, on rolls of paper $8\frac{1}{4}$ in. wide, which may be torn off after each message is completed. Each transmitter is usually fed from four of the operating mechanisms, and as the normal speed of typing is greater than the average number of words that can be sent through each machine, the operator is able to keep well on top of her work, and thus obtains time for corrections, checking and other working details. This is an advantage which is not possessed by some of the other systems of high-speed telegraphy, and is a factor which obviously helps to keep up the average speed of transmission.

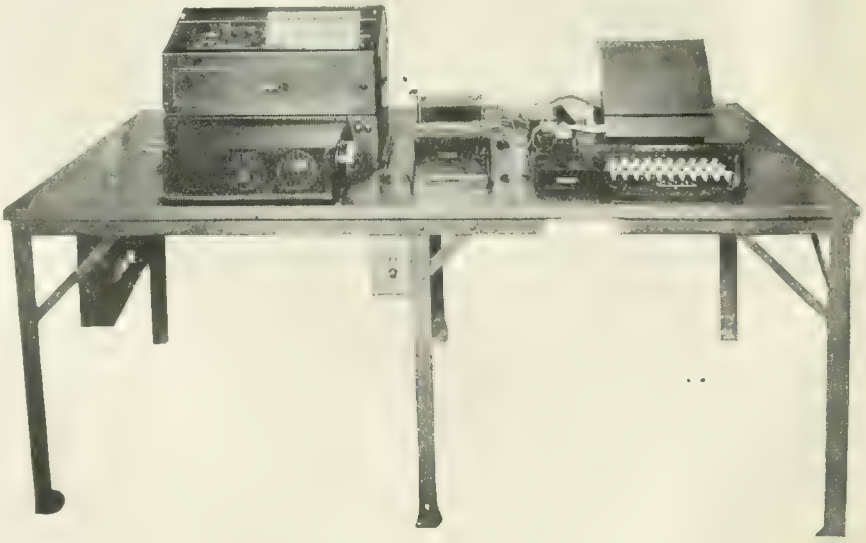

FIG. 2.—VIEW OF THE MULTIPLE MULTIPLEX OPERATING SET.

The "Start Stop" Apparatus.

A second type of apparatus used is the start stop operating set which is intended for working at speeds up to 60 words per minute for single or duplex operation. When operating singly the printer in front of the operator produces a home record of the messages sent. Two of these operating sets installed at the end of a line connecting two towns would, if operated simplex, give a capacity of 60 words per minute in each direction, or if operated duplex 60 words per minute in each direction simultaneously. As this, of course, is a good typewriting speed, it does not provide the same difference between the operator and the machine, as does the multiplex system. On the other hand, as the traffic is so much less this is no real disadvantage. It is interesting to note that in the case where there are a number of receiving stations on the line it is possible to equip each receiving station with selective apparatus which will enable the sending station to determine which shall receive any particular message that the operator is about to send, thus tending to great flexibility.

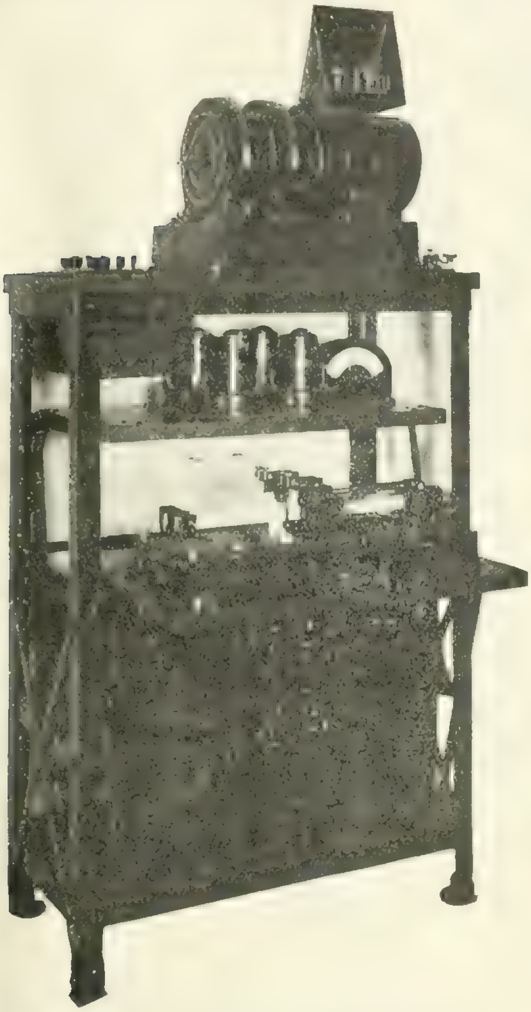

Fig. 3.—View of the Multiplex Terminal Set.

Superposing.

In America many telephone circuits have the start stop system superposed on them so enabling telephone and telegraph to operate on the same pair of wires.

The Western Electric Composite set is designed to enable two telegraph circuits and one telephone circuit to operate simultaneously over the same physical circuit.

Extension Panel.

If is is desired to extend one or more channels of a multiplex terminal set, the operating table is replaced by an extension panel consisting of a start stop distributor and a number of relays. This enables a start stop set to operate on one channel of the multiplex as shown at stations D and E. (Fig. 1.)

The Code Question.

In any printing telegraph system the question of a code is one of primary importance. In the Western Electric system an equal letter or five-unit code is employed, which is a modification of the Baudot system. This is particularly well adapted to the use of the multiplex principle, and is also very economical as regards line time.

The Apparatus Employed.

Turning now to the operation of the apparatus, we may first deal with the distributor, the commutator of which is divided into four sectors of five segments each. At the sending end these segments are connected to switches, which determine whether the line should be connected to positive or negative battery. At the receiving end the segments are connected through relays to the opposite pole of battery to that applied to the line by the sending segment to operate a relay. If the brushes of these two distributors start at the same time and rotate in the same direction at the same rate of speed, the brushes on each will be on corresponding segments at the same time. Therefore, with each revolution the transmitting brush sends out four 5-unit signal combinations, the actual apparatus positions of the switch lever being determined by the perforations in the tape, the perforations being in turn determined by the perforator key depressed. Hence, the combination of relays at the receiving end will be operated in accordance with the perforations in the transmitting tape, and these relays determine the setting of a mechanism which causes the letter corresponding to the combination to be printed. In such a system it is, of course, highly important that the apparatus should be maintained in absolute synchronism, and this is, in the case of the Western Electric instrument, made possible without any loss of line time, since the signals themselves held the distributors in synchronism. Moreover, the synchronous repeaters used are maintained in synchronism by means similar to those used for maintaining synchronism between the terminal distributors of the multiplex.

Multiplex Distributor and Driving Fork.

The distributors for multiplex systems consist of a commutator face with the revolving brush arms. The brush arms are carried by a shaft driven by a La Cour or phonic wheel motor. At the far end of the shaft is mounted a mercury flywheel, which serves as a damper to prevent hunting or oscillation of the motor. The function of the electrically-driven tuning fork is to provide impulses for driving the distributor. The speed of the motor is determined by the rate of vibration of the fork, which possesses a high degree of constancy. Views of the apparatus used in this system are given in Figs. 2 and 3.

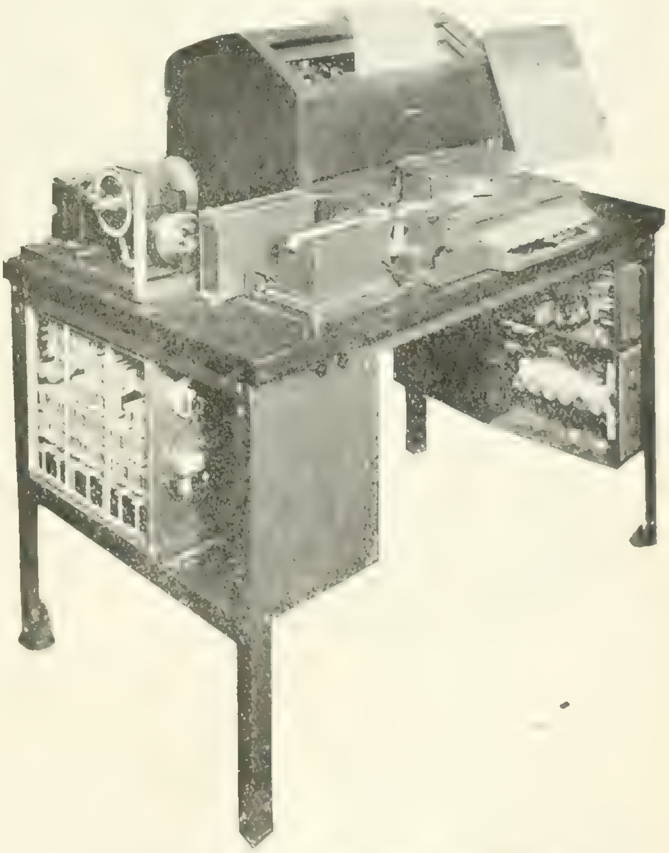

Fig. 4.—View of the Start Stop Operating Set.

START-STOP DISTRIBUTORS.

The 5-A distributor for the "start-stop" system differs from the multiplex distributor, in that it is driven by an ordinary direct-current shunt motor, the speed of which is accurately controlled by a sensitive governor. This distributor has two faces, the receiving face on one side and the sending on the other. In its operation this distributor differs from the multiplex type, for its brush arms are not constantly rotating with the motor shaft, the brushes being connected to the shaft through friction couplings and being maintained stationary by a stop controlled by a magnet. The operation of this magnet withdraws the stop and permits the brush to make one complete revolution. While this results in a certain loss of line economy, in that the code virtually becomes a seven-unit code, it possesses the advantage that it permits of intercommunication.

It is the starting and stopping of the brush arms which gives the distributor and system its name "start-stop." The operating part of the apparatus used in this system is given in Fig. 4.

PERFORATOR.

As already mentioned, the perforator is provided with a keyboard similar to that of a standard typewriter. The operation of keys determines the selection of punches which will be operated to perforate the desired combination in the tape.

TAPE TRANSMITTER.

The tape transmitter translates the combinations of perforations into combinations of positive and negative currents. As the tape passes through the transmitter, five pin feelers feel out the tape. These pins in turn control five levers, which are connected to five segments in the sending ring of the distributor. These levers make contact with positive or negative battery as the corresponding feeler pin finds a perforation or no perforation.

PRINTER.

One type of printer used is of the movable paper carriage type, printing being accomplished by forcing the paper against the type wheel. This type wheel is mounted on a shaft which is maintained under constant torque by a spring. When a letter signal is received the type shaft is released, and the wheel revolves until it engages a stop, which brings the required letter in front of the paper. Buttons are provided which make it possible for the receiving operator to feed up the paper or return the carriage at will. Messages are torn off just above the glass window on a steel cutting edge. A small crank is sometimes furnished at the left-hand end of the printer to permit the operator to feed up the paper more rapidly. The type of message form used has an advantage of economy of paper. It has a further advantage that only one piece of paper is required per message, regardless of the length of the message. The later improved type of printer is of different construction. It employs standard type bar action, and has a stationary paper carriage, the type basket sliding along the paper.

Printing is effected mechanically by a number of eccentric ball bearings on a cam shaft, each one of which is associated with moving members operating the various elements at the proper time.

Blank telegraph forms may be fed into the printer enabling duplicate copies to be made, or a continuous roll of paper may be used.

It is claimed that the cost of maintenance of this pattern of printer is much lower than for the earlier type described above.

Auto-control is provided by an auxiliary piece of apparatus, which serves two very useful purposes. First, it automatically stops the feeding of the tape through the transmitter, providing the perforator operator does not produce the tape as fast as it is required. It thus allows the tape to be fed directly from the perforator. Second, it serves to send the special signals required to operate the bell on the distant printer without removing the tape from the transmitter, or mutilating the message that is being transmitted.

FACILITIES FOR MAINTAINING EQUIPMENT.

With each multiplex terminal equipment there is usually furnished a test table. This table is equipped with a complete set of apparatus, including perforator, transmitter, printer and auto control. The table is also provided with a test distributor, which makes it possible for the maintainer to simulate operating conditions, and thus test and adjust the various apparatus units. This arrangement makes it possible to install regular inspection routine. For example, at intervals each piece of apparatus is taken to the test table and replaced by a similar piece of apparatus taken from the test table. This change is facilitated by the fact that these apparatus units make clip connections to both operating and test table.

POWER SUPPLY.

All the Western Electric printing telegraph apparatus is designed to operate on 110-volt direct current, but considerable attention has been paid in the design of this apparatus to allow of good operation and voltages varying from 90 to 125 volts. In installations which consist of only one start-stop set, or a multiplex terminal equipment, a current of 3 amps. would be sufficient for proper operation; but, owing to the extra current required for testing, table lamps, soldering irons, &c., it has been found advisable not to have a capacity of less than 6 amps. for any single installation, with a proportionate increase for installations of more than one set.

The Outlook for 1921.

By ERNEST J. P. BENN.

For six years now the season's greetings have borne a new significance. During the war we gave up the formula "A Merry Christmas," and borrowed the word "happy" from the New Year, putting in its place a fervent reference to peace. For two years past we have been trying to get back, and when Christmas, 1920, came we were most of us able to bring our consciences to a genuine use of the "merry" in connection with Christmas; but we toned down our voices, and exhibited an element of doubt when it came to the "prosperous New Year." Sir Francis Gould depicted 1920 being kicked from the scene by John Bull and saying: "Ah, you are angry with me because you know that the New Year will be no better." 1921, the third full year of peace, was ushered in with the gravest misgivings on the part of all those who are concerned with the commercial and industrial side of our activities. On January 1, 1919, we all looked forward to great prosperity; on New Year's Day, 1920, we still entertained the same view, but on this occasion we had begun to doubt, and it is in a condition of grave doubt that we go forward with the work of 1921. This is not as it should be, and it behoves every one of us to bring our experience to bear upon the situation, and make up our minds that we, on our part, will spare no effort and lose no chance to enable 1921 to belie the gloomy forebodings which accompanied its birth.

WASH OUT DEPRESSING TALK.

To begin with, all this talk of slumps, of crises, of depression and of difficulties must disappear. There is a certain amount of justification for the doctrines of Christian Science to be found in industry; talk of slumps brings slumps; optimism brings activity. Industry, after all, consists in the courage of a few of us who put in hand or restrain operations which give employment to others; the results of those operations are in any case small to ourselves, but very important to the others. If we allow ourselves to be influenced by political pessimism, we may make or lose those small margins which represent our whole interest in the matter; but we inflict grave injury upon the much larger class of workers and consumers whose interest in our transactions is immeasurably greater than our own. In 1921 we must, therefore, determine that we will keep up our spirits, that we will justify our claim to be practical men of business, and that we will not allow difficulties created by the socialists and other politicians to influence our determination to keep trade and industry alive. Apart from all the fictitious barriers which are making the course more than usually difficult, the situation of the world to-day should make industry extremely busy and extremely prosperous. A boom has followed every war that ever was; that, after all, is only natural, because destruction must be followed by construction.

AN OPPORTUNITY FOR BUSINESS MEN.

We business men have a great opportunity to-day if we will only grasp it. The most useful New Year resolution which we can make is that we will give up politics and get to work. After the experiences of the last six years, we are now able to put a proper value upon committees, conferences, associations, governments, inquiries and all the other weird things with which we have been forced to become familiar. If it were possible to frame an approximate estimate of the amount of time and brain-power used up by these things since 1914, the shortage of commodities and the present difficulties of industry would be at once explained. We must do our best in the New Year to get back to work, real work, not development of theories or enunciation of principles. We have had such an overdose of analysis, classification, co-ordination and other professorial devices that we have almost lost our old habits of work. Little good is to be done by endeavouring to apportion the blame for the present state of affairs. We must, of course, lose no opportunity of pointing out the damage done to industry by Government control and intolerable taxation; we must make every effort to bring Labour to an appreciation of economic truth, and to help it to save its high wages by giving value. We must encourage one another to put forward that private enterprise in which we believe, and which alone can provide a higher standard of living, homes for heroes, and all the other delightful things about which the socialists and the politicians talk.

The Fallacy of "Trying to do Without."

In the last six six years the country has been trying to do without the business men, and its troubles to-day are very largely due to this absurd endeavour. The country is not likely to repent of this folly; we can hardly expect the Government to admit that it has been all wrong and to indulge in a picturesque abdication in favour of private enterprise. It is no use waiting for the impossible to happen. A business man may be defined as a person who is able to take the situation as it exists, and arrange for the supplying of the needs of others; he is no business man if he insists that before he will make a start the situation must be altered. Any such attitude amounts to a confession of incapacity, and a surrender to the socialistic theory. For instance, it is frequently stated that the present prevalence of unemployment is due to the financial conditions of foreign countries who are unable to pay for the goods which we are anxious to sell them. That is an excuse which does little credit to the business man. It is perfectly true that we cannot be enjoying the height of prosperity until the world in general and Europe in particular is also in a prosperous condition; but to plead the difficulties of others as a reason for our going out of business is not worthy of the traditions of the British business man. If our foreign trade were suddenly revived and were to reach its highest point, it would only amount, even at present inflated values, to £20 per head per annum of the population. The rise in wages alone in the last few years has been far more than the thousand millions represented by foreign trade, and if we cut off export altogether there is more purchasing power within our own borders than has ever existed before. As business men we have to realise that while we have created purchasing power, we have failed to produce commodities at a price which would tempt that power to expend itself our way. We have been so much occupied with the theories of the cost of producing as to forget the much greater importance of the selling price. A united effort on the part of Capital and Labour to expedite and cheapen production would absorb all the unemployed at our gates irrespective of our export business. All this will not be done by public agitation, by Acts of Parliament, by committees or even by our own trade associations. It will only come about as a result of the revival of an intense feeling of individual responsibility on the part of all those who call themselves business men, and who are, in fact, the persons upon whom each of us individually and the nation as a whole absolutely and entirely depend.

Applications of Electric Power on Modern Gas Undertakings.*

By H. C. WIDLAKE.

Introductory.

The modern gasworks, with its many power-using units scattered over a wide area, offers a peculiarly suitable field for the application of electric power. Until recently, single-cylinder non-condensing steam engines were in common use, fed by a network of pipes throughout the works; wildly extravagant, their sole claim to continued existence lay in the possession of that reliability which is so essential in gasworks plant. The introduction of retort-charging and discharging machinery first emphasised the necessity of installing electric power, and thus paved the way for the subsequent electrification of the whole works. In the face of a mass of prejudice, the use of electricity has been rapidly extended. How great is the progress that has been made may be seen from the fact that during 12 months in 1919-1920 a typical English gas-works used 620,000 units, amounting to 0·429 unit per 1,000 cubic ft. of gas sold, and these figures will be greatly increased this year. In this case the annual load factor was 50 per cent., and the generating plant installed totalled 540 kw.

At present, the gas-works plant convertible to electric drive includes charging and discharging machines, conveyors, telphers, elevators, cranes, hoists, exhausters, compressors, blowing and gas-boosting fans, pumps, washers, disintegrators, agitators, hydro-extractors, electro-tinning plant, machine tools and wood-working tools.

The distribution of the total output of electricity among the various classes of apparatus in the case cited above was as follows: Coal-handling plant, 30·9 per cent.; coke-handling plant, 19·1 per cent: purification plant, 24·1 per cent.; water-gas plant, 17·6 per cent.; and machine tools, lighting, &c., 8·3 per cent.

Charging and Discharging Machines.

The usual English horizontal retort installation consists of D-section double-ended retorts, about 20 ft. long, arranged five high. Each set of 10 retorts has its own coke-fired regenerative furnace, which maintains it at about 2,000°F. The retorts are charged twice a day with 14 to 15 cwt. of coal, after the ejection at the other end of about two-thirds that weight of incandescent coke.

The charging machine is carried in a frame provided with means for effecting the necessary vertical adjustment, and the frame is mounted on rails on which it can travel along the retort house; the vertical adjustment is about 8ft. for a five-tier retort setting, and the speed of travel is about 100 ft. per minute. The machine is fitted with a coal-hopper, which can be replenished from time to time from one or more bins situated above the charging stage. One, two or three motors are fitted for driving the machine and the different motions, a higher speed of operation being obtained with three motors.

The essentials of the "*De Brouwer*" projector charging machine (see Fig. 1) consist of a rubber band about 15 in. wide and a grooved pulley usually 1 metre in diameter, from between which the coal is shot into the retort. The greater the velocity of projection the higher will the coal pile itself up in the retort, and hence the depth of the charge can be adjusted by shunt regulation of the driving motor. The band runs at 1,100 to 2,200 ft. per minute, and can handle about 18,000 tons of coal before renewal is necessary; the time to charge a 20 ft. retort is 25 to 30 seconds.

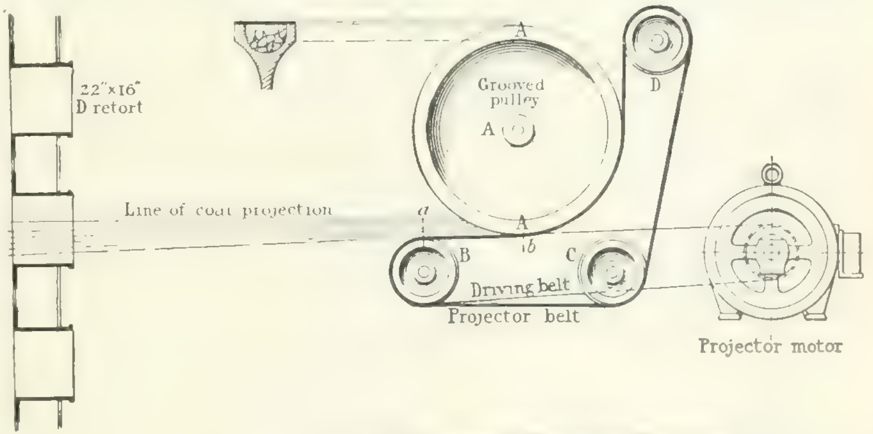

Fig. 1.—Diagram of "De Brouwer" Projector Machine.

The "*Paris*" turbine charger, and a number of more modern machines, act on a similar principle, the coal being impelled in this case by a bladed rotor revolving in a steel casing. A disadvantage is that the coal is struck by the blades with considerable shock, instead of being smoothly accelerated, as in the "*De Brouwer*" machine.

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* Abstract of a Paper published in the "Journal" of the Institution of Electrical Engineers.

The "*Fiddes-Aldridge*" machine (Fig. 2) employs a chain of box-shaped links, accommodated round a polygonal wheel. By rotating this wheel the chain, full of coal, is pushed into the retort, pushing out the old charge before it. As it is withdrawn, the loose swinging ends of the links rise over the coal, which is thus left in the retort. A stop-plate is provided to prevent the coal from spreading out longitudinally during the withdrawal of the chain. The speed of the chain is about 70 ft. per minute, and the complete operation of discharging and charging takes from 45 to 70 seconds. It is not possible to fill the retort quite full, as some space must be left in it to enable the chain to be withdrawn; the charge that can be laid in a retort measuring 22 in. by 16 in. by 20 ft is 10 to 11 cwt.

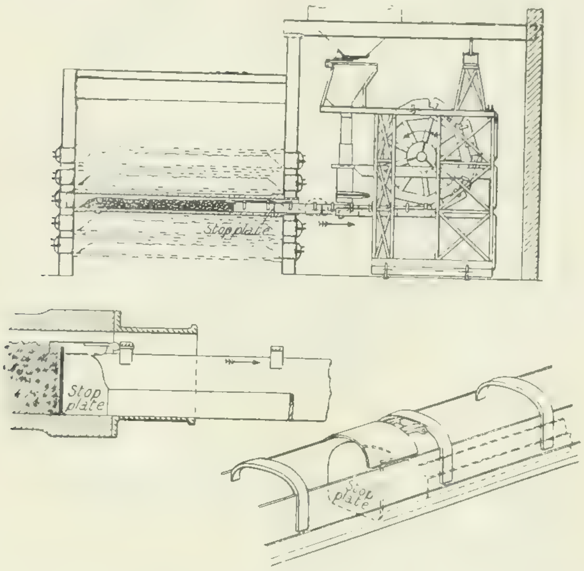


Fig. 2.—Standard "Fiddes-Aldridge" Stoking Mechanism.

To overcome this difficulty, a new type of "*Fiddes-Aldridge*" machine has been introduced, having a different form of chain (Fig. 3), which contains a small flat conveyor, carried on small wheels and kept taut by powerful tension springs. The old charge having been pushed out, the chain commences to withdraw, while simultaneously the conveyor, running at about 600 ft. per minute, carries a rapid stream of coal into the retort. A difficulty lies in the manufacture of a sufficiently "rugged" chain, but this is being successfully overcome.

Among the early French machines are the "*Oerlikon*," "*Bertrand*," and "*Sarraine*," which used a box-shaped scoop constructed in sections, such that it could be driven into the retort as a rigid element, but could be withdrawn piecemeal without drawing back the charge of coal which it had carried into the retort. There was always a separate discharging machine provided with these stokers, though the scoops could easily have been made strong enough for simultaneous charging and discharging.

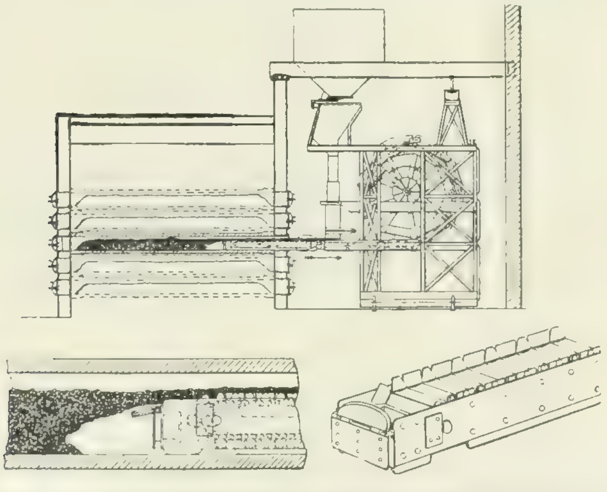


Fig. 3. "Fiddes-Aldridge" New "A" Chain Machine.

In the *Lyons* machine, a steel tube, split along a horizontal axis, was filled with coal and inserted bodily into the retort. The bottom half of the tube was then withdrawn, plates on the top half preventing the coal from receding with it; then the top half was withdrawn in turn, leaving the retort charged. The tube was filled by tilting it at an angle of about 50 deg. and allowing coal to gravitate into it.

Discharging Machines.—The discharger, which is obviously necessary with some charging machines, may either be mounted in the same frame as the latter, or in a similar frame running on the same rails. It usually takes the form of a steel ram, forced into the retort by a rack and pinions. The "Arrol-Foulis" hydraulic discharging machine is also still widely used.

The ram type of machine, which possesses the advantage that no hot coke is handled on the charging stage, can deal satisfactorily with projector charges or with any charges laid in a single operation. Non-uniform charges tend to pile up and choke when pushed, and for these a drawing machine has, therefore, to be used.

Other Gas-Works Machinery.

Transportation Systems.—For handling the hot coke, the monorail telpher is a particularly advantageous piece of apparatus, since by its use the discharging stage can be kept clean and dry, there are no working parts exposed to the heat and dust, and the handling and consequent breakage of the coke are reduced to a minimum. The skips used, which possess self-tipping and locking gear, are of heavy lattice-bar construction, and hold the contents of two or three retorts; the maximum load they will carry is 25 to 30 cwt. The coke can be quenched in the quenching tank en route from the retort house. For dealing with coal-storage piles the electrically-operated travelling jib-crane mounted on a high gantry, furnishes the best transportation service.

Exhausters.—The gas is drawn out of the retorts by the slight vacuum produced in the hydraulic main by an exhausting fan. These exhausters have been aptly described as the "heart of the gas works," and absolute continuity of running is essential for them, for which reason they are still driven frequently by steam engines or turbines. In order to maintain an even "pull," their speed requires to be controlled by an automatic governor such that if the vacuum falls the fan will speed up, and vice versa.

Similar exhausting fans are provided in connection with the water-gas producers, but in this case short stops are permissible if necessary, since a small gas-holder is provided.

Rotary Washers and Pumps.—These frequently have to be installed in remote parts of the works, and consequently are particularly wasteful if steam driven. As far as possible the old plant should be converted, rather than replaced with new apparatus specially suited for motor drive; for example, large slow-speed horizontal rotary washers, running at from 2 to 5 revs. per min., may be driven by a belt drive on to the flywheel of the old steam engine, thus obviating the necessity for special reduction gear. The numerous small pumps used in the by-product plant are a difficult problem, as they are not worth providing with individual motors; they should be group driven where possible, or driven from some other machinery that may be close by, such as a rotary washer.

Gas Boosting Fans are used for supplying outlying districts, and for transferring gas from one holder to another. De Laval turbines have been widely used owing to their high speed, but motor-driven sets are now coming to the fore. The motor, which should preferably drive through a flexible coupling, must be equipped with a starter-regulator, so as to be able to start at a very low speed and thus avoid causing a pressure wave on the district.

Blast Fans, for maintaining the generator heats in a carburetted water-gas plant, require from 20 to 70 h.p., and usually run 24 hours a day. Each fan frequently serves three or four gas-making sets, and accordingly some form of remote control gear must be provided so that it may be speeded up or slowed down by any of three or four different operators. The sets generally work in a series of cycles, say, four minutes blow and then five minutes gas-making run, and thus each operator at such regular intervals either slows down the fan or relinquishes control of it to another operator whose set happens to be blowing.

Generation.

There is a general feeling that such an important centre as a gas works ought not to be dependent for its power supply upon any external sources. Most gas undertakings, therefore, generate their own electric power, usually by means of gas engines. These have given quite satisfactory service, but considerable economies might be expected to result from the installation of modern high-pressure steam-generating plant, especially in view of the large quantity of steam—at present generated in uneconomical low-pressure boilers—which is always required about the works for the processes of coal-gas and water-gas manufacture and for the various chemical process plants. A great advantage which would accrue from the use of this arrangement would lie in the utilisation as fuel of the coke-breeze, a fair quantity of which is always produced in every gas works, and which is otherwise practically a drug in the market.

Further economy might be gained by reclaiming some of the waste heat in the gas leaving the retorts. Probably at least 2 to 3 lb. of steam could be raised in this way per lb. of coke in the retorts, but neither of these possibilities appears to have received due attention as yet.

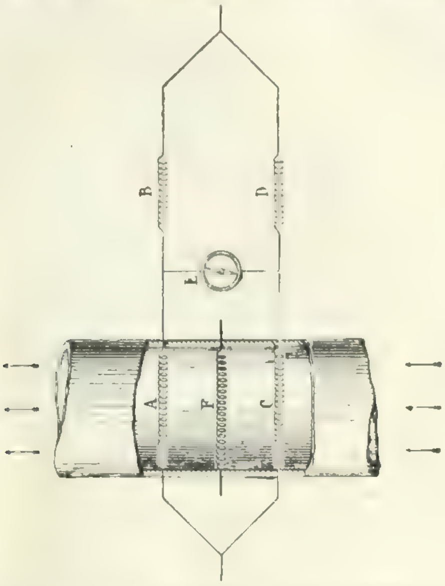


Fig. 4. Diagram showing Principle of the "Thomas" Meter.

The same elaborate and costly precautions as are used in public electricity stations to guard against a failure of the suppy are necessary here. The installation of a gas engine-driven unit as a spare is highly desirable, as it enables the steam plant to be shut down occasionally when necessary. Moreover, such a unit affords a standing testimony to the efficiency and cleanliness of generating electricity from gas, and is therefore a powerful weapon in the hands of the gas salesman.

The "Thomas" Electrical Gas Meter.

This ingenious device (Fig. 4) places the gas engineer on an equal footing with the central station engineer as regards the convenience and accuracy of recording and integrating his output. In the figure, *F* is a heating element, supplied from a small motor-generator set; *A*, *B*, *C*, *D* are equal resistance coils in the arms of a Wheatstone bridge; *E* is a special contact-making galvanometer which controls electrically-operated pawls which in turn actuate the main rheostat in series with *F*. In practice, the meter operates to maintain a constant difference of temperature of 2°F. between *A* and *C*. Thus, if the speed of the gas decreases, the temperature of the gas beyond *F* will become higher; this will increase the resistance of the coil *A*, thus upsetting the balance and causing the galvanometer to reduce the heating current. Consequently, the speed and quantity of the gas passed will be proportional to the power and energy respectively dissipated in the heater, and these can be easily and accurately recorded by a recording wattmeter and a watt-hour meter. The readings are independent of the temperature and pressure of the gas, the measuring instruments may be located in any convenient place, not necessarily near the gas main, and a very large saving of space is effected over the enormous gas meters formerly used.

The Physical and Optical Societies Annual Exhibition.

The annual exhibition of electrical and other physical apparatus, which was held by the Physical and Optical Societies last week, proved to be very interesting and popular. The various discourses and demonstrations were particularly attractive, so that most visitors found the time insufficient for all they wished to see. In his discourse on "Sounds in Nature," Sir W. H. Bragg showed a number of beautiful experiments, and on the second day Prof. C. R. Darling reproduced some of his well-known experiments on surface tension, which lend themselves so admirably to demonstration in the lantern so that a large audience can follow the curious phenomena resulting from one liquid coming into contact with another.

The Thermionic Valve.

An excellent brief discourse and demonstration on the properties and uses of the thermionic valve was given twice each day by Prof. C. L. Fortescue and Dr. Bryan. A mass of apparatus was provided for the purpose and the experiments must have entailed a great deal of time to ensure proper operation. We were interested to see the characteristic curves traced out by a lecture apparatus. A most striking experiment was shown on heterodyne reception where a wave was used having several harmonics, three of which could be plainly detected (audible to the audience) by varying the capacity. This was a pretty verification of the Fourier series.

A very popular discourse, delivered on both days, was that on Dr. Fournier d'Albe's Optophone. Unfortunately, Prof. Archibald Barr was unable to be present to deliver the lecture owing to a severe chill. The instrument is of such interest that we may add here some further details to the description we gave in our issue of August 13th, 1920.

The Optophone.

The importance of divining some means as an alternative to the well-known raised type systems, such as Braille and Moon, will be realised from the statement that a book in Braille is almost 70 times as voluminous as the same book printed in small pica. In the case of the Moon system the figure is even greater, and, of course, the cost of such books is very heavy. Moreover, the available literature so printed is scanty. With the Optophone any ordinary book can be read, and although its cost is somewhat high (being at present £105) there should be a considerable opening for its use. At the same time no claim is made that it will supersede the Braille and Moon systems.

The apparatus is being manufactured by Messrs. Barr & Stroud, and in their hands its form has been very materially altered. It is now a beautifully made instrument, as would be expected, considering the reputation of the makers.

The Principle of the Instrument.

It will be remembered that the apparatus depends upon the intermittent illumination of a selenium cell through apertures in a rotating disc, and that a corresponding note is reproduced in a telephone receiver. The main principle is represented by Fig. 1. If the pulsating light is reflected on to the selenium cell by white paper then all the five notes will be heard in the telephone, as indicated on the left-hand side of the diagram. But if the paper is moved so that the top of the capital T comes into the beam of light the top note will be more or less interrupted as the black type will not reflect the light. When the upright part of the T comes into the beam four notes will be interrupted, and so on. Thus the modified sound, or group of sounds, will give an indication of a particular letter if the reader becomes accustomed to the modifications.

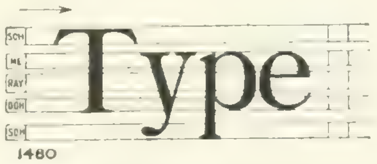


Fig. 1. Diagram Showing Principle of the Optophone.

In the old form of apparatus the printed matter was passed over the beam of light, the position of the latter being stationary. In the present form the print is fixed and the beam oscillates across the page. This is much more convenient, as it permits a bound volume to be read without difficulty, the printed page to be read being placed face downwards on a glass plate supported on a suitable stand. Beneath the plate is a tablet of porcelain pierced with an aperture to permit the passage of light upwards and so through the glass on to the paper. The upper surface of the tablet—around the aperture—is prepared as a sensitive selenium cell (or bridge) and connected up to a battery and to a telephone. The selenium cell receives only light reflected from the page. The light used is obtained from a small straight filament electric lamp placed beneath the rotating disc. For the sake of clearness and simplicity in the diagrammatic arrangement, the lamp is shown immediately below the rotating disc. In the instruments now being made the lamp is so arranged, in conjunction with a reflecting prism and cylindrical lenses, that an image of the filament is produced in the plane of the disc, radially across the circles of holes.

The disc is kept in rapid rotation by means of a tiny magneto-electric motor driven by current from small secondary cells. Above the disc there is an optical system which throws on to the paper an image of the lamp filament as it would be seen through the perforations in the disc. By this means the light that falls on the printed matter forms five bright spots in line, forming what is called the "scala." Each spot is pulsating at a rate corresponding to the number of holes in the circle of perforations to which it belongs multiplied by the number of revolutions per second of the disc.

The present improved type of optophone is modified so as to make it "black sounding." In this form white paper is represented by silence, and notes are sounded as the scala passes over the black letters. With this optophone the letter V is represented by the motif G^1, E^1, D^1, C^1, D^1, E^1, G^1. This is much more easily distinguished than the sound given by "white sounding" just described.

The "black sounding" is obtained by providing a second selenium bridge, which is called the "balancer"—illuminated by a small part of the intermitted light reflected aside before it reaches the paper—and connecting this bridge to the telephone and the battery in the manner shown in Fig. 2, so that the current traversing the balancer cell (Se No. 2) acts in the reverse direction in the telephone to that of the current through the main selenium cell (Se. No. 1). One battery is used, and the two selenium cells are connected one to each end of the battery, and both through the telephone to a selected intermediate junction of the battery in the manner shown. The balancer thus tends to cause the telephone to sound all the notes continuously, and the main selenium cell that receives the light reflected from the paper annuls the effect on the telephone in respect to any note when the spot of light corresponding to that note falls on white paper. The division of the total voltage of the battery can be varied so that when the whole scala falls on white paper the telephone is silent, and notes are sounded only as the scala moves over the black letters, as previously described.

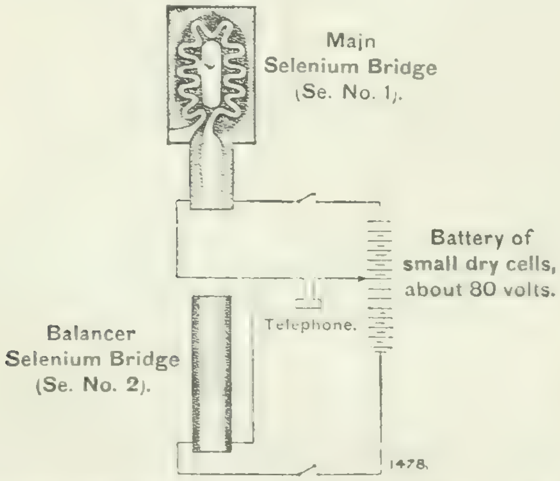


Fig. 2.—Diagram of the Optophone, Showing Arrangement of Selenium Cells.

The optical system is carried on a rocking shaft, so the porcelain tablet already mentioned can oscillate backwards and forwards under a curved glass plate. Upon the latter the page to be read is clamped face downwards.

Everett, Edgcumbe & Company.

A new portable illumination photometer was shown by Messrs. Everett, Edgcumbe & Company. The instrument is called the "Luxometer" (*see* Fig. 3). Measurements are made by comparing the illumination of a surface (which can be varied in brightness) within the instrument with the illumination of a small external screen. The variable illumination is obtained by having a fixed electric lamp whose rays fall upon a screen which can be rotated so that the angle of incidence is varied. The instrument is very compact, and the scale, which is open and direct reading, has a length (circular) of about 6 in. Measurements are made by holding the instrument up to the eye. A convenient attachment is provided by which the window efficiency in a room (*i.e.*, the actual illumination compared with that which obtains outside the building) is readily determined.

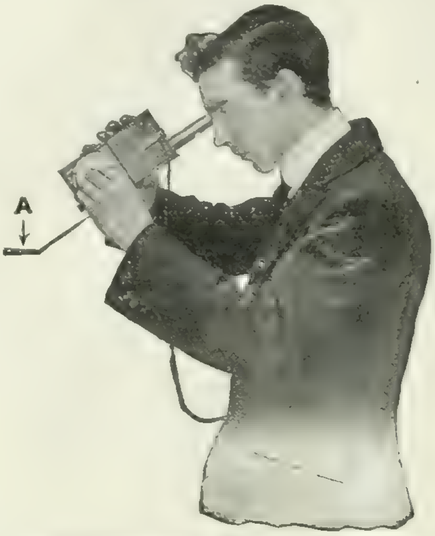


Fig. 3.—The "Luxometer." (Everett, Edgcumbe & Co.)

(To be continued.)

Correspondence.

THE CRAWLING OF INDUCTION MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In his letter in your issue of January 7th Mr. Carr recapitulates the argument of his original article, to which I can only reply that his error has arisen because he has considered one part of the problem apart from the rest. Subsequently he refers to the principle of the homopolar generator in support of his contention; but there is no comparison between this machine and the induction motor, because a sliding contact is an essential component of the former, whereas the circuits we are considering in the latter are closed coils.

The statement that a direct current can be produced in the coils of a rotor winding may be disproved conclusively, by a simple reference to first principles. Consider a closed coil through which a positive flux is forced by moving the coil relatively to a magnetic field, or by induction from neighbouring circuits; a negative E.M.F. is induced, and, the circuit being closed, a negative current flows. So long as the positive flux is increased, just so long the current retains its original direction, and if we wish to produce a direct current in the coil we must continue to increase the flux without intermission. An induction motor may crawl for an indefinite period, but the rotor coils cannot embrace an infinite flux, even if such could be produced. We must conclude, therefore, that a direct current in such a circuit is fundamentally impossible.

Although the rotating field theory (with every other correctly developed theory based on the same data) does indicate a reason for the diminution, or disappearance, of the driving torque of a motor at certain speeds, he would be rash indeed who claimed that it gives a complete account of the causes of the phenomenon of "crawling." A very important contributory cause is to be found in the periodic variations of the total gap reluctance, and of the leakage fluxes, as the rotor turns round. The effect is negligible when the speed is high, but at low speeds, and when the mean driving torque is small, it may lead to sub-synchronous rotation of the rotor. This effect is often described by the apt expression "cogging."—Yours, &c.,

Hendon, Jan. 10. F. T. Chapman.

A QUESTION OF NOMENCLATURE AND WIRE RADIO.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : The question raised by General Squier in your issue of the 17th December last seems to me an important one. He compares the names hitherto proposed for the mode of telegraphy often called "wired wireless," and suggests the new name of "wire radio." For many purposes this would serve, but I beg leave to offer a few criticisms.

In the first place, this name when translated into other languages would take various forms, since the word "wire" becomes very different in different languages. In the second place the term "radio" is scarcely appropriate, for to most people "radio" implies transmission radially or by rays. For instance, a radiographer is a man who works with X-Rays ; a radio-active substance is one giving off rays like radium, and so on. Radio does not mean or imply high frequency.

In the first place I would mention that the word "wire" is used in England as a synonym for the noun "telegram" and for the verb "to telegraph." We should soon have the daily Press speaking of a "wire-radio wire," meaning a telegram not a conductor.

I wish we could have kept the name "Hertzian telegraphy" for the ordinary wireless in commemoration of the fact that Hertz was the first to experiment with free electric waves. Then we could have called telegraphy by means of high frequency electric waves along wires "Lodgean telegraphy," for it was Oliver Lodge who discovered waves along wires, and that even before the date of Hertz's discovery. Or, if we had given the name "Marconi telegraphy" to the one we could have called the other "Squier telegraphy" in commemoration of the men who have done most to bring the two methods to fruition.

As it is, "radio telegraphy" has been so widely adopted for ordinary wireless that it may be necessary to have a very distinct term for telegraphy by electric waves along line wires. The subject is becoming of such importance as to need and deserves a thoroughly distinctive name, even though *at present* it happens to utilise much of the customary apparatus of radio telegraphy.

For a term to have a chance of becoming international we must go as a rule to the dead languages. I have reviewed a number of possible terms, but must not take up your space by enumerating them. I think the most expressive name might be made from the Greek words for a wire and a wave, namely, "kuma" and "linon." We might call the new technical part "kuma-line" telegraphy ; the French would probably modify the new word, for euphony, to "cymoline." We could abbreviate it, if we so desired, to "kumagraphy" or "cymography" ; but I think "cymoline" might have a chance of catching on in English-speaking countries, because the word "line" is familiar and apt.—I am, &c.,

London, W. H. Eccles.
January 11.

MATHEMATICAL ANALYSIS OF THE MECHANICAL FORCES ACTING ON SWITCHES AND BUSBARS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : The undersigned would like to suggest that Mr. Jolley could have improved on his treatment of variable self inductions by the energy method in The Electrician for December 3, 1920, p. 647, if he had expressed with more detail the variable relationship of x with regard to all the factors involved.

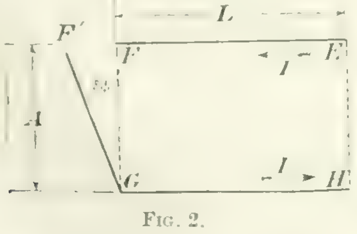


Fig. 2.

Turning to his Fig. 2 it is of course necessary to assume that the gap $F'F$ is conductively supplied by the vapourising spark. The change in x produced by a change in φ involves not only a longitudinal variation $F'F$ in L, but in fact two other changes. Thus there is a longitudinal change produced in A practically equal to one half that in L. On the other hand there is also a mutual induction change produced by the variation from perpendicularity of $F'G$ with respect to the remaining sides.

The "action at a distance" theory is, of course, philosophically unsound except in so far as an intervening medium is assumed. This medium may for example allow of infinite speeds longitudinally, assuming capacity or self induction effects separately. The speed for lateral displacements, however, involving the two types of fields simultaneously, is that of light for a Maxwellian ether.—I am, &c.,

New York, N. Eboracum.
December 24.

"A CHRISTMAS TRAGEDY."

TO THE EDITOR OF THE ELECTRICIAN.

Sir : In your issue of the 7th, you have an article signed by "Electrio Cynic" with the above title. Your contributor hides his identity under a word which is not often associated with our great industry. The electrical worker of every class is, before all others, notable for his enthusiasm. We have all had experience at some time or other of the "candid friend," a difficult person, although well meaning, and no doubt useful to the world.

I cannot help thinking, however, that the modern tendency to relieve one's feeling in memoirs, open letters and critical communications, which may reach a wider circle than that to which the criticism may properly be applied, is unfortunate, doing very often more harm than good. In every industry we find poorly made appliances, and any person competent to criticise them and willing to take the trouble can do a lot of good by drawing the attention of the makers and sellers to what he considers to be faults, and his reasons for thinking so. This is valuable and constructive work. During the past Christmas season there has been no lack of well-finished and substantial electrical apparatus on view in our shops and showrooms. Reports of the trading in goods of this kind are very satisfactory. Probably next year we shall do very much better. This Association will certainly endeavour to bring about an increasing demand for electrical appliances as practical gifts at Christmas and other seasons of the year.

I am, however, concerned to feel the articles, such as the one referred to, may actually cancel out a proportion of the advertising work of this Association. Trading and professional journals are read by many persons who are only indirectly interested in the business dealt with, and who are not in a position to know exactly how far a critical article may apply. I feel that the time has come to make a general appeal to persons like "Electrio Cynic" to see that the benefit of their energies and of their experience is applied to the industry in such a way that it cannot possibly do harm or discourage those who are spending time and money on hastening the development of electrical practice throughout the country.—I am, &c.

J. W. Beauchamp.
London, Director and Secretary
January 8. British Electrical Development
Association.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Office on receipt of published price, plus postage.]

"Annual Report of the Board of Regents of the Smithsonian Institution for the Year ending June 30, 1918." (Washington : Government Printing Office.) Pp. xii + 612. 75 cents.

"Telegraphy, Telephony and Wireless." By J. Poole, Wh. Sch. (London : Sir Isaac Pitman & Sons, Ltd.) Pp. 120. 3s. net.

"Lubricating and Allied Oils." By E. A. Evans. (London : Chapman & Hall.) Pp. xx + 128. 9s. 6d.

"La Illuminazione Elettrica Moderna." By G. Peri. (Turin : S. Lattes & Company.) Pp. xii + 479. Lire 26.

"Hilfsbuch für die Elektrotechnik." By von Karl Strecker. (Berlin : Julius Springer.) Pp. ix + 662. M.70.

An Engineers' Club for London.

We are glad to learn that the idea of forming an Engineers' Club in London has so far crystallised that a provisional committee has been appointed with Mr. Edmund Hill, who did so much to inaugurate the successful Engineers' Club in Manchester, as temporary honorary secretary. As we have already suggested in these columns, the qualifications for membership are to be made as elastic as possible and are to include at least all those who, in the words of the charter of the Institution of Civil Engineers, "turn the great forces of nature to the use and convenience of man." A club catering more or less for engineers has been tried on one or two occasions, with unsatisfactory results. Attempts will therefore now be made to obtain an engineers' club in the widest sense—domiciled, it is true, in London, but with a membership not drawn from London only, but from the provinces and our overseas dominions.

Such an institution, which would be free from all political bias and where engineering thought could find a congenial atmosphere, cannot fail to be of inestimable value to the development of a profession and industry on which largely depends the safety and well-being of our Empire; and it will be agreed that nothing can help engineering in the future more than the gathering together of those working for its progress on the lines we have just indicated.

Financial Difficulties.

Unfortunately, as with every other great enterprise at the present time, the outstanding difficulty is finance, and a subscription which might have been ample six years ago must now be more than doubled. For success a club in London must therefore have at least 1,000 original members with an annual subscription of, say, 10 guineas, with perhaps more favourable terms for provincial and overseas members. These difficulties, though great, are not insurmountable. But they must be surmounted and not circumvented by making the club a glorified saloon bar, a policy that has unfortunately been recently adopted in certain clubs in London.

The Aims of the Club.

The club, the committee consider, should aim at giving the best service possible, at the lowest cost. It should be a club established for the benefit and advantage of its members, run on co-operative lines, and not a camouflaged hotel worked for the sake of profit. Four things are essential to bring about the end in view: First, the assurance of the moral support of all engineering interests; secondly, the necessary financial support; thirdly, the setting up of a really strong and representative Honorary Committee, composed of men who would give a large amount of time, trouble and attention to the formation and conduct of the club; and, fourthly, the finding of a man of experience who can run such a club economically and successfully. No amateur, however good, could fill the bill. The club would need the best that money could buy; a full-time man of great experience in management, buying and catering, of long and varied knowledge of club management, and a gentleman in the best meaning of the word would be essential.

There should be generous bedroom accommodation, for the country membership will be large; and for the same reason it might be well to have a linking-up arrangement with the Engineers' Clubs in Manchester and Birmingham.

As announced above, a strong preliminary committee, comprising prominent men in the civil, mechanical, electrical, gas, transport, iron and steel, shipbuilding and other branches of engineering is being formed, in order to explore the possibilities of a scheme such as we have indicated. As it is vitally important for the framers of a scheme to have some idea of the magnitude of the probable membership, those of our readers who are in favour of such a club are invited to send their names either to the offices of The Electrician, or to Mr. Edmund L. Hill, 39, St. James's-street, S.W.1, who has kindly consented to act *pro tem* as honorary secretary to the committee.

Air Ministry and British Magnetos.

In commenting on the results of the competition held in 1920 with the object of ascertaining the best types of aeroplanes and amphibians which would be safe, comfortable and economical for air travel, the Air Ministry remark that it is satisfactory to note that the items of foreign equipment utilised by competitors were insignificant in number. The magnetos fitted were all of British design and construction. While there is little doubt but that when a few mechanical details have been improved the British magneto will be the best in the world, the results of the competitions show that the British magneto manufacturers are now abreast of any of their foreign rivals.

Hydro-Electric Survey of India.

The Second Report on the Water Power Resources of India, prepared by Mr. F. E. Bull, chief engineer of the Hydro-Electric Survey, and Mr. J. W. Meares, electrical engineer to the Government of India, has been issued and contains summaries of the data and information ascertained during the season 1919-20. An abstract of Mr. Meares' preliminary report appeared in The Electrician for October 31, 1919 (p. 506). The second report is divided into three parts. The first section contains the general principles of the development and storage of water for electrical purposes, a reconnaisance, survey and report form, pipe data and diagrams, and other useful technical information. Part two is devoted to a discussion of administrative matters and the State control of water power, &c.; and part three gives particulars of the progress made with the survey during the past year.

Progress of Survey.

A number of reconnaisances of possible sites were made by Mr. Bull and Mr. Meares, and a précis of the work done and of the results obtained is set out. Surveys were made in Alwar, Assam, Baroda, Bengal, Bhopal State, Bihar, Bombay, Burma, the Central Provinces, Coorg, Indore State, Madras, Punjab, Rajgarh (C.I.), Rampur and Travancore. In each case a special report was made and in several instances more reliable information than that hitherto available was ascertained. Some schemes suitable for development are referred to and some concessions and leases have already been granted, but in many cases further surveys will have to be made before a definite opinion can be expressed as to the capacity of the power available.

Provincial Surveys.

The past year's work has been mainly on reconnaisance, particularly in areas where there is a prospect of power being utilised. The result has been to show that in India the prospect of power depends, in 95 per cent. of the sites examined, on the prospects of storage, and hence the necessity of obtaining accurate information about the actual rainfall and the proportion discharged from the catchment area, &c. The collection of the necessary data will require some years and the work has also been retarded by insufficient staff and by the absence of self-recording rain-gauges. For the current season's work a number of temporary engineers will be recruited from England.

In the Assam Provincial survey reference is made to seven possible sites, three of which are associated with projects for electric railways.

The Bihar and Orissa survey, has been held up by want of subordinate staff, but one good new site has been located. On the Subarnarika river from 30,000 to 50,000 E.H.P. could be generated and on the Dumragarhi about 9,000 or 10,000 E.H.P.

The prospects of power in the Bombay Presidency are very great, but in some of the areas of the western Ghats, irrigation has a prior claim. Reference is made to about 40 rivers and sites, the majority of which could be utilised without much difficulty. On the Kalinadi and Pandri rivers about 90,000 E.H.P. could be developed, on the Tattihalli about 15,000 to 20,000 E.H.P., on the Kaneri 30,000 E.H.P., on the Gangavali 30,000 E.H.P., on the Sonda 37,000 E.H.P. (with a flume), at the Lushington Falls on the Tadri river 50,000 E.H.P., on the Bene Nala 8,000 to 10,000 E.H.P. There are several sites where 3,000 to 5,000 E.H.P. could be secured and many falls and rivers remain to be surveyed.

In Burma there are more possibilities for power than in any other province. Some of the sites in the preliminary report have been rejected, but new ones have been discovered. On the Pan Laung river four sites are mentioned with power ranging from 13,000 to 39,000 E.H.P., and at the Mong Hing Falls on the Zawgyi river about 10,000 E.H.P. could be cheaply developed as a minimum.

In the Central Provinces survey six sites are referred to. On the Indravati river some 70,000 to 80,000 E.H.P. can be developed, on the Nahara 5,000 E.H.P., and on the Pench river about 12,000 E.H.P. There are three other sites, capable of giving 3,000, 2,000 and 4,000 E.H.P. respectively.

In regard to Madras, it is reported that 6,500 E.H.P. could be developed on the Kolab river (or 13,000 E.H.P. with storage), on the Machkand river 5,200 E.H.P. (15,000 E.H.P. with storage). In the Vizagapatam district, where these sites are, there are other sources of power and all the conditions are favourable if load can be found. On the Varani river there is a site good for 5,000 E.H.P., on the Ayzar river some 500 to 600 E.H.P., on the Palni Hills three falls would yield 16,000 to 18,000 E.H.P. continuously. Among other projects referred to is the concession obtained by Messrs. Tata & Company for utilising the water power of the Kundah river and electrical energy will be supplied to Coonoor, Wellington, Ootacamund and Coimbatore for lighting and power.

The schemes referred to in the Punjab Provincial survey include the Sutlej hydro-electric project, which is being surveyed by Lt.-Col. Battye, R.E. A scheme has already been worked out for developing some 6,000 E.H.P., and power will be supplied to Simla for pumping and for operating the Kalka-Simla railway, but the undeveloped resources are very great and a 50 years' lease of four of the principal falls has been granted to the Punjab Hydro-Electric & Industry Development Association. It is estimated that 24,000 E.H.P. can be generated at these falls, and power will be transmitted about 100 miles at 100,000 volts for industrial works and factories in the Punjab.

In the United Provinces two falls on the Karamnassa river would give 8,500 E.H.P., on the Odda river 10,000 E.H.P. can be obtained, on the Tons river 3,000 to 50,000 E.H.P., on the Belon river 5,000 to 6,000 E.H.P., and the Goorma 4,000 to 5,000 E.H.P., with several smaller falls.

Electricity Districts.

Severn Joint Electricity Authority.

The inquiry into the formation of a Joint Electricity Authority for the Lower Severn District was opened at Bristol on Tuesday, but in the absence of engineering details the proceedings were adjourned until March 1. The Electricity Commissioners present were: Sir John Snell (chairman), Sir Harry Haward, Mr. Harry Booth and Mr. Archibald Page, and they were accompanied by their legal adviser (Mr. E. W. Hudson) and their clerk (Mr. D. S. Cumberlege).

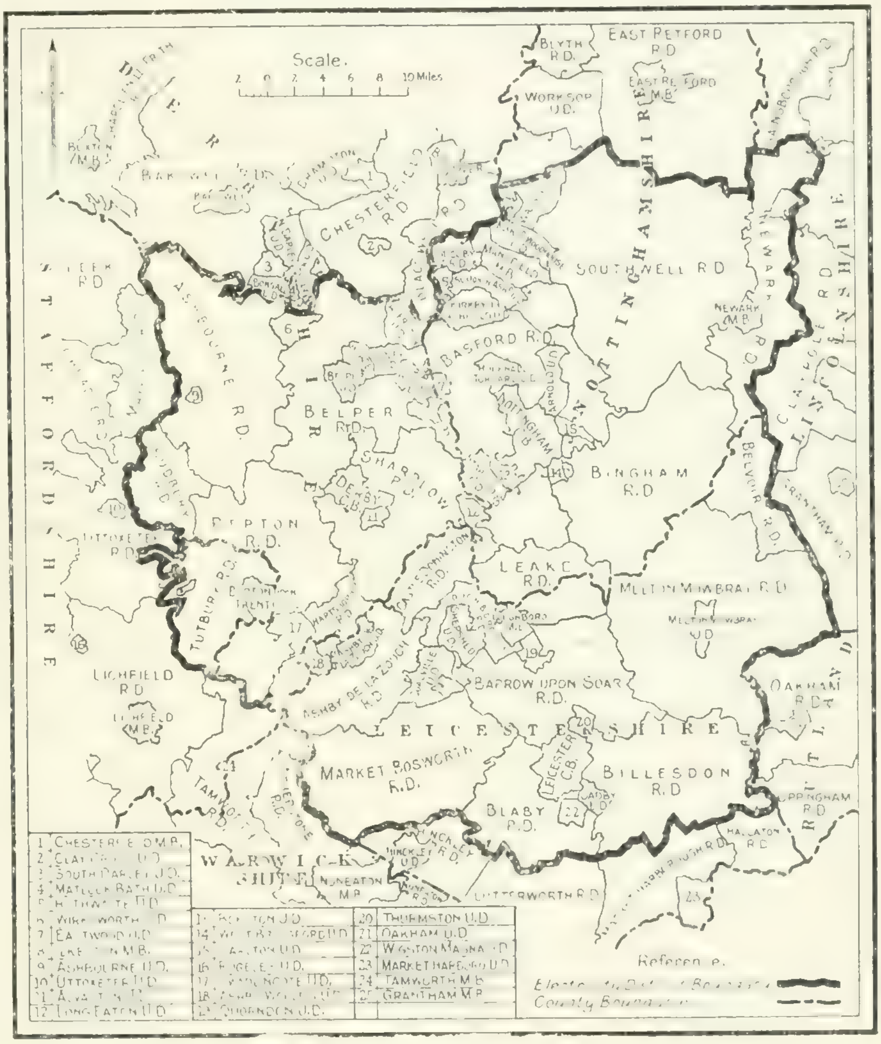
The County, Borough, Urban District and Rural District Councils in the area were represented by their legal advisers, and the engineers of the various electricity undertakings were also present.

In opening Sir John Snell read the notice convening the inquiry, and mentioned that the present Electricity Acts did not confer any financial powers upon Joint Electricity Authorities, but the Bill which was to be laid before Parliament next session would confer the necessary powers on a Joint Authority to borrow money and to issue stock, &c. The procedure would be to call upon the Chairman of the Organising Committee (Mr. H. Faraday Proctor), who had submitted the scheme, to open, and afterwards evidence would be taken. He had expected that the Committee would have been represented by counsel, but Mr. Proctor, as Chairman of it, would present its case and then he would have to put himself into the box as a witness and be cross-examined by those representing the other interests.

Mr. H. Faraday Proctor said general particulars and financial estimates had been prepared, and had been submitted to the Commissioners with the request to authorise certain interim works and estimates, more particularly those referring to the Beachley generating station in the Forest of Dean. Additional information was furnished to the Commissioners as desired, embracing general statistics and an outline of a scheme showing the feasibility of transmitting energy to various localities in the south-eastern portion of the district on a sound financial basis. Those details had not been submitted to other authorities in the proposed districts. The scheme submitted dealt particularly with the constitution of a Joint Authority, and the method of securing proportionate representation on it. It was deemed to be essential that those bodies or companies who, through their representatives, were entrusted with the control and direction of the affairs of the Authority, including its finances, should be responsible for its solvency. It had been, and was, considered undesirable and indeed impracticable for a Committee which was not regularly constituted and had not time or means at its disposal to undertake the detailed investigation of the engineering problems, more particularly having regard to the fact that the area had not been finally determined.

Sir John Snell enquired how came it that the district was in that position, when to the knowledge of the Commissioners other districts which had sent in schemes had submitted the full engineering particulars. Corporations and companies could not possibly criticise the proposals of the Organising Committee unless those particulars were put at their disposal. They ought to have something concrete to go upon. He was disappointed that the Organising Committee had not the information which had been submitted to the Commissioners available for distribution to the various representatives present.

At this stage the Inquiry was adjourned until March 1, by which date it is hoped that all available information, both technical and otherwise, will be furnished to the parties interested.



E. Midlands Electricity District.

The accompanying map shows the area of the East Midlands Electricity District which was recently provisionally determined by the Commissioners.

At a recent conference of representatives of electricity undertakings in the Mersey and West Lancashire Electricity District, held at Liverpool, a committee was appointed, consisting of representatives of Liverpool, Bootle, St. Helens, Warrington, Litherland, Hoylake, West Kirby and Ellesmere Port, to prepare the necessary information for the public inquiry which will be held at Liverpool on the 25th prox. Birkenhead and Wallasey Councils have presented to the Electricity Commissioners an alternative scheme. The Mersey Power Company, which supplies in the districts of Ellesmere Port, Runcorn (Rural and Urban areas), Frodsham, Halsby, Whitby and Widnes, has also lodged opposition with the Electricity Commissioners to the proposed scheme.

South Wales District.

A numerously attended conference of representatives of electricity undertakings (municipal and company owned), and of collieries and electricity users in the South Wales district, was held at Cardiff on the 21st inst. in order to consider the formation of a Joint Electricity Authority for the area as provisionally determined by the Electricity Commissioners. After the Lord Mayor of Cardiff, as convener of the conference, had welcomed the representatives and referred to the enormity and importance of the work they had undertaken, Mr. W. A. Chamen was elected chairman.

Mr. Chamen pointed out that the area provisionally determined by the Commissioners included the counties of Brecknock, Carmarthen, Glamorgan, Pembroke and Radnor, the county of Cardigan, except the rural and urban districts of Aberystwyth, and the county of Monmouth, except the urban and rural districts of Chepstow and the urban and rural districts of Monmouth. He said that the South Wales and Monmouthshire Linking-up Committee, of which he was chairman, had recently given considerable attention to the question of the proper boundaries for the South Wales electricity district, and they found no fault with the district as provisionally determined by the Commissioners, except that perhaps the two extreme eastern districts of Monmouthshire might have been included.

With regard to the preparation of a scheme or schemes for effecting improvement of the existing organisation for the supply of electricity, he said that the primary factor in any scheme was finance, and in the circumstances of general financial depression which now obtained, it may be unwise to plan any scheme which may be warped owing to the distorted conditions prevailing during its conception, and which might not be at all the best scheme under the conditions which may exist at the time it may become an accomplished fact. If it should be deemed wise to appoint a committee to go thoroughly into the matter and report to a further conference, that committee should be representative of all interests concerned, not only of existing statutory undertakings and County Councils, municipalities and local authorities. The owners of private plants were among the largest ratepayers, and therefore would be decidedly interested parties in any scheme.

Mr. Arthur Ellis, who represented several local authorities, including the Monmouthshire County Council, suggested that the present Linking-up Committee, together with any fresh members they might co-opt, should try and evolve a scheme. So far as the Lower Severn scheme was concerned, he thought it would be accepted by the Commissioners, regardless of any opposition, and that a good deal hinged upon the power station of the Government at Beachley, which was acknowledged by common consent to be a "white elephant." He objected to the kind of scheme outlined in the letter of Mr. Dalziel, chairman of the South Wales Electrical Power Company, because, apparently, the effect of it would be that the local authorities would only be supplied with power if they were shareholders in the co-operative scheme, and they would have no authority in the management of the concern. He thought that the collieries, steel works and other industries could be of the greatest possible service to the community in their area if they would come in and take their part in some mutual arrangement. On behalf of Monmouthshire County Council, he objected to the division of the county, so that part of it would be in the Lower Severn and the remainder in the South Wales district. He did not see what good purpose would be served by delaying procedure; the difficulty of obtaining money would still exist under the co-operative scheme, as well as under any joint local authority scheme.

Mr. Chamen, in reply, asked what alternative could be offered in place of a co-operative arrangement, unless it be some scheme secured on the rates, which must react primarily upon the large industrial concerns, as the largest ratepayers.

Mr. W. Angus Scott, speaking on behalf of several large industrial interests, said that from their point of view any venture in regard to raising capital upon the security of the rates would be considered most objectionable. He referred to a scheme of his in Yorkshire where, by linking together 12 mining plants, the power available had been increased by 50 per cent. He favoured the consideration of such possibilities in South Wales.

Mr. Spowart (Llanelly Corporation and Llanelly Docks) asked for information as to the scope of the power company's authority to supply details of location and capacity of existing supply stations, &c.

Mr. Chamen explained that the Linking-up Committee had already prepared a great deal of information. The South Wales Power Company's area did not include the County of Carmarthen; the South Wales electricity district would go far beyond the limits of the Company's area; but the Power Company necessarily appeared on the scene, being the largest statutory undertaking, covering an area of over 1,000 square miles, and having some 150 miles of transmission and distribution mains with an output of 56 million units per annum. It must be taken into account, together with the Cardiff, Newport and Swansea Municipal undertakings. It would not, however, be possible to get in South Wales what was aimed at by the Commissioners, without the linking together of all the electricity demands, including those supplied by private industrial undertakings from their own plants. Universal unification of the whole of the generating plants and systems was the only means of reaching the minimum cost of production, though, unfortunately, such complete unification was not attainable in present circumstances. The aggregate capacity and output of the private industrial plants in South Wales far outweighed the aggregate of all the other plants.

Mr. W. L. Madgen said the only lower Severn "scheme" so far before the Commissioners was a kind of Memorandum and Articles of Association, with no technical or financial details of any kind, and would not, he thought, be generally acceptable in South Wales.

Sir Walter Nicholas (Rhondda Urban Council) thought that the right note had been sounded by Mr. Chamen. A serious financial change had come over the country, and (particularly in the light of experience during the war in regard to Government Departments) it was now necessary to "hasten" very slowly indeed. The Commissioners had obviously given their notice with the object of moving matters, and they had considerable alternative powers under the Act, which should be investigated. He moved that a representative Committee be appointed to look into the whole matter and report to a future Conference, and this was adopted unanimously.

It was decided that the members of the Executive Committee of the Linking-up Committee, together with Mr. Arthur Ellis, should be the nucleus of the South Wales District Committee. The members of the Executive Committee are:—

J. M. Bowman (Rhondda), J. W. Burr (Swansea), W. A. Chamen (S. Wales Power Company), Lewis W. Dixon (Merthyr Electric Traction & Lighting Company), H. Holliday (Rhondda Tramways Company), A. Nichols Moore (Newport), C. G. Morley New (Cardiff), J. E. Stewart (Llanelly Lighting, &c., Company), J. E. Teasdel (Pontypridd) and G. H. Thomson (Neath Rural D. C.).

Emphasis was laid on the necessity for adequate representation of industrial interests, and it was resolved to add the following to the Committee: Sir Walter Nicholas (Rhondda), Councillor Sidney Jenkins (Cardiff), Ald. John Moxon (Newport), Ald. Col. A. Sinclair (Swansea), Mr. L. Forestier Walker, M.P. (Monmouthshire County Council), Mr. G. T. Sibbering (Taff Vale Railway), Sir John Wyndham Beynon, Bart., C.B.E. (Chairman of Monmouthshire & S. Wales Coal Owners' Association), Sir Leonard W. Llewelyn, K.B.E., J.P. (Consolidated Cambrian Collieries, &c.), Mr. E. M. Hann (Powell Duffryn Steam Coal Company), Mr. W. Angus Scott (Consulting Engineer to Guest, Keen & Nettlefolds, &c.), and Mr. B. Nicholas (Tirpentwys Black Vein Steam Coal Company).

It was unanimously decided that a strong recommendation be made to the Commissioners to postpone for six months the date for submitting schemes and also the proposed inquiry. Since the meeting the Commissioners have extended the date for sending in schemes.

North Wales and Chester District.

At Chester on the 6th inst. a conference of local authorities and others was held to consider the draft scheme prepared by Chester Corporation for the formation of a Joint Electricity Authority for North Wales and Chester. Ald. John Prichard (Carnarvon) presided. The area embraces the six counties of Flint, Denbigh, Carnarvon, Anglesey, Merioneth, and Montgomery, and parts of Cheshire and Cardiganshire. Under the proposed scheme the two water-power stations at Dolgarrog and Cwmdyli would be extended, a new station erected at Maentwrog, and 12 new ones similar to that at present working in Chester built on the banks of the Dee, with a large steam-generating station to be built on the Dee estuary. With these co-ordinated and in operation, the authorities hope to be able to supply electrical energy at from 3d. to 6d. per unit for lighting, against the present charges of from 6d. to 1s. per unit, and substantial reductions are also expected in the cost of electricity for power and industrial purposes.

A Rival Proposal.

The North Wales Power & Traction Company propose to supply the whole of North Wales and Chester with power in bulk only, and the district would be divided into 26 areas, in which the local authorities would act as distributors.

Mr. E. Noel Humphreys, former chairman of Chester Electricity Committee, explained the Chester Corporation scheme and pointed out that since the initial conference in February, 1920, at Chester, the Electricity Commissioners had defined the electricity district and had called for schemes for improving the organisation of electricity supply. His Corporation had in mind the objects of the Electricity Supply Act. The district contained the essential facilities for successful industrial development. At present the industrial centres were in and around Bangor, Carnarvon, Chester, Colwyn Bay, Connah's Quay, Crewe, Dolgarrog, Flint, Halkyn, Holyhead, Holywell, Middlewich, Northwich, Penmaenmawr, Queensferry and Wrexham. The total rateable value of the whole district was £4,500,000, while the population was 800,000, and the area in square miles was 4,000. The new steam station would be on the estuary of the Dee, and it was also proposed to utilise the section of the river Dee between Llangollen and Erbistock, where there were facilities for the erection of 12 low-fall water-power stations and the formation of dams and waterways to produce heads of water varying from 9 to 37 ft. In the Vale of Clwyd there were water-power resources, and he cited a single instance, where by erection of a dam 40 ft. to 50 ft. high, hydro-electric plant could generate approximately 3,000,000 units per annum, which would be sufficient for the requirements of the valley from Denbigh to Rhyl for some time. Chester wanted more electrical energy, and to get it meant either extending its own station, which probably the Commissioners would not permit, or the town would have to get it from outside. Therefore, the city wanted a cheap and abundant supply, and because of their needs and because they happened to be the largest authorised undertaker in the district they had pushed the matter forward.

After discussion, the Chester scheme was referred to a committee which is to report to a future meeting of the conference.

The Electricity Commissioners have extended the time within which objections or representations may be made in regard to the North-East Midlands Electricity District until March 31, 1921.

Labour Movements.

By ARTIFEX.

Owing to trade depression and truck shortage, the total number of miners idle in South Wales exceeds 25,000.

The Chemical Employers' Federation are considering refraining from granting the increased wages awarded to the workers last week. They assert that wholesale unemployment will follow the increase.

After many years' uninterrupted activity, Messrs. Players' tin plate works have closed down through trade depression. There are now over 25 tin plate and steel works at a standstill in the Ssansea district.

On Monday last the sixth meeting of the International Labour Office was held at Geneva. It considered various questions arising out of the work of the International Labour Organisation, set-up under the Peace Treaty.

Because of its limited terms of reference and exclusion of any investigation into root causes, the Labour Party will not take part in the inquiry of the Commission to be appointed by the Government, to investigate the problem of unemployment.

At the end of last year there were 784,000 people out of work. This number is rapidly increasing. It is estimated that the Boards of Guardians for the Greater London area are paying out-relief at the rate of £1,000,000 a year.

Mr. J. H. Thomas, M.P., in a message to railwaymen, says that during the next few months the whole future of the railways will be determined. Questions not only of importance to railwaymen but of vital interest to the community will be involved.

In reply to a deputation of the executive of the Miners' Federation, headed by Mr. Robert Smillie, who urged the early introduction of legislation on the lines recommended by the Federation regarding Workmen's Compensation, the Home Secretary replied that the Cabinet could not find time in the coming Session to introduce a Bill on the matter.

In the official report of the National Committee meeting of the Amalgamated Engineering Union held in York recently, it is stated that the executive council were requested by 28 votes to 18 to consider the advisability of opening up negotiations with the employers on a basis of different rates for time workers and workers on the system of payment by results.

The dispute on the question of wages between Messrs, Morton & Weaver (Coventry) and their workpeople, has been the subject of a conference between the Engineering & National Employers' Federation and the various trade unions concerned. Following the refusal of the men to accept a reduction in rates the works were closed down indefinitely. The meeting was adjourned for further negotiation between the firms and its employees.

Selling Benjamin Industrial Illumination.

As an indication of the improved selling methods that are being adopted by the more progressive members of the industry it may interest our readers to know that the Benjamin Electric, Ltd., are conducting a well planned advertising campaign, which is designed to raise the standard of industrial illumination throughout the country, by bringing home to the works owner, the architect and the consulting engineer in a convincing manner the necessity of correct practice and the importance of efficient lighting as a factor in increasing production. A striking, though practical series of full page advertisements have been prepared. The absence of illustrations in the advertisements of the many types of Benjamin fittings will be noted. These advertisements are designed to sell "better illumination," rather than any particular type of reflector. The advertisements will appear in the press devoted to the following industries, apart from the general advertising which embraces the majority of the electrical trade papers: Mechanical engineering works, iron and steel foundries, paper and textile mills, shoe and leather factories, shipbuilding and shipping, &c.

THE men who have experienced the benefits [illegible] know that their firms have [illegible] by it. They *know* they are doing better work and doing it quicker—with greater safety and less waste of material—than ever before. And they feel better physically and are better satisfied with their jobs.

Wholesale Distributors

THE EDISON SWAN ELECTRIC Co., Ltd.
ENGLISH ELECTRIC & SIEMENS SUPPLIES, Ltd.
THE GENERAL ELECTRIC Co., Ltd.
METROPOLITAN-VICKERS ELECTRICAL Co., Ltd.
SIMPLEX CONDUITS Ltd.

Advertisement of the Benjamin Electric Ltd., Brantwood Works, Tottenham, London.

In addition to the press advertisements over 52,000 letters (enclosing reprints of the advertisements) and folders are being distributed through the post to owners of works and factories in all industries, and also consulting engineers, architects, &c. Special letters and printed matter are being sent to those concerned with the sale and installation of Benjamin reflectors, including electrical contractors throughout the country and the sales engineers of the wholesale distributing firms. The campaign will form one of the most effective sales helps to the dealer and contractor yet launched by any manufacturer. The ground will be thoroughly prepared by the advertisements and the messages to the users. The fact that over 250,000 pieces of printed matter have had to be produced and collated for the campaign speaks well for the thoroughness with which the Benjamin Electric, Ltd., conduct their business.

The Minister of Labour has decided, in pursuance of his powers under the Industrial Courts Act, 1919, to appoint a COURT OF INQUIRY IN CONNECTION WITH THE DISPUTE IN THE TRAMWAYS INDUSTRY arising out of the workers' claim for an increase in wages. The Court will be constituted as follows: Right Hon. Sir David Harrel, G.C.B. (Chairman), Mr. Harry Gosling, C.H., Mr. G. H. Hume, Mr. W. F. Purdy, O.B.E., J.P., and Sir Herbert Rowell, K.B.E. The Terms of Reference are: "To enquire into the causes and circumstances of the dispute between the employers' representatives and the workpeople's representatives on the National Joint Industrial Council for the Tramway Industry and to report thereon to the Minister of Labour." The Secretary is Mr. H. C. Emmerson, Ministry of Labour, Montague House, Whitehall, S.W.1. A preliminary meeting of the Court was held on Tuesday, when certain points of procedure were settled, and it was agreed that the Inquiry should be held in public. The Trade Union side will open the case at the first meeting of the Court on the 26th inst.

Electricity Supply.

HARROGATE Corporation decided on Tuesday to apply for sanction to a loan of £6,390 for condensing plant at the electricity works.

EAST HAM Corporation has received sanction to a loan of £5,428 for mains.

TREDEGAR Urban Council has authorised the preparation of an electric supply scheme in order to comply with its statutory powers and duties.

The salary of the KIRKCALDY burgh electrical engineer and tramway manager (Mr. O. F. Francis) has been increased to £675 per annum.

DORCHESTER Corporation has decided to acquire the local undertaking of the County of Dorset Electric Supply Company, and to apply for a special order to authorise the transfer, &c.

BARROW IN FURNESS Corporation has referred back a proposal to apply for a special order to authorise a scheme for utilising the River Leven at Backbarrow for power purposes.

The South Wales Electrical Power Distribution Company has obtained a special order to enable it to supply and distribute electricity in the PANTEG urban district.

Sanction has been received by BLACKPOOL Corporation to the borrowing of the following sums: Buildings, £600 for 30 years and £26,426 for 25 years; transformers, &c., £2,974 for 20 years.

A loan of £15,000 is wanted for the extension of LYTHAM electricity works and plant. There are now 2,408 consumers, the output for November being 188,350 units, against 156,519 for the corresponding month in 1919.

The borough electrical engineer (Mr. H. Tomlinson Lee) recently reported to the WIMBLEDON Corporation that extensions of plant and mains, estimated to cost £136,490, would be necessary in order to meet consumers' requirements until March, 1924. As there was some opposition to this expenditure it has been decided to ask Mr. C. P. Sparks to report generally upon the undertaking and upon the possibility of obtaining a bulk supply from Kingston-on-Thames.

The Council has offered to purchase for £4,000 the local undertaking of the Fixed Price Light Company, but as the Company consider the offer inadequate, the Electricity Commissioners will be asked to adjudicate upon the matter.

BURTON-ON-TRENT Corporation propose to ask the Electricity Commissioners to sanction a loan of £26,000 to enable them to supply electricity in the South Derbyshire district. The proposal is to run duplicate mains from the power station at Burton to the Stanton and Nethersea Collieries, the last named some eight miles away, and, with the sanction of the Swadlincote Urban Council, to extend them as far as Gresley Common. If it materialises the scheme will aid the development of the colliery district contiguous to Burton, with its numerous factories

TORQUAY Corporation, which proposes to erect a new power station at Newton Abbot to supply electricity in Torquay and to adjacent electricity undertakers, recently approached the Electricity Commissioners with the view of obtaining financial assistance for the scheme. Sir John Snell has, however, informed the Council that the Electricity Commissioners has no powers or funds by which to subsidise developments, and financial assistance from them was out of the question. He knew of no company that would be likely to be willing to undertake Torquay's obligations to itself, and a company would not be able to raise money on such favourable terms as the borough. Its standing charges would consequently be higher, and a profit would be sought in addition. He advised the Council to go to work under Sec. 19 of the 1919 Act, which confers powers upon two or more authorised undertakings to enter into agreements for mutual assistance. Negotiations might be opened with the Newton and Paignton companies with a view to entering into such an arrangement, Otherwise, the Commissioners would not withhold consent to the formation of a joint electricity authority for the area prescribed, extending along the coast from Start Point to Dawlish Warren, and inland, to include Totnes, Ashburton, Bovey Tracey and Newton Abbot. If those towns, with Torquay, could be induced to form such an authority and guarantee the necessary capital, the Commissioners would be prepared to advise the construction of the generating station, main transmission lines and other necessary works, the Treasury advancing the necessary capital. The Treasury would require absolute guarantees of repayment within the specified period before any sums would be advanced.

The electrical engineer is to report on the subject.

Like most industrial areas, BELFAST is at present short of electricity supply, and there is much unfair criticism of the Electricity Committee. The position was discussed at last week's meeting of the Corporation, when proposals for extension of plant were submitted. The committee submitted a report from the consulting engineers Messrs. Preece, Cardew & Rider on the installation of further plant at the Harbour power station. The report stated that Mr. Bloxam had estimated his maximum demands, including general supply (d.c. and a.c.) and tramways as follows: Winter of 1921, 21,738 kw., and winter of 1922, 28,238 kw. The safe maximum output from the plant at East Bridge-street is not more than about 13,000 kw., which added to the output from the Harbour (6,000 kw.) gave a total output of about 19,000 kw., but the net output might be taken at 18,500 kw. It was, therefore, evident that the estimated load in 1922 of 28,000 kw. could not be met without further plant. A new 12,500 kw. set was required at the Harbour station, and further plant extensions would have to be considered within the next 18 months. The cost of completing the first section of the Harbour Station would be £289,799, but this does not include the cost of the general scheme of h.t. distribution which will be necessary in order to make provision for the large prospective load which will eventually have to be taken over. There would be no possibility of dealing with any considerable increase in the demand until the further extensions, involving the provision of the second section of the Harbour station had been carried out. There was, however, an urgent need for a supply in the Ballymacarrett district. A sub-station in a central position in the district, together with two h.t. feeders from the Harbour station and a system of l.t. distributors would cost £56,000. The total estimate is as follows: Extension of Harbour station, £289,799; extension of existing feeders, £16,000; supply to Ballymacarrett district, £56,000, or a total of £361,799.

The chairman, Sir James Johnston, explained the situation, and pointed out that during the past month they had machinery equal to 5,000 kw. out of action owing to breakdowns. The situation should be discussed at a meeting of the Council in committee. There was a difficulty in raising money, but it was a question of stopping where they were or making a special effort to meet their requirements.

Though electricity supply has been discussed by NEWARK Corporation at various times during the past 21 years, the town is still without a supply. There is, however, a prospect of progress in the near future for a conference of representatives of local manufacturers met Mr. C. H. Wordingham, C.B.E., on the 6th inst. in order to consider the Corporation scheme. Ald. Priestley presided. and said the time was opportune to evolve some scheme if Newark wished to maintain its industrial position.

Mr. Wordingham gave a resume of the proposals embodied in his special report to the Corporation. He saw no hope of the East Midlands area benefiting for at least four or five years from any scheme under the Electricity (Supply) Act, and Newark would be one of the last towns to receive power, being on the extreme edge of the area. It would be more costly to bring the electrical energy in bulk from Nottingham than to have a generating station at Newark, the town being well situated for securing an economical supply. He did not think the River Trent could be relied upon for the power to give a consistent supply, because it would be an extremely costly undertaking, and troublesome to work. Greater and more reliable production could be obtained by steam. His scheme could be developed in three stages. The initial capital expenditure would be £158,500 to meet a demand of 1,500 kw. with a plant capacity of 3,000kw.; stage two (after two years) would involve an increase of £42,750 in the expenditure, and stage three (after five years) a further £122,000. He calculated that there would be a saving of a half-penny per unit (on stages one and two) and of a farthing (on stage three), compared with the East Midland area scheme. The first stage of the scheme could be in working order within two years, and he believed the Electricity Commissioners would raise no objection to a generating station being erected at Newark. The cost of distribution per unit sold (stage 1) would be 0.57d., and total cost per unit sold 2.29d.; stage 2, 0.40d. and 1.60d. respectively; and stage 3, 0.36d. and 1.45d. Manufacturers would take energy from the Corporation because of the cheapness of production.

Lieut.-Col. Higgs (Messrs. Ransome & Company) said his firm could produce and supply others for 2.25d., so that the Corporation should supply power at as low a cost at least.

Mr. Wordingham replied that his figures were the maximum. The cost would probably be much less. For power supplied the charge would be ¾d. per unit, plus £1 2s. 6d. per e.h.p. per quarter installed.

It was decided to circularise the representatives and ask them for their opinions, so that the matter could be dealt with by the Council at an early date.

Electric Traction.

In future the HALIFAX Tramways Committee is to have control of the tramway track, but the Council has referred back recommendations to appoint Mr. J. W. Galloway as tramways general manager for 12 months, at £700 per annum, and to pay £250 per annum for three years to Mr. J. D. Caird, traffic manager, who, in consequence of illness, is unfit to resume his duties.

As the outcome of this decision, Ald. C. F. Spencer, chairman, and Ald. A. Broadley, vice-chairman of the Tramways Committee, and Councillor R. Stirk, chairman of the Tramways Sub-committee, have resigned. They state that they disagree with the decision of the Council. They point out that the increased costs have become a heavy burden; that the increased fares are inadequate to meet the added and prospective costs of operation; and that receipts may decline owing to trade depression. In addition, a large portion of the track is in a bad condition.

The proposal to introduce a minimum fare of twopence on the LIVERPOOL tramways caused much discussion at the meeting of the Corporation last week. It was urged that the increase would be a hardship on many working men living in the centre of the city, while others thought that on the revised fares they would lose money. However, Sir Archibald Salvidge pointed out that money for the upkeep of the undertaking had to be got from somewhere, and the increased fare would be paid chiefly by many people who travelled short distances.

Mr. F. C. Wilson, chairman of the Tramways Committee, said that in 1910 the people of Liverpool prided themselves on having the longest penny tram ride in the country, but the value of a penny now was only one-third, and that 2d. to carry a person from the Pierhead to the old city boundary was less than before the war. The total operating costs in 1910 were £405,561, in 1919 they were £1,029,000, while the estimate for this year was £1,900,000, nearly five times as much. How could they expect to carry people at a penny fare? Only 40 per cent. of the passengers were penny riders. Unless the proposal was carried it would mean an additional charge on the rates.

The proposal was ultimately passed by a substantial majority.

Telegraph and Telephone Notes.

What will be the MOST POWERFUL RADIO-TELEGRAPH STATION in the world is being erected at Sainte Assise (France), between Cesson and Mélun. The laying of the first stone took place on Sunday in the presence of M. Louis Deschamps, Under-Secretary for State for Posts and Telegraphs, and a number of politicians, engineers and others. The power of the new station will be double that of the station at Croix d'Hins, and from it communication will be established with America, India, Japan, China, South Africa and Oceania.

WIRELESS TELEGRAPH GREETINGS were exchanged between His Majesty the King and the President of the French Republic on the occasion of the opening PUBLIC WIRELESS TELEGRAPH SERVICE between England and France on Saturday last. The service is conducted by Marconi's Wireless Telegraph Company and the Cie Generale de Telegraphie sans fil under licences from their Governments. The current telegraph rates between the two countries will apply. Telegrams to France, intended for transmission by this new service, may be handed in at the Marconi Company's London offices at Fenchurch-street and Marconi House, Strand, or at any postal telegraph office within the United Kingdom. For the service the latest high-speed automatic apparatus, such as was recently used so successfully between Geneva and London, will be employed.

The COMMITTEE ON INTERNATIONAL COMMUNICATIONS of the United States Senate has resumed the taking of evidence on the submarine cable position. The first witness on Monday was Mr. Clarence H. Mackay, president of the Postal Telegraph Cable Company, and of the Mackay Cable Companies, who argued that the submarine telegraph cables between Germany and the United States should be returned to their pre-war uses. While Great Britain and France had the right to seize the portion of the cables between Germany and the Azores, he considered that they had no right to seize the portions between the Azores and America, because both Portugal and the United States were then neutral.

In regard to the controversy between the U.S.A. Government and the Western Union Telegraph Company as to the landing of a cable at Miami (Florida). Mr. Newcomb Carlton, president of the Western Union Company, complained that the State Department was using threats against the Cuban Government, in order to prevent his company from getting permission to land their South American-Barbados cable at Cojimar. As to the alleged supervision by the British authorities of official despatches sent from Washington to American diplomatic representatives in Great Britain, Mr. Carlton refused to answer, and added that the Department was in possession of the facts.

Mr. Roy Martin, acting general manager of the Associated Press, pleaded for the extension of cable facilities, and urged that the most suitable method was Government support of private cable interests. He would like to see direct cables between America and Italy and America and Scandinavia. The British censorship was not narrower than the American.

Business Items, &c.

Messrs. H. W. Smith & Co., Ltd., electric wire and cable manufacturers, have opened a sales office at Central House, Kingsway, London, W.C.2. Telephone: Regent 2368.

The telephone number of the new London Office of the CHLORIDE ELECTRICAL STORAGE COMPANY, LTD., has been altered to "Victoria 5542."

Geo. Herbert Bradbrook and Frank Leslie Oxenham, electrical and general engineers, &c., The Street, Gt. Clacton, Essex, have dissolved partnership. Debts by Mr. Bradbrook, who continues as "BRADOX."

Norman Hamilton and Arthur G. Foulds, electrical engineers, &c., 23, Douglas-street, Glasgow, have dissolved partnership. Debts by Mr. Hamilton, who continues the business as Hamilton, Foulds & Co., at the same address.

In an advertisement of the S.K.F. pulleys, which appeared in THE ELECTRICIAN for the 31st ult., an error occurred in the spelling of the name of the manufacturers. These are the SKEFKO BALL BEARING COMPANY, LTD., of Luton, Beds.

Messrs. Wallis-Jones & Dent, consulting engineers (Mr. Reginald J. Wallis-Jones, M.Inst.C.E., M.I.E.E.), have removed to Adam's House, 23, Old Queen-street, Westminster, London, S.W. 1. Telephone: Victoria 8070; Telegrams: Alteration, Vic., London.

The partnership between Horace Louis Petit Boot and Reginald John Spencer-Phillips, carrying on business as HORACE BOOT & PARTNERS, consulting engineers, 7, Victoria-street, Westminster, S.W. 1, has been dissolved. Debts by Mr. Boot, who continues the business.

The partnership between Joseph A. Hogan, Ernest Blackburn and Henry Blackburn, trading as the PEERLESS ENGINEERING COMPANY, manufacturers and dealers in lighting sets, dynamos, &c., has been dissolved. Debts by Mr. J. Atkinson, District Bank-chambers, Halifax.

The partnership between Fredk. Tompkin Middleton, Jas. Orton and Thos. Wright, trading as the CENTRAL LIGHT AND POWER COMPANY, electrical engineers, &c., Friar-lane, Leicester, has been dissolved so far as concerns Fredk. T. Middleton. Debts by Mr. Orton and Mr. Wright, who continue the business.

We are asked to correct an impression which has gained ground to the effect that Messrs. J. B. SAUNDERS & COMPANY, LTD., have amalgamated with the Twiss Electric Transmission, Ltd. The incorporation covers the transmission line business only of the former company; otherwise Messrs. Saunders & Company retain their individuality, and carry on their railway telegraph and telephone business.

Imperial and Foreign Notes.

PICTON (N.S.W.) Council have declined the offer of the Public Works Department to supply electrical energy to Picton, and have decided to establish a generating station of their own.

Mr. W. A. G. Douglas read a Paper recently before the Sydney division of the Institution of Engineers (Australia) on the development of the SYDNEY TRAMWAY ROLLING STOCK. He states that there are 1,140 motor cars, including 985 large double truck bogie cars, seating from 50 to 80 passengers, the balance being of the four wheeled single truck type. 218 cars are permanently coupled and 948 can be operated as coupled sets when required. The average schedule speed is 8½ miles an hour in the city, and 12½ miles in the outer suburbs. It is calculated that there are on an average 30 seats per car occupied throughout the day. The new standard cars are all to be motor cars of the maximum size. Electric welding has been found very satisfactory for rolling stock repairs and will be used for practically all work of that class.

The ANGLO-ARGENTINE TRAMWAYS COMPANY recently put in service at Buenos Ayres a new type of single-deck trailer car with central doorways only. The car carries 32 passengers seated.

The ALLIED CHEMICAL & DYE CORPORATION has been incorporated in New York with a capital of $48,043,000 for acquiring important American Chemical Companies. Mr. Roscoe Brunner, of Brunner Mond & Company, and M. Emanuel Jansen, of Brussels, are among the directors of the new company.

H.M. Consul General at Rotterdam states that a small temporary building which was erected during the war to accommodate part of his staff, is available for use as a sample room for the Commercial Department of the Consulate. It is in a favourable position for visitors desirous of inspecting the samples, and British firms wishing to have samples of their manufactures exhibited should forward same to the Consul General at Rotterdam, at the same time advising the Department of Overseas Trade of any action so taken.

A French priest, Father Piedfort, head of the Calais Industrial Institute, is anxious to emulate Sir E. Geddes, for he has drawn up a scheme to supply his city with cheap electricity. Calais possesses an unused dock, the Bassin des Chasses, which measures about 100 hectares and has a lock between it and the sea. The Abbé has estimated (though no details are given) that the power generated by turbines placed there would suffice to pump water into a natural reservoir which is situated 125 metres above the sea-level, and that the water thus stored could be used to drive a power station to serve Calais. He also suggests that a continuous generation of current could be effected if tidal-power stations at different parts of the coast were joined to central stations which might be situated several hundred miles apart.

In April 1919 the ASSOCIATION BELGE DE STANDARDISATION was formed in order to study the question of standardisation from the commercial and technical points of view. It is composed of important industrial and technical associations and a general committee has been elected to direct its activities, to examine proposals which shall be presented and to keep in touch with similar organisations existing in foreign countries. When the committee decides to attempt standardisation, the matter will be referred to a committee of experts. In its first report rules are given for the construction and standardisation of metal frameworks, metal reservoirs, walls and roofs of galvanised corrugated iron, transmission shafting and pulleys, metal bridges and bolts and rivets. The Association is now considering the measurement and construction of buildings in reinforced concrete, and also questions affecting the mining and electrical industries.

Personal and Appointments.

GLASGOW Corporation have appointed Mr. Geo. Morgan, formerly superintendent of power stations, to the position of assistant chief engineer, rendered vacant by the death of Mr. G. L. Black. Mr. William Ross will succeed Mr. Morgan as superintendent of power stations.

The Board of Trade have appointed Sir R. T. Glazebrook, K.C.B., F.R.S., to be Chief Gas Examiner under the Gas Regulation Act, 1920, and Mr. C. V. Boys, F.R.S., Mr. J. S. Haldane, F.R.S., and Mr. W. J. Atkinson Butterfield, M.A., F.I.C., F.C.S., to be Gas Referees. Mr. H. C. Honey has also been appointed Director of Gas Administration in the power transport and economic department of the Board.

Of the many NEW YEAR HONOURS conferred by His Majesty none was more deserved than the Baronetcy bestowed upon Col. Sir Wm. Dupree, J.P., D.L., who, early in the great war, foresaw that one of the greatest problems that would evolve from the conflict would be the question of relationship between employers and employed. Events have proved the wisdom of Sir Wm. Dupree's judgment of what would be the trend in industrial matters, and his broadminded munificence and indefatigable energy have contributed materially to the factors which have enabled England so far to avoid the industrial rocks on which she would undoubtedly have foundered. So keen was Sir Wm. Dupree on what he felt to be his duty to his countrymen in this connection that in December 1918 he gave, without any reservation, a cheque for £20,000 to Mr. G. H. Roberts, M.P., who was then president of the Industrial League, to be used by the League. This handsome donation formed the nucleus of the fund which has enabled the Industrial League and Council, as it is now known (with the Rt. Hon. G. H. Roberts, M.P., and the Rt. Hon. J. H. Whitley, M.P., as its presidents), to carry on its great work of striving, by improving the relations between employers and employed, to promote industrial harmony.

Institution Notes.

The annual dinner of the LIVERPOOL ENGINEERING SOCIETY will be held on Thursday, January 27th, at 7 o'clock, at the Exchange Station Hotel, Liverpool. Tickets, 1 guinea each, are obtainable from Mr. T. R. Wilton, the Hon. Secretary, 1, Crosshall-street, Liverpool.

The annual dinner of past and present engineering students of the UNIVERSITY COLLEGE (LONDON) ENGINEERING SOCIETY will be held at the Connaught Rooms on Friday, the 28th inst., at 7 p.m. Particulars may be obtained from Mr. H. R. H. Ward, Dinner Secretary, at University College, Gower-street, W.C. 1.

We have received the programme of the BIRMINGHAM AND DISTRICT ELECTRIC CLUB, from which we note that Papers will be read on "Reminiscences of the Test Bed," by Mr. C. J. A. McDonald, on Feb. 12; "Common-Sense Methods of Recording Costing and Progress in Shop Management," by Mr. H. C. Young, on March 12; and "Supply of Electrical Energy in Birmingham and District," by Mr. F. Forrest, on April 9. The annual dinner will be held on March 4.

The following arrangements for informal meetings of the INSTITUTION OF ELECTRICAL ENGINEERS for the month of January have been made:—Jan. 17, "The Mental Equipment of an Engineer," Mr. P. Pitt; Jan. 24, discussion on "Improving the Usefulness of the Institution," with Mr. L. B. Atkinson (President) in the chair; Jan. 31, "Possible Economies in House Wiring," by Mr. L. Milne. The meetings on Jan. 17 and 31 will be held as usual at the Chartered Institute of Patent Agents, Staple Inn-buildings, Holborn, W.C., beginning at 7 p.m., while the meeting on Jan. 24, as already announced in THE ELECTRICIAN, will be held at the Institution of Civil Engineers, beginning at 6 p.m.

The annual meeting of the West of England Division of the ELECTRICITY SUPPLY COMMERCIAL ASSOCIATION was held at Bristol on the 10th ult. There was a good attendance of members. Mr. A. N. Allen (Gloucester), having resigned the secretaryship of the division, was thanked for his services during the past two years, and Mr. C. Hancock (Bristol) was elected to fill the vacancy. The chairman (Mr. T. H. Gait) reported that the following members had been elected to the Divisional Council for the ensuing year: Messrs. R. H. Morris (Bath), A. N. Allen (Gloucester), Tripp (Cornwall), Toutt (Plymouth), W. Hounsell (Minehead), T. H. Gait, C. Hancock, E. Macvitie (Bristol), W. P. Short (Taunton) and Miss Radford (Bristol). The business meeting was followed by a musical programme arranged by the Bristol members.

Catalogues, Price Lists, &c.

The General Electric Company is issuing a new design of "sticker," illustrating the "KINGSWAY" EXTENSIBLE TELEPHONE BRACKET, which is manufactured by the company.

Ozonair Ltd., 96, Victoria-street, S.W. 1, have issued a new edition of their No. 3 pamphlet, which gives a full description of the OZONAIR SYSTEM OF PURE AIR VENTILATION. Illustrated particulars are given of the various apparatus employed and the advantages of the system are clearly and succinctly set out.

In a neat and well-illustrated pamphlet of 40 pages on the VAUGHAN OVERHEAD CRANE, particulars are given of the various types of electric cranes, hoists, blocks, &c., manufactured by the Vaughan Crane Company, of Openshaw, Manchester. Data of some standard cranes, electric blocks, hoists and travellers are included as well as of some typical installations carried out by the Company.

A brochure on WESTINGHOUSE MORSE ROCKER JOINT CHAIN DRIVES, just issued by the Westinghouse Morse Chain Company, Ltd., of Letchworth, will be of interest to power users and those interested in economy in power transmission. Illustrated particulars are given of the various types and sizes manufactured by the company, together with technical details, prices, &c.

In the EXPORT LIST (No. 8120) of MESSRS. DONOVAN & CO., 47, Cornwall-street, Birmingham, prices and particulars are set out of various high-class English-made accessories, including lampholders, switches, fuse boards, wires and cables, batteries, &c. The prices include packing and delivery f.o.b. British port, but the firm are also ready to quote c.i.f. prices if desired by foreign customers.

In a leaflet on "DORICLITE" SEMI-INDIRECT ALL-GLASS PENDENTS, the GENERAL ELECTRIC COMPANY, LTD., 67, Queen Victoria-street, E.C.4, give illustrated particulars and prices of four of these lighting units. The objects of the units is to make possible semi-indirect lighting in lofty rooms, or where a white ceiling is not available, and this is effected by the introduction of an upper reflector of similar material to the translucent bowl.

In the new illustrated catalogue of the B.E. COMPANY (of LONDON and BIRMINGHAM), LTD., particulars and prices are set out of a great variety of British made electrical supplies and accessories. These include switches, ceiling roses, cutouts, fuse boards, lampholders, flexibles, Pyrotin fuse wire, electric irons, hand lamps, shades, and other fittings, &c. The same company has also issued a price list of "Hendon" metal filament lamps, and copies may be obtained from the offices at 57, Upper Thames-street, London, E.C.4.

The SWEDISH GENERAL ELECTRIC, LTD., 5, Chancery-lane, W.C.2, have issued their stock list No. 26, relating to d.c. "Century" single-phase, repulsion induction motors, c.d. portable electric drills, &c., and list No. 27 on 2 and 3-phase motors, single-phase commutator motors, transformers, &c. The lists, which give motor ratings, prices and other particulars, are of a comprehensive character and show that the Company have large stocks of new machines available for prompt delivery. Copies of the lists may be obtained by those interested.

Tenders Invited and Accepted.

Edinburgh Corporation invite tenders for the supply of circulating water pipes and valves. Tenders to the Town Clerk by Jan. 24.

Hampstead (London) Council require tenders by Jan. 24 for one year's supply of electrical stores, &c. Forms of tender from Town Clerk.

Camberwell (London) Council require tenders by Feb. 7 for the supply of stores, including electric lamps and fittings. Forms of tender from the Borough Engineer.

Hammersmith (London) Council require tenders by Jan. 21 for three or more water-tube boilers capable of supplying 150,000 lb. of steam per hour. Specifications from the Borough Electrical Engineer.

Manchester Electricity Committee require tenders by Jan. 26 for the supply and erection of d.c. switchgear at Dickinson-street generating station. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Chester-le-Street Urban Council require tenders by Jan. 25 for wiring 512 houses at Bullion-lane, equipment of sub-station, erection of overhead mains, &c. Particulars from the Electrical Engineer.

Tenders are required by Feb. 3 for 12 months' supply of lighting fittings, lamps, switches, cables, meters, tubes, &c., to Halifax Electricity Department. Forms of tender from the offices,

The Victorian Railway Commissioners (Melbourne) want tenders by Feb. 2 for various requirements, including axle generator train-lighting material and accumulator cells (contract 33,750) and miniature electric staff instruments (contract 33,694.)

Tenders are also wanted by February 3 for 12 months' supply of stores to Halifax Tramways Department, including lighting fittings, insulating materials, cable, wires, trolly and overhead line material, castings, oils, &c. Forms of tender from the Tramways Engineer.

Antwerp Municipal Council invite tenders for supply and erection of rotary converters with switchboard for Wharf No. 77 of the Bassin Canal. Tenders by noon Feb. 1. Specifications (in French) may be seen at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

Aberdeen Corporation invite tenders for supply and erection of electric pumping machinery capable of delivering 6½ million gals. per 24 hours, including transformers, motors, pumps, &c. Specifications from the Water Engineer, 41½, Union-street, and tenders by Feb. 21.

Pretoria (Transvaal) municipality require tenders by March 10 for one 20 ton overhead crane, six boilers to evaporate 18,000 lb. an hour each at 350 lb. pressure; three 3,000 kw. steam turbo-generators, condensing plants, five 750 kw. converters. Specification from Town Clerk

Tenders are invited up to March 2 for the supply and delivery to the Australian Postmaster-General's Department, State of South Australia, of (A) telephone parts (Schedules 558 and 559); and (B) telegraph and telephone materials (Schedule 560). Tender forms from the High Commissioner for Australia, 406, Australia House, Strand, London, W.C.2.

New Zealand Public Works Department invites tenders for the supply and delivery (ex ship's slings Lyttelton) of seven 4,000 k.v.a. transformers complete wth accessories. Tenders (accompanied by a deposit of £500) by noon March 1, to the Secretary, Public Works Tenders Board, Wellington, N.Z. Specifications may be seen at the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1.

The Directors of the Great Western Railway Company invite tenders for the supply of various stores, including electrical apparatus (insulators), &c., electric wires and cables, telegraph instruments, ironwork and tools and drysalteries, oils, indiarubber goods, &c. Specifications from the Stores Superintendent, Swindon, and tenders to the Secretary, Mr. A. E. Bolter, Paddington Station, London, W., by Jan. 24.

Canterbury Council has accepted the tender of Ferguson, Pailin, Ltd., for supply of switchgear and cables at £2,495.

Wrexham Corporation has accepted the tender of E. V. Walker & Company for wiring the Acton Park houses.

Bankruptcies and Liquidations.

Geo. Dolby, electrician, 39, East Marsh-street, and 129, Freeman-street, Gt. Grimsby, has been adjudicated bankrupt.

A meeting of creditors of the Leyburn Electric Supply Company, Ltd., will be held at the registered office of the Company, Leyburn, on Jan. 24.

Claims against R. Wolf, Ltd., engineers, Norfolk House, 7, Laurence Pountney-hill, London, E.C., which is being wound up under the Trading with the Enemy (Amendment) Act, 1918, are to be sent by Jan. 17, 1921, to Mr. A. Dangerfield, 56, Cannon-street, E.C.

The first meeting of creditors of Chas. Carlisle Thompson, electrician, &c., formerly trading at 78, Salisbury-street, Hull, will take place on Jan. 18 at York City Bank-chambers, Lowgate, Hull, and the public examination on Feb. 14 at the Guildhall, Alfred Gelder-street, Hull.

The first meeting of creditors of Geo. Dolby, electrician, 39, East Marsh-street, and 129, Freeman-street, Great Grimsby, will take place on Jan. 15 at the Official Receivers' Office, St. Mary's Chambers, Great Grimsby, and the public examination on Feb. 3, at the Town Hall, Gt. Grimsby.

John H[illegible] trading as H[illegible] & Son, electrical [illegible] street, Southend, appeared for his adjourned examination at Chelmsford last week. Debtor could not explain why he had paid away £447 16s. more than he had received, but admitted that he ought to have added many receipts which did not go through the bank. The examination was again adjourned as the Receiver wished to make further inquiries.

Miscellaneous.

A contribution of £5,000 has been made by the Drapers' Company for the equipment of the new library of the East London College.

During the past week the secretary of the James Watt Memorial Fund, Birmingham, received donations amounting to £1,315, including 250 guineas from the American Society of Mechanical Engineers of New York as a first donation.

The workers employed in the manufacture of electric lamps, batteries and accumulators throughout the country have decided to apply to the Engineering & National Employers' Federation for an extension to the workmen concerned of the rates and wages obtaining generally in the engineering trade.

The proprietors of "The Autocar" (Messrs. Iliffe & Sons, Ltd.) have issued a well-printed souvenir booklet commemmorating the 25th anniversary of the establishment of "The Autocar." Among these excellent illustrations in the booklet are two showing the contrast between autocars in 1900 and 1920. These prove the great strides made by the motor industry in the interval.

The death took place at South Stoke, near Bath, on Monday of Mr. Walter Pitt, chairman of the well-known firm of Messrs. Stothert & Pitt, Ltd., engineers and crane manufacturers. Deceased, who was 68 years of age, took out many patents relating to cranes and hoists, and was the author of the article on cranes in the "Encyclopædia Britannica." He was a member of the Institutions of Civil and Mechanical Engineers.

British nationals who have registered claims against German nationals in respect of pre-war debts, will shortly receive a notification from the clearing office that the last day for making the necessary statutory declaration in support of their claims is March 31. No claim will be admitted which is lodged after that date, unless the Controller of the clearing office is satisfied that the omission arose from circumstances for which the creditor could not justly be held responsible.

The dates of a number of local and other exhibitions are announced, and as there will be displays of electric supplies at the majority of them it might be worth the while of electrical manufacturers to make exhibits. At *Aylesbury*, the borough electrical engineer (Mr. Turnbull) expects to hold a small electrical exhibition from Feb. 14 to 16. There will be co-operation with the electrical contractors.

The *Sheffield* Chamber of Commerce has arranged for an exhibition of the following (among other) samples, to be held in the Cutlers' Hall, on Monday, Feb. 28 and Tuesday, March 1:—Domestic electrical goods of Swiss, German and U.S.A. manufacture, intended for Switzerland. Various electrical goods of U.S.A., Japanese and Canadian manufacture from various markets. Invitations will be dispatched to those desiring to inspect the samples.

At *Birmingham*, a trades exhibition will be held at Bingley Hall in March.

At *Cardiff*, a local electrical exhibition will be held at the end of the month.

The Public Works and Transport Exhibition will take place at the *Agricultural Hall*, Islington, London, N. 1, from Nov. 17 to 25 next.

We have always pleaded that a greater use should be made of our roads for transport purposes, and especially that the place of electric vehicles in developing this branch of our national communications had not been realised either by electrical engineers or by the public generally. Recent occurrences, not remotely connected with our railways, have drawn attention in no uncertain fashion to the part which our roads can play in commercial development. The result is that the road transport industry is now entering up on a period of vast development, and offers the very best prospects of enterprise to all engaged in it. Such enterprise, as in all commercial concerns, can only be achieved by means of well-thought-out organisation and attention to details. "The Transport World and Motor Freight Exchange," the first issue of which we welcome, is an attempt by Messrs. Benn Brothers, Ltd., to provide a medium of exchange between freight producers and transport owners, so that the load factor of their vehicles may be kept to as high a figure as possible. We feel, therefore, that in coming into the journalistic field with this object in view the "Transport World" will meet a great need, especially as its leading aim will be to solve the problem of the return load by making it possible for transport owners and users to employ every running mile by means of a weekly register of freight offers and wanted.

On the 4th inst. the Admiralty carried out a successful demonstration of the use of a leader cable for directing ships into harbour There were two parties: one embarked with Captain Preston in H.M.S. "Truant," Commander G. A. Gandy, and the other with Commander Murray in a drifter. After leaving Portsmouth harbour both vessels picked up the cable which they followed along Spithead to its end, and then turned and listened their way back. Throughout the signals transmitted along the cable were very clearly received by the ships. The leader cable system enables ships, by means of submarine sound signals, to make a good landfall in foggy weather, to lead ships into harbour, to lead a ship from open water through a restricted channel to open water, to give warning of outlying dangers, and to assist a vessel to keep a straight course from port to port The system was invented by the British Navy, which made a very successful use of it in war time, but owing to the great potential value of the system to the Mercantile Marine during the war the Admiralty have not hitherto disclosed the full methods of working it. The present tests were designed as a practical demonstration to all the Powers of the utility of such cables. A leader cable has already been laid in the Ambrose Channel, New York Harbour.

The cable at Portsmouth, after an experimental existence of over a year, is now a permanent addition to the navigating facilities of the port, and all large war vessels are being fitted with the receiving apparatus necessary to enable them to use it. The apparatus consists of two coils of wire (one on the port and one on the starboard side of the ship). Connected to telephones installed on the bridge, and by means of an electric generator at its shore end, the cable is charged with an alternating current. A signal key inserted in the cable at the transmitting station enables the current to be so broken that any pre-arranged signal or Morse code letter can be sent along it. An amplifier is used to strengthen the sound of the signals received by the ship. When approaching harbour in foggy weather a ship shapes her course so as to cross the end of the cable. By listening in with the bridge telephones the navigating officer is able to tell when the cable has been picked up. The Portsmouth cable gives out a clear musical note which is easily audible for about 300 yards on either side of the cable.

IMPORTS.—The following are official values of electrical machinery, apparatus and material imported into this country (*a*) during November, 1920, and (*b*) the aggregate figures from January 1 to November 30, with increase or decrease compared with corresponding periods of 1919:—

Electrical machinery (*a*), £142,655 (increase £102,040), (*b*), £1,188,378 (increase £515,920); telegraph and telephone cables, submarine (*a*), nil; (*b*), £50 (increase £12); other than submarine (*a*), £9,537 (increase £8,759), (*b*) £20,529 (increase £8,767); telegraph and telephone apparatus, (*a*) £34,234 (increase £22,438), (*b*) £191,894 (decrease £46,996); other electrical wires and cables, rubber insulated, (*a*) £3,731 (increase £1,133), (*b*) £28,917 (increase £21,443); with other insulations, (*a*) £19,815 (increase £19,122), (*b*) £123,323 (increase £107,659); carbons, (*a*) £15,045 (increase £14,611), (*b*) £135,401 (increase £108,469); glow lamps, (*a*) £12,692 (increase £12,692), (*b*) £63,244 (decrease £150,429); arc lamps and electric searchlights, (*a*) £3,753 (increase £3,753), (*b*) £7,767 (increase £7,767); parts of arc lamps and searchlights (other than carbons), (*a*) £1,569 (increase £304), (*b*) £12,956 (decrease £54,447); batteries, (*a*) £22,518 (increase £21,037), (*b*) £116,763 (increase £75,583); meters and measuring instruments, (*a*) £12,704 (increase £9,143), (*b*) £82,471 (increase £45,955); switchboards, (*a*) £1,191 (increase £1,099), (*b*) £2,752 (increase £1,486); electrical goods and apparatus unenumerated, (*a*) £106,519 (increase £79,458), (*b*) £758,206 (increase £355,447). Total of electrical machinery, apparatus and material other than uninsulated wire, (*a*) £385,963 (increase £295,589), (*b*) £2,732, 352 (increase £996,555).

EXPORTS.—The exports of electrical machinery, apparatus and material (*a*) during November, 1920, and (*b*) from January 1 to Nov. 30 with increase or decrease compared with corresponding periods of 1919, were as follows:

Electrical machinery, (*a*) £469,842 (increase £247,769), (*b*) £2,348,367 (increase £1,638,761); including railway and tramway motors, (*a*) £2,419 (decrease £9,233), (*b*) £34,342 (decrease (£50,982); other generators and motors, (*a*) £216,198 (increase £106,939), (*b*) £1,333,758 (increase £400,078); and electrical machinery unenumerated, (*a*) £251,225 (increase £150,063), (*b*) £980,267 (increase £289,665); telegraph and telephone cables, submarines, (*a*) £81,609 (increase £31,210), (*b*) £1,450,645 (increase £906,263); other than submarine, (*a*) £130,596 (increase £47,565), (*b*) £915,517 (increase £452,087); telegraph and telephone apparatus, (*a*) £108,369 (increase £54,427), (*b*) £1,075,010 (increase £703,307); other electrical wires and cables, rubber insulated, (*a*) £200,220 (increase £105,019), (*b*) £1,586,844 (increase £856,273); with other insulation, (*a*) £197,967 (increase £52,187), (*b*) £1,897,116 (increase £956,481); carbons (*a*) £13,399 (increase £10,634, (*b*) £120,469 (increase £108,271); glow lamps, (*a*) £59,083 (increase £46,338), (*b*) £292,921 (increase £153,121); arc lamps and searchlights (*a*) £1,544 (increase £1,093), (*b*) £17,371 (increase £9,892); parts of arc lamps and searchlights (other than carbons), (*a*) £2,257 (increase £1,213), (*b*) £13,944 (increase £4,050); batteries, (*a*) £80,557 (increase £27,347), (*b*) £551,652 (increase £144,347); meters and measuring instruments, (*a*) £41,059 (increase £22,403), (*b*) £366,533 (increase £148,950); switchboards, (*a*) £20,497 (increase £17,590), (*b*) £103,172 (increase £59,620); electrical goods and apparatus unenumerated, (*a*) £280,941 (increase £117,110) (*b*) £1,872,910 (increase £685,196). Total of electrical machinery apparatus and material other than uninsulated wire, (*a*) £1,687,940 (increase £781,905), (*b*) £12,612,471 (increase £5,826,619).

Companies' Reports, &c.

The directors of the ANGLO AMERICAN TELEGRAPH COMPANY, LTD., have declared a balance dividend of 1½ per cent. for the year 1920 on the ordinary consolidated stock, and of 1½ per cent. on the preferred stock, making 3¾ per cent. on the ordinary and 6 per cent. (less tax) on the preferred for the year. A first and final dividend of 1½ per cent. (less tax) is also declared on the deferred stock.

The net profit of S. SMITH & SONS (MOTOR ACCESSORIES), LTD., for year ended July 31, 1919, after providing for excess profits duty and income tax, was £59,444, plus £8,344 brought forward, making £67,789. Dividends absorbed £39 375, directors' fees £1,500, carried forward £26,914. The net profit for year to July 31, 1920, providing after for all charges, estimated liabilities for corporation tax, income tax and adjustment in connection with excess profits duty, is £98,337, plus balance brought forward (£26,914), making £125,251. Interim dividend on ordinary shares absorbed £[illegible], directors' fees £1,750, leaving £91,451. Works are now fully organised to manufacture various products under most favourable circumstances. Branches and connections throughout the world have all been extended. No further dividend on the ordinary shares is recommended.

Patent Record.

SPECIFICATIONS PUBLISHED.

[illegible] specially [illegible] Patent [illegible], 70 and 72, Chancery-lane, London, W.C.

Whenever the date applied for differs from the date on which the application was lodged at the Patent Office the former is given in brackets after the title.

[illegible]

[illegible] devices. (16/11/16.)

[illegible]

[illegible] M[illegible] & [illegible] ([illegible]/19.)

1919 SPECIFICATIONS.

131,285 POUCHAIN. Electric switches. (14/8/18.)
132,255 BJERREGAARD. Automatic time switches or interrupters for use in electrical circuits. (13/7/17.)
133,025 AMERICAN BOSCH MAGNETO CORPORATION. Magneto-electric machines. (27/9/18.)
[illegible]
153,340 CROSS. (Hulfish.) Automatic-telephone line-finder systems. (8/5/19.)
153,357 WESTERN ELECTRICAL CO. (Western Electric Co.) Electric signalling systems. (24/7/19.)
153,368 HAZELTON. Electrical heating elements. (30/7/19.)
153,370 HEURTEBISE. Electric motors. (31/7/19.)
153,376 ROWE. Electric lamp holders for the lamps of motor and other vehicles. (13/7/19.)
153,378 BRITISH THOMSON-HOUSTON CO. (General Electric Co.) Electric heaters. (1/8/19.)
153,405 AUTOMATIC TELEPHONE MANUFACTURING CO. & FLYNN. Alternating current relay. (21/8/19. Addition to 121,385.)
153,407 WESTERN ELECTRIC CO. & DEAKIN. Senderless automatic telephone satellite systems. ([illegible])
153,409 HALL & THORKELIN. Arc-lamps for photographic and other purposes. (27/8/19.)
153,411 VILLIERS ENGINEERING CO. & POUNTNEY. Flywheel magneto devices for internal-combustion engines. (28/8/19.)
153,412 BRITISH THOMSON-HOUSTON CO. (General Electric Co.) Regulating systems for electric circuits. (29/8/19.)
153,421 CALVERT. Electric incandescent lamps. (13/9/19.)
153,431 CROMPTON & CO. & JONES. Device for securing electric cables. (19/9/19.)
153,467 GARRETT & SONS & GARRETT. Safety-controlling gear for electrically propelled vehicles. (19/11/19. Addition to 103,617.)
153,471 HUBENER. Adjustable connection for electric-light fittings. (2/12/19.)
153,628 BRITISH THOMSON-HOUSTON CO. (General Electric Co.) Electric motor control systems. (8/7/19.)
153,643 TUCKER & TUCKER & CO. Electric switches. (6/8/19.)
153,651 COMPARE. Electric switches. (6/8/19.)
153,661 BRITISH THOMSON-HOUSTON CO. (General Electric Co.) Electric-heating units. (9/8/19.)
153,672 WESTERN ELECTRIC CO. (Western Electric Co.) Electric signalling systems specially applicable to multiple carrier current systems. (12/8/19.)
153,681 TAGGART. Wireless receiving systems. (14/8/19.)
153,687 COULSON & OPTAYLTE, LTD. Electrical batteries. (16/8/19.)
153,689 BRITISH THOMSON-HOUSTON CO. & GIVEN. Controlling apparatus for electrically-operated hoisting mechanism and the like. (18/8/19.)
153,690 ROBINSON, MACROBIE, GRENFELL & AIKEY. Wireless reception apparatus. (18/8/19.)
153,700 BRITISH THOMPSON-HOUSTON CO. (Compagnie Francaise Thomson-Houston.) Electric hoisting or winding apparatus. (22/8/19.)
153,701 SMALLEY. Heating elements for electric furnaces. (22/8/19.)
153,721 BOWMAN & ASPDEN. Electrical equipment of mechanically-driven motor vehicles and aircraft. (6/9/19. Cognate Application 26,057/19.)
153,723 WEST & CO. & BREEZE. Control devices for electrically-driven lifts, cranes, winches, and like apparatus for dealing with variable loads. (8/9/19.)
153,765 MCLOUGHLIN. Electrical contact makers for magnetos. (1/11/19.)
153,775 BLAKE & MCNAUGHT. Carriers for electric storage batteries. (11/11/19.)
153,787 CALVETE. Electric switches. (1/12/19.)

APPLICATIONS FOR PATENTS.

July 7, 1920.

19,907 GES. FUR DRAHTLOSE TELEGRAPHIE. Wireless telegraph receivers. (10/9/15, Germany.)
20,090 GES. FUR DRAHTLOSE TELEGRAPHIE. Transmitters of high-frequency oscillations (6/11/18, Germany.)
20,091 GES. FUR DRAHTLOSE TELEGRAPHIE. Multiple telephone wires. (27/5/19, Germany.)
20,092 GES. FUR DRAHTLOSE TELEGRAPHIE. Reception of continuous electric oscillations. ([illegible], Germany.)
20,093 GES. FUR DRAHTLOSE TELEGRAPHIE. Electric current amplifiers. (16/11/15, Germany.)

July 9, 1920.

19,837 B[illegible] & H[illegible] [illegible]
19,842 ROBINSON. Incandescent lamps.
19,844 SOC. FRANCAISE RADIO-ELECTRIQUE. Electro-magnetic wave-receiving systems, self-induction coils, &c. (1/6/15, France.)
19,849 SIEMENS-SCHUCKERTWERKE. Arc lamps. (5/4/17, Germany.)
19,851 B.T.-H. Co. Means for controlling electric currents, &c. (5/2/14, U.S.)
19,852 B.T.-H. Co. Dynamo-electric machines. (16/1/17, U.S.)
19,853 B.T.-H. Co. Electric motors. (14/2/18, U.S.)
19,855 B.T.-H. Co. Electric regulating systems. (10/7/18, U.S.)
19,856 B.T.-H. Co. Wireless receiving systems. (15/6/18, U.S.)
19,857 B.T.-H. CO. Electric starting systems for internal-combustion engines. (16/1/17, U.S.)
19,858 B.T.-H. Co. High-frequency alternators. (23/9/16, U.S.)
19,859 B.T.-H. Co. Means for transforming direct current. (29/12/13, U.S.)
19,860 B.T.-H. Co. Enclosed electric arc devices. (30/10/15, U.S.)
19,861 B.T.-H. Co. Wireless receiving systems. (11/10/17, U.S.)
19,862 B.T.-H. Co. Enclosed electric arc devices. (30/10/15, U.S.)
19,863 B.T.-H. Co. Dynamo-electric machines. (13/10/15, U.S.)
19,864 B.T.-H. Co. Electron discharge devices. (31/10/17, U.S.)
19,865 B.T.-H. Co. Electrically-driven vehicles. (24/7/14, U.S.)
19,866 B.T.-H. Co. Electric motors. (13/2/18, U.S.)
19,867 B.T.-H. Co. Electron discharge apparatus. (16/10/13, U.S.)
19,868 B.T.-H. Co. Wireless signalling systems. (29/12/13, U.S.)
19,885 SOC. FRANCAISE RADIO-ELECTRIQUE. Wireless telephony. (24/2/17, France.)
19,908 KASSEL. Elec. discharge tubes. (23/12/16, Germany.)
19,931 SIEMENS-SCHUCKERTWERKE. Electricity meters. (15/3/18, Germany.)
19,934 SIEMENS-SCHUCKERTWERKE. Dynamo electric machines. (15/6/18, Germany.)
19,936 SIEMENS-SCHUCKERTWERKE. Voltametric electricity meters. (11/3/19, Germany.)
19,937 SIEMENS-SCHUCKERTWERKE. Manufacture of stranded conductors for electrical machines. (29/12/17, Germany.)
19,942 FERY. Primary batteries. (1/12/14, France.)
[illegible] (4/5/18, Germany.)
19,999 SIGNAL GES. Polarised electro-magnetic sound apparatus. (30/5/18, Germany.)
20,004 AUTO-COMBINATOR, SOC. ANON. Electric switching apparatus.
20,029 B.T.-H. Co. Signalling systems. (14/10/19, U.S.)
20,030 B.T.-H. Co. Electron amplifiers. (3/1/19, U.S.)

New Companies.

ATLANTA LTD. has been [illegible] with a nominal capital of £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in automobiles, motors and other cycles, and electrical appliances, engineers, [illegible], &c. First directors are: Hon. Lady Katherine Parsons, Hon. Lady [illegible] Hollis, Mrs. Caroline H. Haslett, Miss Annette Ashbury, Mrs. [illegible] W. Turner, H. [illegible], M.B.E., and W. P. [illegible]. Secretary: Mrs. Dora W. Turner. Reg. office: Atlanta Works, [illegible], Loughborough.

BAKER LTD. ([illegible]). Private company. Reg. Dec. 30. Capital £[illegible] in £1 shares. To carry on the business of mechanical and electrical engineers, manufacturers of machinery, &c. First directors are: H. [illegible] and H. W. Humphries. Reg. office: [illegible] Southwark street, S.E.1.

DAWSON ELECTRICAL INSTALLATIONS LTD. ([illegible]). Private company. Reg. Dec. 31. Capital £[illegible] in £1 shares. To take over the business of an electrical engineer and contractor carried on by Joseph Dawson at Oldham. Permanent directors are: J. Dawson and J. [illegible]. Reg. office: [illegible] Henshaw street, Oldham.

GEORGE NORRIS LTD. ([illegible]). Private company. Reg. Dec. 30. Capital £[illegible] in £1 shares ([illegible] per cent. cumulative preference). To carry on the business of manufacturers of and dealers in electrical appliances, &c. [illegible] is permanent governing director. Reg. office: [illegible] street, W.1.

HADLAM AND [illegible] ENGINEERING AND MOTOR UTILITIES LTD. ([illegible]). Private company. Reg. Jan. 6. Capital £[illegible] in £1 shares. To take over the mechanical, electrical and motor utility supply business of Hadlam and [illegible] Ltd. First directors are: [illegible] Hadlam, [illegible], W. [illegible] and C. H. [illegible]. Reg. office: [illegible] place, Bristol.

JOHN PATERSON & COMPANY LTD. ([illegible]). Private company. Reg. in Edinburgh Dec. [illegible]. Capital £10,000 in £1 shares, to carry on the business of [illegible] metal workers, electricians, mechanical engineers, &c. Directors: Mrs. M. Wood, J. P. Wood and J. Mann. Reg. office: [illegible] street, Glasgow.

OPTERLAMP LTD. ([illegible]). Private company. Reg. Dec. [illegible]. Capital £1,000 in £1 shares. To carry on the business of dealers in, exporters and importers and manufacturers of electrical [illegible] and [illegible] goods and accessories, &c. Secretary: [illegible]. Reg. office: [illegible], E.C.

WELDING SPECIALISTS COMPANY LTD. ([illegible]). Private company. Reg. in Edinburgh Dec. [illegible]. Capital £[illegible] in £1 shares. To acquire the welding business [illegible] by [illegible] and H. [illegible] and known as the "Welding Specialists Company." Secretary: D. M. [illegible]. Reg. office: [illegible], Edinburgh.

Prices of Metals, Chemicals, &c.

		Tuesday, Jan. 11		
		Price.	Inc.	Dec.
Copper—				
Electrolytic	per ton	£[illegible] 0 0	—	—
[illegible] Wire Bars		£[illegible] 10 0	—	
H.C. wire, basis	per lb.	1s. [illegible]	—	
Sheets		1s. [illegible]		
[illegible]				
[illegible]				
[illegible]		1s. [illegible]		
[illegible]				
[illegible]		[illegible]	—	—
[illegible]		[illegible]	[illegible]	—
[illegible]		[illegible]	[illegible]	—
Pig Iron—				
[illegible]	per ton	£[illegible]		[illegible]
[illegible]				
[illegible]		£[illegible] 0 0		—
Lead Pig—				
English		£[illegible] 0 0		[illegible]
[illegible]		£[illegible] 0 0		[illegible]
Tin—				
[illegible]		£[illegible] 10 0	£[illegible] 10 0	
Wire, basis	per lb.	[illegible]	[illegible]	

[illegible]

[illegible]

The Editorial, Advertisement and Publishing Offices of "The Electrician" are at [illegible] Bouverie Street, London, E.C. 4. Telegraphic Address: "[illegible]," London. Telephone: [illegible].

The subscription to "The Electrician" is £[illegible] per annum, [illegible].

Forty Years Ago.

(THE ELECTRICIAN, JANUARY 15, 1881.)

MIDDLESBROUGH. — Complaints having been made as to the inadequacy of the Middlesbrough telegraph service, the Secretary of the Chamber of Commerce has been directed to inquire into the matter, and to ascertain on what terms the telephone will be placed between private residences and offices.

THE NEW ATLANTIC CABLES. — The following paragraph in some shape or other has been going the round of the papers during the past fortnight. A Woolwich paper gives it thus: "The chief topic of conversation in Woolwich this week has been the news that Messrs. Siemens Brothers have secured an order for the construction of a double line of cable between America and Europe. The length of cable to be manufactured is 9,000 miles, the largest order probably ever given in the history of ocean telegraphy. It is stated that the firm will find employment for 2,000 hands for 18 months." We have reason to believe that Mr. Jay Gould is now in London, and that the order for the two new cables has actually been given.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics": "Aeroplane v. Warship", "U.S.A. Air Mail Activities in 1920", and "Aeroplane Design," by Capt. F. S. Barnwell, B.Sc., O.B.E., A.F.C., F.R.Ae.S.

"Cabinet Maker": "Foreign Trade in Furniture in 1920", "The Treatment of the Billiard Room", and "How Winter Furniture Sales Were Advertised."

"Chemical Age": "Coal Handling in Chemical Works", and "Chemical Imports and Exports."

"Farm and Home": "Symptoms of Foot and Mouth Disease", "Points in the Agriculture Act", and "The Weather of 1920."

"The Fruit Grower": "The Control of Apple [illegible]", "Fruit Acreage in 1920", and "Hull Wholesale Market."

"Gardening Illustrated": "Fine Coloured Hardy Plants", "Carnation [illegible] (illustrated)", and "Mulching Roses with Living Plants."

"The Gas World": "Appointments and procedure under the Gas Regulation Act", "The Ratepayer and the Cost of Private Bills."

"Hardware Trade Journal": "Formulæ for Sheet Iron and Steel", "A Winter Window Display Problem", and "Mechanical Handling."

"Transport World": "National Petrol Economy", "Roads or [illegible]", and "The Vehicle Tax."

Arrangements for the Week.

FRIDAY, January 14th (to-day).

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. At the Literary and Philosophical Society, Westgate road, Newcastle-on-Tyne. Paper on "Advantages of Water-tube Boilers in Merchant Ships," by Sir James Kemnal.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At Caxton Hall, London, S.W. Chairman's Address on "[illegible]," by Mr. R. F. Dunbar [illegible], M.A.

MONDAY, January 17th.

INSTITUTION OF ELECTRICAL ENGINEERS. INFORMAL MEETING.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn Buildings, High Holborn, London, W.C. Discussion on "The Mental Equipment of an Engineer," opened by Mr. [illegible].

INSTITUTION OF ELECTRICAL ENGINEERS. LIVERPOOL SUB-CENTRE.

7 p.m. At the University, Liverpool. Papers on "Electric Arc Welding Applied to Shipbuilding," by Mr. [illegible] Hayes; "The [illegible] and Metallurgical Aspects of Electric Arc Welding," by Dr. [illegible]; and "Uses of Electric Resistance Welding," by Mr. [illegible].

TUESDAY, January 18th.

ILLUMINATING ENGINEERING SOCIETY.

8 p.m. At the Royal Society of Arts, John street, Adelphi, London, W.C. Discussion on "Use and Abuse of Light in [illegible]," opened by Mr. [illegible].

INSTITUTION OF ELECTRICAL ENGINEERS.

NORTH WESTERN STUDENTS' CENTRE.

7.15 p.m. At [illegible] Hall, [illegible], Manchester. Paper on "[illegible] of Insulating Materials," by Mr. [illegible].

WEDNESDAY, January 19th.

ROYAL SOCIETY OF ARTS.

8 p.m. At John street, Adelphi, London, W.C. "The [illegible]," by Mr. [illegible].

THURSDAY, January 20th.

ROYAL INSTITUTION.

3 p.m. At Albemarle street, London, W. Lecture on "[illegible]," by [illegible].

FRIDAY, January 21st.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "The Mechanical [illegible] Ships," by Mr. [illegible].

INSTITUTION OF [illegible] ENGINEERS. [illegible].

[illegible] At [illegible], Southampton row, London, W.C. "[illegible] Electric Welding," by Mr. [illegible].

THE ELECTRICIAN

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Notes.

The Kelvin Lecture.

The average electrical engineer is so pestered nowadays with financial, economic and human questions that he finds the amount of attention he can devote to purely engineering problems becoming more and more limited, while a portion of the attention which he can devote to the more theoretical parts of electrical knowledge is shrunk to almost electronic dimensions, if it has not disappeared altogether. A dissertation like the Kelvin lecture given by Sir William Bragg before the Institution of Electrical Engineers last week is therefore doubly useful in that it not only, like a buoy, marks the channel in the stream of progress, but it crystallises in one document a vast amount of information in a form palatable to the ordinary engineer. The subject of electrons and of electronic theory is becoming so important that we hope every engineer will seize this great opportunity to pay Sir William Bragg's able scientific and literary effort the compliment of close study, Following our usual custom we shall not publish our account of this lecture until the proofs have been revised by their author. We make no excuse for taking this course. Almost any Kelvin lecture, and certainly this one, is a pronouncement which is of no ephemeral interest, but is likely to be referred to with benefit and even with increasing frequency as years go on. Accuracy in presentation and publication are therefore not without their importance.

The Place of the Electric Locomotive.

The conditions imposed on the publications of scientific and technical societies unfortunately render some of the articles which appear in their Journals out of date before they appear. To some extent this applies to the Paper from the "Journal" of the Institution of Electrical Engineers by Lieut.-Col. H. E. O'Brien on "The Application of the Electric Locomotive to Main Line Traction," of which we give an abstract on another page of this issue. Nevertheless, a good deal of what he has to say is still of considerable value. It is now obvious, for instance, that the question of railway electrification, whether it is to be undertaken wholesale or in detail, must be looked at largely from the economical point of view, and the point which Col. O'Brien makes, that with the same loading gauge an electric locomotive can develop a horse power 50 per cent. in excess of that obtainable from a steam locomotive at an extra cost not exceeding 50 per cent. of that of the same steam locomotive without strengthening the bridges and other works, is therefore very important. There are, moreover, certain other properties about the electric locomotive which give it decided advantages over steam traction and these are not by any means cancelled out by its disadvantages which are very fairly stated in Col. O'Brien's Paper. Some of these disadvantages, however, such as the difficulty of heating the carriages, need not surely be unduly stressed, while even failure of current will certainly soon be rather a theoretical than a practical difficulty. Problems incidental to electrical operation which arise from the presence of a trolley wire or third-rail, from the arrangement of time tables, and from the higher first cost of the electric locomotive, though more important, are questions which we feel sure will not be long before they receive satisfactory solution. There seems to be a tendency among both electrical and railway engineers to consider electrification, whether it is to be applied to one particular system or to the railways of the country in general as a whole, and to take up the attitude that, as it will certainly not pay to electrify certain sections of the railways, there is every reason for delay in electrifying any section. This is quite wrong, and we feel that the great thing, especially now, is to make a start. If that is done, many obstacles, which at present seem almost insurmountable, will be overcome almost automatically in the ordinary course of progress.

The West of England Inquiry.

The adjournment of the public inquiry into the West of England Joint Electricity scheme, for six months, in order to enable the parties interested to study the technical details for the reorganisation of electricity supply in that district, may turn out to be a blessing in disguise; for, in the interval, the proposals will, we hope, be so modified as to allow general agreement on the main principles to be secured. In fairness, however, it must be repeated the scheme was drawn up to meet a condition of affairs for which there was no precedent, and Mr. Faraday Proctor therefore deserves the thanks of the electrical engineering industry for the courageous way in which he tackled a complicated subject. It may also be noted as a warning that, judging by the requirements of the Electricity

Commissioners, as set out in their memorandum of July last, not one of the five schemes for the creation of Joint Electricity Authorities which we have seen, will be found satisfactory from the point of view of procedure. We hope, also, that when the inquiry is resumed on March 1, Mr. FARADAY PROCTOR will rid himself of the burden of presenting the legal and administrative proposals to the Commissioners, and confine himself to the engineering and technical details of the scheme. He cannot do full justice to both, and it is awkward, if not impossible, to be advocate and witness in one.

Representation on Joint Authority.

IT is perhaps hardly to be wondered at that the proposals for the reorganisation of electricity supply in the West of England area have not aroused so much interest among the urban and rural councils concerned as the subject of representation on the Joint Electricity Authority, and the liability for a deficiency rate thereby imposed upon them. If these Councils as well as the County Council are represented on the Authority there will probably be dual representation for the same area, and what is more important, liability for a deficiency rate twice over. In our view the point is mainly of theoretical interest, for we can see little danger of a deficiency if the scheme is carefully prepared, and if it is carefully and judiciously carried out in stages as the demand for electrical energy arises. The point as to representation is, however, more important. Urban and rural district councils are in many cases the lighting authorities, and are the local authorities within the meaning of the Electric Lighting Acts for carrying out electric lighting undertakings. In cases where the undertaking has been commenced by a company, they are also the purchasing authority, and, as such, they should be represented on the Electricity Authority.

A Scheme for the Aire and Calder District.

EACH week now brings the publication of one or more draft schemes which are to put the electricity supply of the country on a proper footing. The latest of these, of which we give a detailed account on another page of this issue, has been prepared by the Leeds Corporation for the West Riding (Aire and Calder) district. This is certainly one of the most important districts in the United Kingdom, so far as electricity supply is concerned, and the details suggested for developing it electrically will, therefore, be studied with interest. A rather smaller representation than usual with a vote basis of 60,000 units is suggested, and an important point is the proposal to purchase the undertaking of the Yorkshire Electric Power Company. This is likely to lead to a good deal of discussion, as the whole of that undertaking's system is not in the area scheduled, and even should the company be willing to submit to dissolution the necessary carving operation would have to be performed by the Commissioners.

Interesting Technical Details.

THE scheme is also interesting from the fact that fuller technical details are given than usual, and it is evident the question both of future development and existing requirements has been carefully considered. For the present it is proposed to link up the larger stations in the area, and to connect the smaller stations with certain of these stations, so that indirectly, at least, they would also help to supply the general needs of the area. Systems and pressures are to be standardised, and capital stations, of which, by the way, no definition is given, are to be erected at Leeds, Wakefield and Knottingley, giving an ultimate generating capacity of 580,000 kw. The first of these stations to be erected will be the one at Leeds, and, as soon as that is in action, certain of the smaller stations will be closed down entirely while the output from certain others will be reduced, especially in the summer time. As might be expected, the most controversial portion of the scheme is that which deals with finance. As is well known Sir ROBERT FOX, the town clerk of Leeds, holds very strong opinions as to the advisability of further mortgaging the ratepayers' wealth; and it is, therefore, probably for this reason that it is suggested that the Ministry of Transport or the Electricity Commissioners should find the necessary capital for the work mentioned above, the Electricity Authority repaying the amount expended from the revenue derived from the working of the stations. As, however, neither the Ministry of Transport nor the Electricity Commissioners have any money at present for such a purpose, it is difficult to see how this transfer of responsibility can be adopted. And in any event there should be no great difficulty in financing electricity supply in the Aire and Calder area, where the demands for industrial power are rapidly increasing with the result that the authority would certainly be self-supporting at the end of a very short time. Interesting as all these schemes are, as showing how the same end can be reached in different ways, we should prefer to see more whole-hearted attempts to produce one agreed result for each district rather than to take up the time of the Commissioners or, what is the same thing, to delay matters by making alternative suggestions, a policy which we fear will only lead to the introduction of local politics into concerns from which it is better that they should be excluded.

Mersey and West Lancashire District.

WHILE in the West of England area only one scheme has been submitted, this happy state of affairs will not be present in the case of the second enquiry, which will be held at Liverpool on January 25th on the Mersey and West Lancashire district. In a recent issue we gave the principal features of one scheme for the formation of a Joint Electricity Authority for the whole of the area, but a rival scheme has now presented for that portion of the area known as the Wirral peninsula. The second scheme is the child of the Wallasey Corporation, which together with Birkenhead and other authorities object to Cheshire being supplied with Lancashire electricity. According to their proposals the joint authority for the Wirral would consist of 18 members, compared with 30 for the other authority, and of these three would be appointed by the Birkenhead Council, three by Wallasey Council; one each by the District Councils of Hoylake and West Kirby, Bromborough, Higher and Lower Bebington, Neston and Parkgate, and Wirral; one each by Caldy Manor Estate, the Mersey Docks and Harbour Board, Cammell, Laird & Company, Lever Brothers, and the railway companies affected; and finally two members by other large consumers in the district.

Engineering Suggestions.

TECHNICALLY the first stage in the reorganisation would be to interlink the generating stations at Birkenhead, Wallasey and Hoylake, and then to carry out extensions as necessity arises for supply in other parts of the district, subsequently linking up with the generating stations at Port Sunlight, at Messrs. Cammell, Laird & Company's yard, and at the Mersey Railway Station at Birkenhead. The Wallasey Station is already being extended, but it is proposed to enlarge it still further by the provision of three 10,000 kw. sets with the necessary boilers, condensing plant, and switchgear. The scheme would, it is claimed, provide for all possible railway and tramway requirements, and also effect a considerable saving. It is pointed out that if the 6,300,000 units sold by the Birkenhead Corporation last year were generated at the proposed

Wallasey Station there would be a saving of £11,450 per annum in generating costs, representing, after allowing for repayment over 10 years of the cost of cables, a net saving of £8,450. If the 600,000 units sold by Hoylake and West Kirby Council were likewise generated at Wallasey there would be a saving of £2,500 per annum in generating costs, or, after allowing for the cost of cables, a net saving of £1,300, or a total of £9,750 per annum. The draft scheme also provides for the issue of stock, bonds and bills, &c. To us the scheme looks like parochialism in a thin disguise, and we prefer the original proposals covering the whole area.

Ilford in the Middle Ages.

ON Thursday night in last week Ilford was suddenly transported into the Middle Ages, or at any rate into the early Victorian era, by a strike of the members of the E.P.E.A. employed at the electricity works. The supply for lighting and power was entirely cut off and the tramway service was also suspended. The failure of the latter has caused the most inconvenience, as a number of shopkeepers still use gas, while the preliminary threats drew many recruits into the ranks of those wise virgins who had taken the precaution to provide themselves with oil lamps and candles. Naturally places of amusement suffered considerably, though what they lacked in business they seemed to have made up in the enterprise with which they managed to carry on after some fashion or another. The point at issue between the disputants is simple. After considerable pressure the Ilford authorities agreed to put into operation the National Joint Board's award about which there was nearly a national strike a few weeks ago, but they proposed to review the question at the end of six months. The E.P.E.A. objected and, the municipal authorities showing no signs of retiring from their position, a strike was the natural outcome.

An Awkward Position.

While the E.P.E.A will doubtless be blamed for their impulsive action and will be told that to strike for what is almost a quibble is doing themselves more harm than good, it is difficult to see how they could have done anything else. As we pointed out a week or so ago they had already marched or been manœuvred into a position from which they could not retreat. The fact that most of the electricity undertakings have agreed to the demands which Ilford will only provisionally concede makes their position more difficult. As to the harm to the fortunes of the Association we fear the worst. For we have no doubt that what will happen at Ilford is that the ten engineers or so concerned will lose their positions, and this is the more likely to be the case owing to the strike of the members of the Municipal Employees' Association, which, though it is said not to be sympathetic, is yet so reminiscent of combined action as almost to amount to a coincidence. The best that can be remarked about the whole affair is that the public seem to have taken the awkward position into which they have been forced with the utmost good humour; there has been an entire absence of disturbance and also of anything in the way of reprisals. We sincerely hope there will be a speedy settlement. We hear there is every likelihood of one being reached, but we fear the E.P.E.A. will only emerge from the battle with loss of prestige

Trouble at Newport.

ANOTHER town where the electricity supply authority did not see their way to admit the claims of the E.P.E.A. in their entirety is Newport (Mon.). Here, however, a more politic action, or lack of action, has been adopted by the technical staff who up to now have shown a restraint which cannot be too highly commended. The Town Council object generally to the system of grading the employees of the electricity supply undertaking laid down by the National Joint Council and particularly to the sick pay question, which incidentally has been a point at issue with other authorities. Naturally the E.P.E.A. members take their stand firmly on the National Joint Council's award and there matters rest for the present. We can only hope that there will be a successful issue out of the dispute, but it is also obvious that a real settlement can only be obtained by one side giving way, and as the E.P.E.A. are in a position where no compromise is possible, the outlook is none too rosy, which is a great pity for all concerned. Newport might, however, learn a useful lesson from Ilford

The Telephone Crisis.

WHEN "The Times" has a leading article on four consecutive days upon the same subject it is a natural supposition that either the Empire is in sore straits, the Government is tottering to its fall, or that some cataclysm is about to involve the world in premature disaster. If this view be of general application the question of the new telephone rates is much more important than we had thought it, for our contemporary last week held forth on "The Telephone Blunder," "The Telephone Dictatorship," "Future of the Telephone," and "Telephone Inefficiency," a series of excellent titles wanting neither in pungency or directness, which the contents of the articles did not belie. A dispassionate examination of these outpourings, however, brings with it a sense of disappointment. The first criticism is that the new rates will reduce revenue, and to prevent this a committee of business men is to be appointed with a view to bringing to bear upon the question a greater broadness of view. Such a committee would obviously recommend the continuance of the present system which gives an advantage to the large at the expense of the small telephone user. As we pointed out last week, the unlimited system is economically wrong and, whatever we may think of the Post Office methods of doing it, discarding it is in theory at least the right thing to do.

An "Ad Hoc" Authority.

THE second criticism "The Times" makes is that the Post Office when attacked, like the cat, most unreasonably defends itself. To remedy this Parliament is to be called in as referee, which is no remedy at all. Probably the most that it would do is to postpone the dawn of the evil day when the rates would be raised, and it would almost certainly mean that to obtain financial stability the increases would have to be more than is now suggested. The third point is that politics should be kept out of the question. We heartily agree with this. It is very desirable. But a physician should take his own medicine! Fifthly, "The Times" approves the idea that the telephones and the telegraphs should be transferred to an *ad hoc* body like the Metropolitan Water Board or the Dock Board. But neither of these two bodies is noted for the efficiency of operations or for its consideration to those who are unfortunate enough to have dealings with them, a failing which, we understand, is one of the qualities of the Post Office. To establish such a body would, it is true, free the telephones from political pressure. But would that be an improvement, for it is interesting to note that it is just this political pressure that is now being used to obtain the improvements which are considered necessary in the system. The sixth point, with which we are also in agreement, is that there should be more alertness in managing the system. The difficulty is, of course, that the Post Office, like any other Government and municipal bodies, does not work for profit.

Hence all the trouble! The agitation seems so far to have justified itself as to have directed the attentions of the Cabinet to the question; but will this really mean any ultimate improvement? We doubt it.

Electricity Supply in Dundee.

In commenting in our last week's issue on the features of the certain Scottish water-power schemes, we regret that we should have given a wrong impression of the attitude of the Dundee Corporation and of their chief electrical engineer, Major H. Richardson. We are authorised to state that there is no antagonism between the Dundee Corporation and the promoters of the Grampians Company, or, rather, that any opposition there is is of a purely political character, so as to enable the Dundee Corporation to obtain a proper *locus standi* at any investigations that may be made into the details of the scheme. The position at present is, we understand, that the investigation which is already being conducted by the Dundee Corporation is coming to a point when it will be possible to determine what is the best for the future power interests of the city. It may also be said that the Corporation officials and the Company are working together in this matter, an arrangement which can only be for the good of the city and the surrounding district generally, and that Major Richardson has withheld no information from the proposed syndicate which would enable them to give the Corporation a supply of electricity at a reasonable figure, and that negotiations with this end in view have not yet reached finality. We are the more relieved to hear this, as the whole scheme, of which we have already given the details, shows breadth of view and enterprise in dealing with a very difficult problem. The supply of an industrial area like Dundee, with its large power requirements, from a hydro-electric scheme, will certainly lead to beneficial results, whether considered from the engineering or financial points of view.

The Engineers' Club.

The Batti-Wallahs Society is nothing if not up to date. For if any movement friendly or inimical to the electrical industry arise, they always are among the first to get hold of some expert to tell their members all about it. Moreover, they cast their net very wide, and we yet look forward to the day when we shall have the opportunity of hearing such great thinkers as Mr. George Robey or Mr. Tom Webster tell us how the electrical industry can be brightened and improved by the application of the particular panaceas for which they are so famous. For the present, however, the Batti-Wallahs have not reached that stage. Nevertheless, the address given by Mr. Edmund L. Hill on Monday last on the live question of an Engineers' Club for London, is one whose social importance is not likely to be exceeded by anything that can be said by either of the speakers we have just mentioned. The principal point that Mr. Hill made is that such a club can only be formed with the enthusiastic assistance of every branch of the engineering profession, and by the work, persistent and intensive, of those few public-spirited protagonists who serve on the executive committee. We are glad to learn that the club will be run on the broadest possible lines and that a move will be made to obtain temporary premises without delay. This is a wise move as the availability of premises will act as an excellent bait for recruits. The committee are rightly setting out with the high ideal of making the club comfortable, giving a service as perfect as is humanly possible and generally providing an establishment which will be fit at least for engineers, if not for heroes, to belong to.

Radio-Telegraphy and Telephony in 1920-1921.

The commencement of a new year in any branch of science brings with it a desire—laudable enough in its way—to review the progress that has been made during the past twelve months, to summarise in our minds the new lessons that have been learnt and to note the starting points from which endeavours during the coming year are to be pursued. In wireless communication during the last year there have been no outstanding inventions or discoveries. Rather has it been a question of consolidating the remarkable number of inventions produced by the principal nations during the war. Many of these only came to light during the past year, although they date back in some cases to late 1913.

The Development of the Thermionic Valve.

The majority of the inventions have related to the use of thermionic valves, and it has required a long time to decide which circuital arrangements are best for certain purposes and why preference must be given to certain arrangements rather than to others. There has been little time until this year to study in detail the mathematical theory and design of apparatus involving the use of valves. During the past twelve months we have, however, been able to prepare a very good groundwork, and it is to be hoped that the time and energy expended will be justified. It is a matter of gratification that the analysis thus far carried out on this question has in no small measure been due to British scientists.

The Development of High-powered Stations.

Developments in all directions have taken place. Perhaps one of the principal lines has been in high-powered stations The aerials used on the American high-power stations of recent construction are a new departure in design and construction. The Alexanderson alternator, though complex and expensive, has continued to be successful, and America, with its elaborate systems of multiple aerials and multiplex transmission, bids fair to lead the world in long-distance radio-communication. The work that has been carried out in connection with the transmission of a number of messages simultaneously from the same aerial is of the very highest importance.

Coming to commercial ship installations, we find a number of improvements, due largely to competition in the business of fitting the mercantile marine. The cabinet type of instrument is beginning to be favoured. One type of installation designed during the year marks a new departure in ship installations in this country. In this apparatus automatic starting and stopping is effected by a remote control push button placed close to the operator's key. The note frequency is high and the tuning sharp. The emergency transmitter also gives a high note and is much more powerful than has previously been the case. The receiver employs a valve detector and is arranged to receive continuous waves of all lengths. Another development in this field is a receiver employing a double-grid valve, which is being fitted to stations of the older type. Continuous-wave and wireless-telephony cabinets have also been supplied to ships and have given good results. Another interesting departure is the fitting of ships with 5 kw. and 10 kw. arcs, which speaks well for the suitability of this type of installation for marine work. Radio-navigational apparatus has been somewhat improved and *sense* as well as direction is now obtainable.

As far as static eliminators are concerned, the Weagant system appears to be giving good results on the transatlantic service, where valve transmission has been used with success. As far as high-powered valves are concerned, much work has been done on silica valves, which are now easily made to operate with powers up to 5 kw.

Little Progress in Reception.

Receiving valves have not improved in any way during the year except towards the end, when a special filament of tungsten was produced which enables less than half the usual filament current to be employed. The dimness of the filament ensures a longer life, and the use of small filament currents makes the valve very useful in service and aircraft work. During the year the **Shephard** selector as an automatic call device has been demonstrated with success. High-speed signalling has advanced with giant strides, very valuable work having been accomplished by the Army. The use of valve relays has enabled high-speed reception to be accomplished.

Wireless Telephony.

Advance in wireless telephony during the last year has been small—probably because the demand for it is really less than the popular imagination would have us believe. Changing over from sending to receiving is still a bar to proper conversation, and there is a real need for an efficient duplex system. Popular interest has been roused by high-power wireless telephony tests over long ranges and these, it must be admitted, have had some scientific as well as advertising value.

Aircraft wireless has only advanced in detail and the art of direction finding is still in a state of comparative imperfection. Much has still to be done in this latter direction. The wireless control of naval vessels from aeroplanes has received the attention of the Services during the year, but no details have been published.

Progress in Arc and C. W. Stations.

In the high-power station list is now to be found the great arc station at Lafayette, near Bordeaux. The arc stations at Leafield and Cairo are in course of erection and France is building several new installations. Germany has been very active erecting an internal chain of communication which duplicates many of the telegraph routes. A wireless commercial service between London and Paris has been inaugurated. Another feature of the year has been the high-speed service between London and Geneva, which was established temporarily, though quite successfully, to report the conferences of the League of Nations.

Commercial Items.

In the commercial world the year has seen the combination of the General Electric Company, of U.S.A., and the American Marconi Company to form the Radio Corporation of America. In this country the monopoly has at last been broken by the successful entry of the Radio Communication Company into the competitive field. The rapidly extending influence of this organisation is likely to produce a great effect—and a beneficial one—on wireless in this country. The wireless societies have had a very successful year, the wireless sectional meetings of the I.E.E. being particularly well attended. Valuable papers have been read, although preference seems to be given to papers of an analytical nature.

Lines for Future Development.

The progress made during last year has still left vast fields to be opened up in the years ahead. Although the statement that "wireless is in its infancy" is an absurd and damaging one, yet there is no doubt that there is room for further improvement in many directions. Commercially, we want a cheap, reliable, secret and rapid communication service all over the world. To make it cheap we must reduce the capital cost of stations and their annual upkeep. This can be done by using smaller and cheaper aerial systems and less power. It is possible to signal across the Atlantic with 5 kw. Why is this power not *used?* It is for wireless engineers to see that it *can* be used.

The problems before investigators are complex. The elimination of atmospherics is the first necessity. Much has been done but there is much more required if we are to solve the problem in an inexpensive manner. There is also the question of mutual interference of stations. Even with modern tuned high-frequency amplifiers we are a long way off obtaining a selective wireless system. The problem of note frequency tuning as well as high-frequency tuning is of great importance, and we look to the future to obtain a highly selective note tuning arrangement.

The Secrecy Problem.

The secrecy of radio communication is a problem yet on the brink of achievement. High-speed transmission may eliminate amateur eaves-dropping, but some thing better is required. Probably the solution will be found by interfering with the signals during the transmission and then for the receiver to cut out the interference effect. For example, in modulated wave signalling it has been proposed to leave cut one of the essential modulating effects, and to supply it locally at the receiver to obtain understandable signals. The problems of high-speed signalling have been largely solved. Any troubles which arise are almost entirely due to certain inherent disadvantages of ether wave communication. It would appear then that the future of wireless telegraphy as a method of communication is exceedingly bright. The technical problems still to be solved will be solved and every day brings us nearer to that time. Developments will take place along other lines. Radio-navigation is of immense value, but progress in it has been very slow. We look to the future for improvements in the art of direction finding, but great difficulties of an uncertain nature will have to be overcome.

Wireless Control Systems.

Wireless control mechanisms have never received adequate attention in this country but there are indications that this branch of radio signalling will be greatly developed in the near future. Future warfare, especially naval warfare, will probably be conducted in large measure by wireless control. A fighting ship even now may be made to carry out practically all its evolutions solely under the control of wireless signals from shore or from an aeroplane. The direction of aircraft by wireless is also a feat which has been proved possible. It is possible to steer torpedoes by wireless and when aerial torpedoes are controlled by the same agency war will become still more a struggle for scientific supremacy.

Directive signalling and the concentration of electric waves into a beam are matters for attention in the future. We are still a long way off moderate success in these directions.

The next year will see the development of multiplex signalling with a single aerial, and the results will be far-reaching. Transatlantic wireless telephony also will become an established fact.

Chief Problems for the Future.

The chief problems for solution in the future have been indicated. Turning to details, an efficient trigger relay is required; a valve which operates without a filament battery, and in any case one with a much larger amplification factor than modern types; really high-power vacuum tubes capable of dealing with, say, 100 kw., and if possible at low input voltages; a simpler and more reliable form of high-frequency alternator; new limiters and X-eliminators; methods of eliminating spark interference during continuous wave reception. These are some of the lines along which development work must proceed and there is little doubt that a very large measure of success will be obtained within the next year or two.

A Loop Test for High Resistance Faults.

By H. V. HIGGITT.

The test here described is a modified method of taking the loop test devised by Prof. Jamieson, which test gives probably an accuracy of the same order as a Varley loop, the accuracy for high-resistance faults being more or less proportional to the resistance of the fault. By the method described here the accuracy is independent of the fault's resistance, though the higher the latter the longer is the time required to take the test, and providing there be sufficient insulation of certain parts of the apparatus. The test is dependent upon the accumulation of charge in the capacity of the line. The theory is simple, and is illustrated in the accompanying diagram.

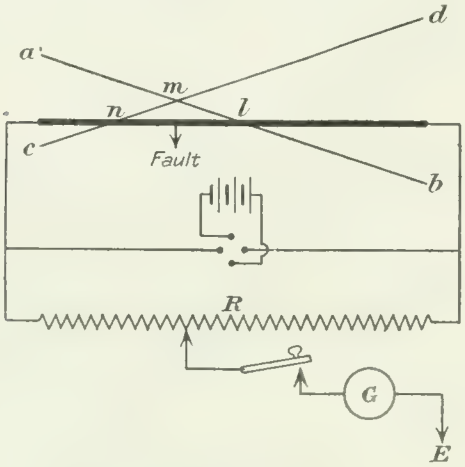

FIG. 1.

THE THEORY OF THE TEST.

A battery is joined to the line and also to a resistance, R (a Sullivan shunt would be very suitable), through a reversing switch. Both battery and resistance must be well insulated; the insulation of the galvanometer is not important. The index, when using a slide or Sullivan shunt, or the junction if using two resistances, is joined to the galvanometer key, the other side of the galvanometer being to earth. With a low resistance line it is advisable to use an accumulator in order to maintain a steady current.

There will be the usual fall of potential along the line with the correspondingly proportionate charge. The potential curve and the charge will adjust themselves by leakage through the fault until the potential at the fault is equal to its natural potential. This is shown, with the current in one direction by the line ab, the height, m, of the line at the fault being its natural potential. The cable is at zero potential at the point, l. If the slider on the resistance is at any other point than that corresponding to l, when the galvanometer key is closed, the point that does correspond to the position of the slider will immediately change to practically zero, as the resistance of the galvanometer is small compared to that of the fault. This change will cause a charge or discharge through the galvanometer proportional to the resistance between the slider and the point corresponding to l. The slider is adjusted till there is no throw. A certain time must be allowed for the charge to adjust itself before each trial. A useful guide is the time constant which is found in seconds by multiplying the fault resistance in megohms by the capacity in microfarads. The time constant is the time it takes the charge to approach the limit to within 37 per cent. of the difference between the limit and the previous value; after five times the time constant it will be within 1 per cent., which is amply sufficient to work with.

The null point being found, the battery is reversed, and, the charge having adjusted itself through the fault, produces the potential curve cd, being at zero at the point n. The slider is adjusted till the null point is again found, and the position of the fault is then midway between the two positions in the cable corresponding to the null points.

THE ACCURACY OF THE TEST.

It is seen that the accuracy of the test depends upon there being no change in the natural potential of the fault. This is probably invariably the case when there is no actual exposure of copper, as is usual with high-resistance faults in submarine cable, that has once been under water. (This natural potential is no doubt largely, if not usually wholly, due to the earth used, but it simplifies matters to regard it as being all at the fault). The test is probably capable of a limited application to laid cable, particularly with such a fault as that due to a bad joint. It should also prove of value for localising incipient faults on power mains, due to the degree of accuracy it is possible to obtain. If the fault were close to one end it might be found that the slider in one test wanted a position beyond the end of the resistance; to overcome this it would be necessary to add resistance to the end of the line that the fault was near.

It is interesting to note that though the test depends upon the capacity, the distribution of the capacity does not enter into it, the result being true to the distribution of the resistance. The sensitiveness of the test could be increased, therefore, by putting a condenser in parallel with the capacity of the cable. This would be useful when the capacity was small, but it would be necessary to allow for the lengthening of the time constant; also, the leakage of the condenser would have to be negligible compared to the fault, or a correction would be necessary.

THE ADVANTAGES OF THE TEST.

The test has two advantages over an ordinary loop for high resistance faults. Firstly, with a loop, it is, as a rule, necessary to make use of considerable battery power in order to obtain sufficient sensitiveness. This is usually undesirable, as faults often occur which seal with either current, particularly with a high voltage. Sealing is avoided with this test as the voltage across the fault is negligible practically all the time. Also, with a loop, the change in resistance of the fault due to the current causes a redistribution of charge, conducing to unsteadiness if the fault be "jumping" at all. Secondly, it is far more sensitive than a loop. To illustrate this we will take the case of a loop upon such a fault as that in the example given later (which gave 2·4 megohms at its lowest), and with a similar galvanometer (Sullivan shipboard type), which, unshunted, had a constant of 72 divisions per microampere, a throw constant of 125 divisions per micro-coulomb, and a resistance of 1,000 ohms. With a Varley loop, under these conditions, when testing with 100 volts, an alteration of one ohm in the bridge will mean a little more than a division on the scale; so that balancing to one division gives an accuracy to within half an ohm on the localization. This, however, is under the most favourable conditions, being contingent upon the fault being steady and not sealing, and requiring the perfect insulation of galvanometer and bridge. Using the test here described, the cable having a capacity of 0·75 microfarads, with a battery of six volts, and adjusting to one division, an accuracy should be obtained to within one fivehundredth of the length. Actually, a good appreciation of ten ohms on the reading was obtained, equal to a three-hundredth of the length, or a tenth of an ohm on the localisation. This compares very favourably with the loop, considering the difference in the voltage used.

RESULTS OBTAINED.

The results actually obtained are given on the next page. A six volt accumulator was used and an ordinary resistance instead of a slide, both standing on Pell's insulators. The galvanometer key was dispensed with, as possibly adding leakage, a lead from the galvanometer being touched on the resistance to obtain the throw. The resistance of the cable was 31·4 ohms, and the fault 2·4 megohms, but sealed to about 50 megohms with either current. The capacity being 0·75 microfarads gave a time constant of roughly two seconds.

The difference in the results is within the possible error in the resistances. A good appreciation of ten ohms was obtained on all readings. The fault was removed 11·0 ohms from the end, the dielectric leakage having pulled the result slightly towards the centre of the line. It was impossible to compare an ordinary loop due to the sealing of the fault.

A high resistance telephone (2,000 ohms), and interrupter was tried in place of the galvanometer, and gave about the same appreciation, but was more troublesome as it gave no indication whether more or less resistance was required.

TEST A.

$$\text{Readings}: 1{,}000 \text{ ohms to } \left\{\begin{matrix} 2{,}305 \\ \& \\ 1{,}165 \end{matrix}\right\} \text{ ohms.}$$

$$\left.\begin{matrix} \frac{1{,}000}{3{,}305} = \cdot 3{,}026 \\ \\ \frac{1{,}000}{2{,}165} = \cdot 4{,}056 \end{matrix}\right\} \text{Mean } 0{\cdot}351$$

$$31{\cdot}4 \times \cdot 351 = 11{\cdot}12 \text{ ohms from end.}$$

TEST B.

$$\text{Readings}: \left\{\begin{matrix} 1{,}350 \\ \& \\ 860 \end{matrix}\right\} \text{ohms to 2,000 ohms.}$$

$$\left.\begin{matrix} \frac{1{,}350}{3{,}350} = \cdot 4{,}030 \\ \\ \frac{860}{2{,}860} = \cdot 3{,}007 \end{matrix}\right\} \text{Mean } 0{\cdot}352$$

$$31{\cdot}4 \times \cdot 352 = 11{\cdot}05 \text{ ohms from end.}$$

Some New Circuits for Radio-Telegraphy Employing a Double-Grid Vacuum Tube.

By JOHN SCOTT-TAGGART.

The present writer about two years ago devised a number of new receiving circuits of great practical utility, and as the patent for these (No. 153,681) has now been published, it is possible to give a description of some of them.

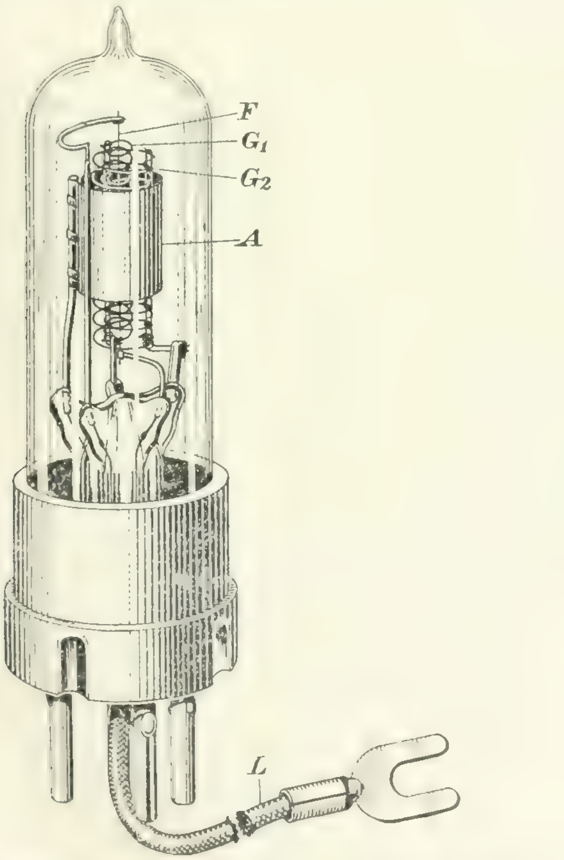

FIG. 1. A FORM OF DOUBLE-GRID VALVE EMPLOYED. (ACTUAL SIZE.)

A special vacuum tube is used, which consists of a filament, an anode and two grids both arrranged so as to control the electron current from filament to anode. One type of this tube—produced while the author was in charge of the design and production of valves at the works of the Edison Swan Electric Company—is shown in Fig. 1. The valve was designed on the lines of the *ES* 2 and *ES* 4 tubes, but an additional grid was placed around the inner grid. The anode is slightly larger than the *ES* 4 anode (9 mm.), and the second grid, *G* 2, is supported by an additional "pinch" in the stem. A flexible lead is taken from this grid to a fish-tail clip through the centre of the ebonite base of the usual four-pin cap.

AMPLIFICATION OF LOW FREQUENCY IMPULSES.

One of the uses to which this valve may be put is shown in Fig. 2. The leads from the condenser C_1 are taken to the grid G_1 and to the filament *F* of the four-electrode valve. The anode circuit contains an aperiodic inductance coil, L_2, preferably possessing a fairly high resistance coupled to a tuned circuit, $L_3 C_2$, adjusted to the incoming wave-length. The incoming oscillations are amplified by the tube, the magnified current being passed on to the circuit $L_3 C_2$. A crystal detector *D* is connected as shown and the condenser C_3 accumulates the rectified pulses. These audio frequency currents are now passed on to the grid G_2 which also controls the main anode current. The valve now amplifies the low-frequency impulses which influence the telephone receivers *T* in the anode circuit. A blocking condenser C_4 is connected across telephones and anode battery *H* to by-pass the high-frequency component of the anode current. In this case, the vacuum tube carries out the dual role of high-frequency amplifier and low-frequency magnifier. The result is that a

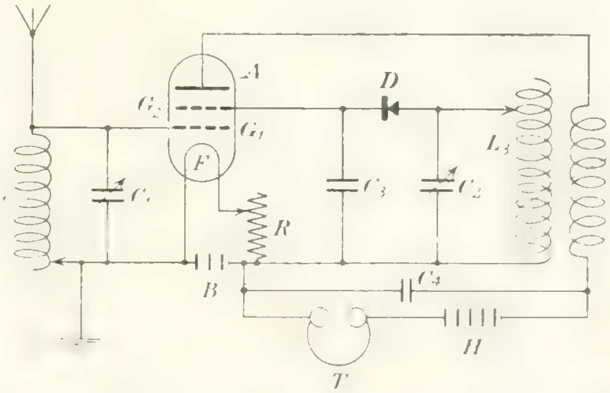

FIG. 2. THE SCOTT-TAGGART DOUBLE-GRID VALVE USED FOR DOUBLE AMPLIFICATION.

highly sensitive and stable circuit is obtained, which, moreover, possesses great selectivity, especially if the coupling between L_2 and L_3 is loose.

Another circuit of special utility is shown in Fig. 3. An aerial circuit, L_1C_1 is coupled to a closed circuit, L_2C_2, connected across grid and filament of the four-electrode tube. The amplified oscillations now appear in the tuned anode circuit L_3C_3 and are passed on to a grid coil L_4, which may be aperiodic. This coil L_4 is placed across the negative side of the filament F and the grid G_2. Telephones T and anode battery H also form part of the anode circuit. When receiving spark signals the circuit L_3C_3 is tuned to the incoming waves and the coupling between L_3 and L_4 is adjusted to give the best results. Retroaction is thus obtained, not in the main grid circuit, but in the output and secondary input circuits. Rectification will usually take place on the grid G_2 and a leaky grid condenser might be included in the G_2 grid circuit. In this circuit we have a form of retroaction, high-frequency amplification detection and low-frequency magnification.

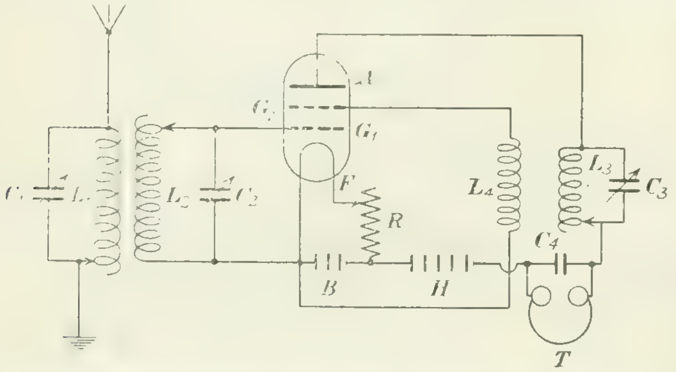

Fig. 3. A New Patent Non-radiating Continuous-Wave Receiver.

Reception of Continuous Waves.

If the coupling between L_4 and L_3 be increased beyond a certain limit, the four-electrode tubes will commence to generate oscillations in the circuit L_3C_3, the frequency of these oscillations depending chiefly on the value of C_3. If incoming continuous waves are received they will be amplified unchanged in wave-form and will form beats in the anode oscillatory circuit L_3C_3 which is slightly tuned to one side; these beats are passed on to the coil L_4 rectified by the valve action of G_2 and amplified by the tube, the resultant signals affecting the telephones T.

Remarkably good results are obtained with this circuit. It is to be noted that the beats are not formed in the circuit L_2C_2 nor do they affect that circuit. The oscillations are of ordinary form in the circuit L_2C_2. It is possible that the electrostatic fields of the two grids combine to produce the heterodyne effect on the electron flow to the anode.

A Trap Action.

The fact that the oscillations produced by the tube only take place in the circuits L_3C_3 and L_4 is of importance. The circuit is the only existing one employing one valve which does not radiate continuous waves from the aerial when receiving incoming undamped waves. The special vacuum tube thus acts as a trap which allows incoming oscillations to pass through to be heterodyned, but does not allow the local oscillations to pass the other way and set up oscillations in the aerial. Another feature which in this case affects the strength of signals is that the receiver circuit L_2C_2 is *tuned* to the incoming signal and not detuned as in the case of the ordinary self-heterodyne circuit. The arrangement possesses all the advantages of the autodyne, together with those of the external heterodyne circuit, which latter, however, is very much less sensitive than the author's present circuit, even in the case of very strong signals. As an indication of the sensitivity of the vacuum tube under these conditions, the station of Annapolis is readable in this country on an aerial 100 ft. long and 30 ft. high.

The last figure (Fig. 4) shows a circuit which has been found of special use for the reception of spark signals. Both anode and secondary grid circuits are preferably tuned and the coil L_3 should be connected the right way round. The coupling, if loose, results in a very high selectivity, which is much greater than that obtained with any ordinary valve circuit.

Although some of the circuits employing the double-grid vacuum tube are described here, yet there are other applications and developments which it is proposed to disclose at an early date. The circuits given may themselves be modified in many ways, as for example by coupling the primary grid circuit to one of the others or by inter-changing the tuned and the aperiodic circuits. Preliminary tests have shown that the double grid valve with two input circuits, which constitutes the writer's invention, proves a very convenient receiver for general ship installations.

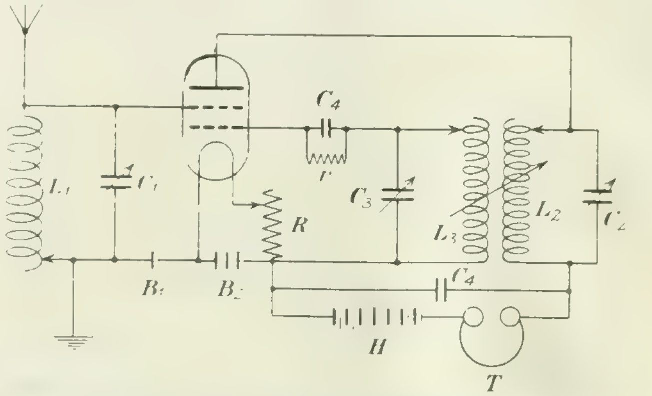

Fig. 4. A Highly Selectivity Circuit involving Double Magnification and, if Desired, Retroaction.

A Handbook of Wireless Telegraphy.

Mr. W. H. Marchant's handbook on wireless telegraphy, a second edition of which has recently been published by Sir Isaac Pitman & Sons, is primarily intended for operators and those preparing for the Postmaster-General's certificate of efficiency. The subject is lucidly explained without excessive detail. The Fleming valve is described and the three-electrode valve receives two pages to itself. Incidentally, the author tends to mislead his readers when introducing the triode by stating that "another type of detector recently brought into use by the Marconi Company has a third electrode." The author, if desiring to give any credit, should have given it to Dr. de Forest. His account of the action of valves is exceedingly poor, and one is left with the impression that gas resistance governs the action of these devices, no mention being made of electron currents. Apart from this, he says that the high-frequency potentials on the grid produce large increases and decreases of current through the telephones, a click being produced at each half-cycle! As an explanation of the detector action of the valve, this is distinctly novel and leads one to believe that the author would have been well advised to leave valves severely alone. The author, it is to be noted, uses the term "detector circuit" when he means the secondary or closed circuit. When speaking of retro-active amplification, the author declares that if the circuits oscillate, the reception of signals is impossible. This, of course, is far from being the case. Signals are frequently improved.

An interesting feature of the book is the introduction of details regarding systems of wireless not usually found in most text-books on the market. Another chapter of interest deals with portable installations of different systems. At the end of the book is a page of conventional signs, but the convention in several cases is apparently the author's. Chapters XII. and XV. are extracts from the official operator's handbook. Such extracts are of interest to the casual student, but the candidate for the P. M.-G. certificate has in any case to obtain the complete handbook. A chapter on fault-localisation is included, but is inadequate for the use of P. M.-G. candidates who would probably never "get the spark" without further instructions and warnings of the devilish ingenuity of the average inspector. This chapter could be amplified with advantage.

The Gas Engine in Iron and Steel Works.

Modern Development in Power Generation.

By T. B. MORLEY, D.Sc., M.I.Mech.E.

Economy of fuel is to-day of the utmost importance. The ideal for iron and steel works is, therefore, to confine the use of coal entirely to the coke ovens; the gases from them and from the blast furnaces being sufficient, if properly utilised, to meet all the demands of the works for power and heating purposes. The best prime mover from the point of view of thermodynamic efficiency is the internal-combustion engine, and in the large gas engine the ironworks engineer has an apparatus which can be obtained in sufficiently large power units, avoids the losses inherent in boilers and steam engines (or turbines), and its modern form gives as reliable a service as they do. The capital cost of the large slow-speed gas engine, with its foundations and engine house, is certainly very high. Nevertheless that its high fuel economy and low running costs justify the initial outlay is proved by experience, and is reflected in its increasing use in iron and steel works both on the Continent and in this country. Remarkable evidence of the success of the large gas engine was given in two important reports presented in September, 1919, to the Iron and Steel Institute.

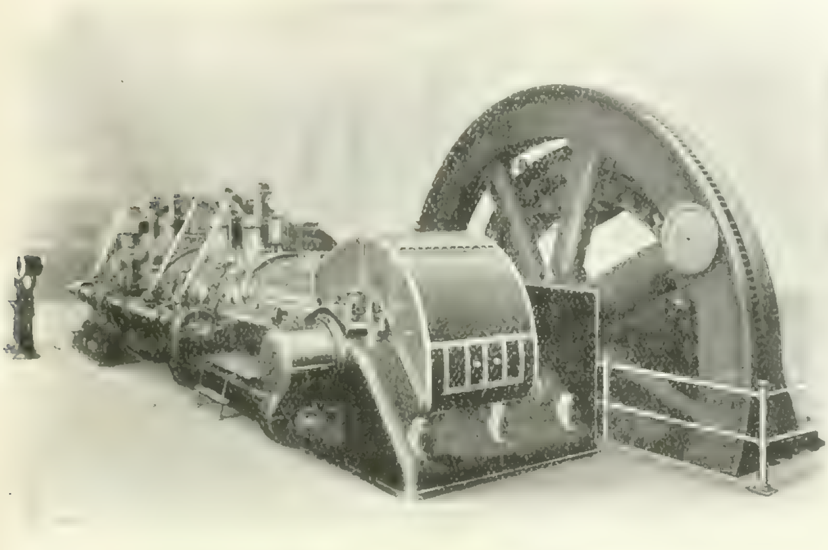

FIG. 1. 1,350 B.H.P. GAS ENGINE DRIVING ALTERNATOR.

DETAILS OF MODERN DESIGN.

Messrs. Galloways, Limited, after a careful study of the best Continental practice, took up in 1909 the construction of large gas engines, selecting as the best type the horizontal double-acting engine, working on the four stroke cycle. While adhering to that type the firm have since introduced many important improvements in details.

The standard Galloway gas engine has two cylinders arranged in tandem, so that the crankshaft receives an impulse each stroke, as in a double-acting steam engine. The engine can be arranged to work either on blast furnace or coke oven gas, or on a mixture of the two, and is supplied to iron and steel works for blowing air for the blast furnaces, and for driving electrical generators, both direct and alternating-current types. In the present article the engine employed for electrical generation only is described.

The powers usually required so far have been from 1,000 B.H.P. to 2,000 B.H.P., the speeds being 107 to 94 revs. per min. The two-cylinder tandem engine can be built in sizes up to 3,000 B.H.P., and still larger powers up to 6,000 B.H.P. are obtained by using "twin tandem" engines working upon a common crankshaft—*i.e.*, there are two cranks and four cylinders. A photo of a typical engine is given in Fig. 1, with a longitudinal section in Fig. 2.

The generator is mounted upon the engine crankshaft, between the engine frame and the outer bearing, or between the two engine frames in twin tandem engines. The necessary flywheel effect may in some cases be embodied in the generator itself, but usually a separate flywheel is advisable mounted on the shaft beside the rotor of the generator, to which it may with advantage be bolted. The number of crankshaft journals is thus limited to three for single tandem or four for twin tandem engines, with consequent comparative freedom from alignment difficulties.

The engine is arranged with its principal fixed members in the following order: Main frame, front gas cylinder, intermediate distance piece, rear gas cylinder, and rear guide. The cylinders are secured at their ends to the adjacent frame members, which carry their entire weight, the cylinders having no contact with the foundations. The main frame is rigidly bolted to the foundations. The distance piece and the rear guide are free to slide on machined subbed plates, so that free expansion of the engine is permitted. The engine when working at any load is thus absolutely free from expansion stresses. The frame is of cast iron, and rests on the foundations along its entire length. The sides are in the form of box girders, each carrying a crankshaft bearing. The side walls are

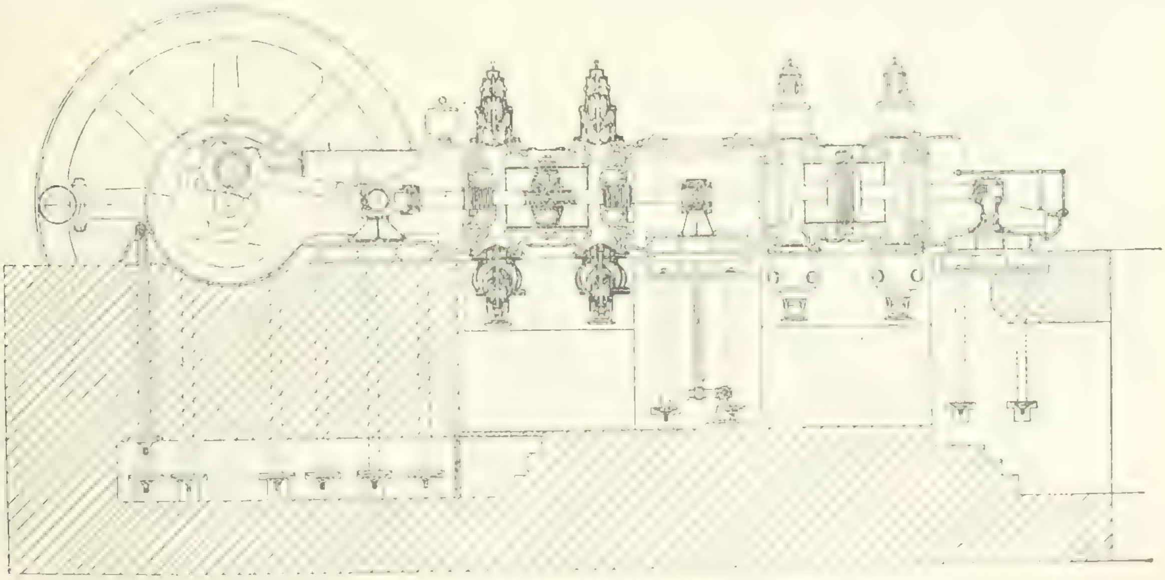

FIG. 2. SECTION OF GALLOWAY GAS ENGINE.

made high, so that the piston load produces only direct stress in the frame, unaccompanied by bending. The main bearings are each in four parts, of cast iron lined with white metal, the two side steps being adjustable.

The upper part of the frame and distance piece are open, so allowing easy access to the cross-heads and piston rod packings. The slide surfaces for the cross-heads are sufficiently low to enable the cylinder covers and pistons to be easily withdrawn. The cylinders and frame members are connected by circular spigot joints concentric with the cylinder bores and the slides in the frames, so ensuring accurate alignment of the whole engine.

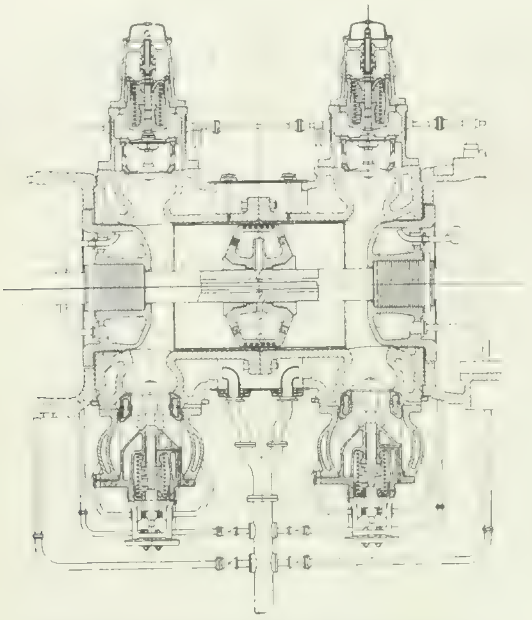
Fig. 3. Section of Cylinder and Valves.

Cylinder Construction.

The patented built-up cylinders embody several features of special interest. The casting of a large cylinder with its water jacket in one piece presents great difficulties, and there is much risk of severe internal stresses in the casting and also stresses in working due to unequal expansion of the barrel and the water jacket. The Galloway cylinder body (*see* Fig. 3) is divided into two main parts, and the central portion of the outer shell closing the water space is formed by a detachable mild steel casing. The division of the cylinder greatly simplifies the casting, and has an important additional advantage. Each half is cast with its axis vertical, the end containing the valve ports being lowermost in the mould, and a large head of metal is cast above the central flange. Uniformly dense and sound metal is thus ensured at the valve ports at *both* cylinder ends. The steel jacket casing which completes the water jacket round the cylinder barrel is made in two—or more—parts heavily bolted together longitudinally, so as to make a water-tight joint on rubber rings placed in grooves on the cylinder end castings. This method of jointing permits expansion of the cylinder barrel relatively to the jacket to take place without stress

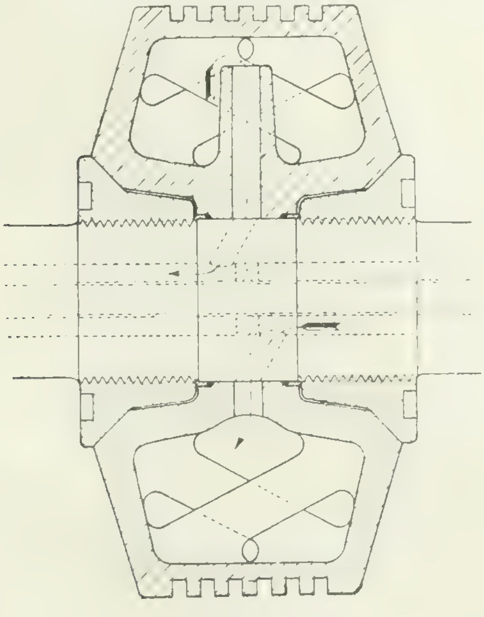
Fig. 4.—New Type of Piston.

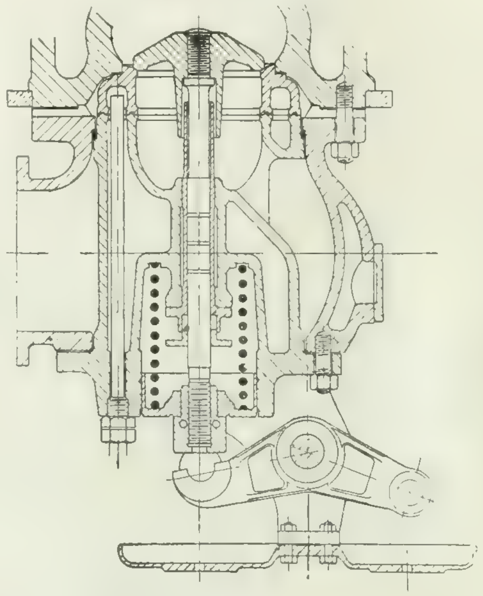
Fig. 5. New Type of Exhaust Valve Box.

Cleaning holes on the jacket casing enable the water spaces to be washed out and the whole casing can, if required, be easily removed, affording very ample access to the water spaces for removal of any deposit.

A liner of special cast iron is forced hydraulically into the two main cylinder castings and a central collar on the liner fitting into recesses in the flanges by which the cylinder halves are bolted together absolutely prevents subsequent movement. Wear of the liner is very slight, but if in course of time renewal becomes advisable, a new liner can be fitted at little expense.

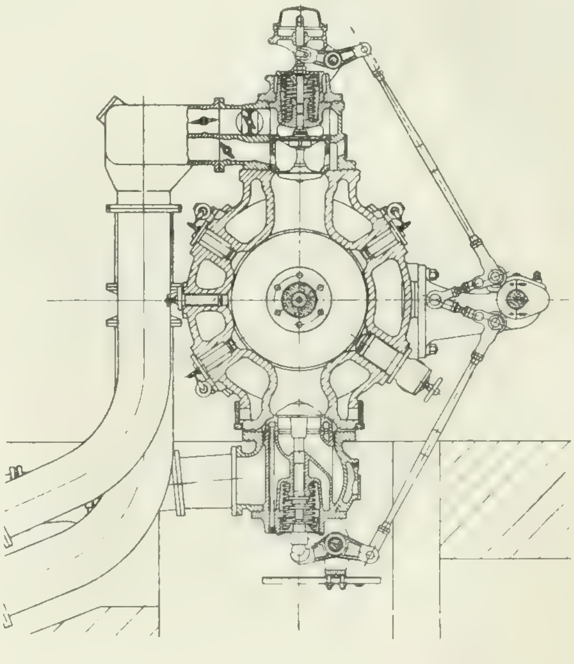
Fig. 6.—Section of Cylinder and Valve Gear.

Piston Arrangements.

The pistons (Fig. 4) are of cast iron; their faces are coned, the corners are well-rounded, and sudden variations in the thickness of the metal are avoided. They include an interesting patented feature, viz., the casting in of pairs of internal diagonal ribs which brace the piston against deflection and thus eliminate deleterious bending stresses. The cast iron piston rings are self springing, and their construction is such as to give a uniform and known pressure all round the circumference. The Galloway piston has been most successful in freedom from cracks and other troubles.

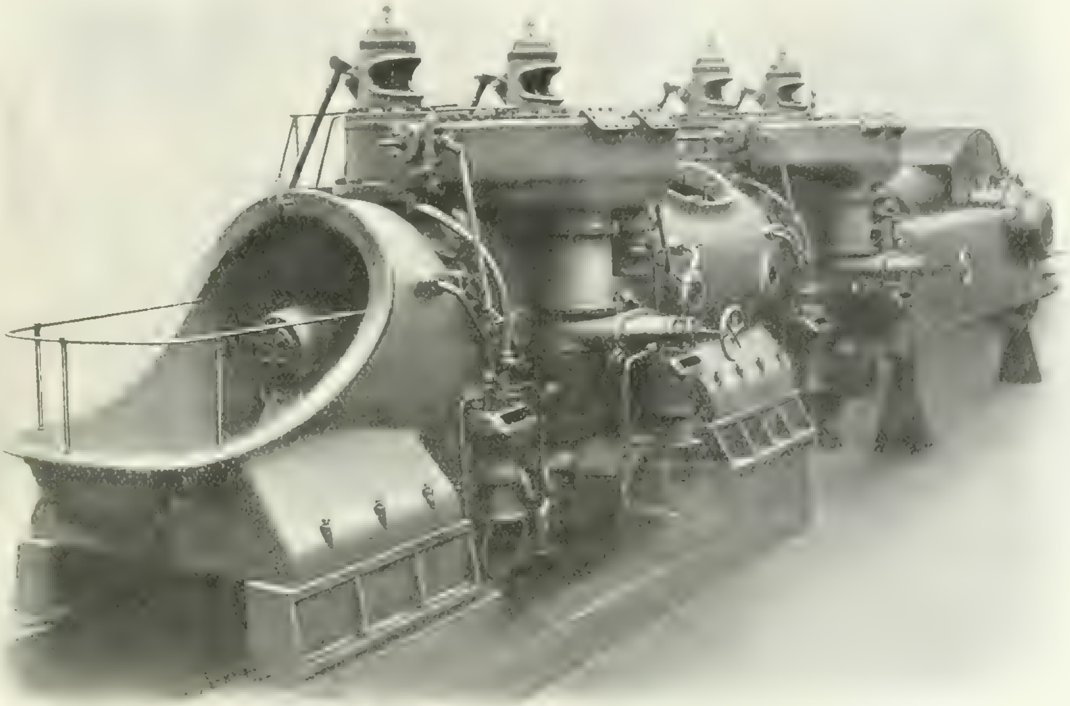

FIG. 7.—1,850 B.H.P. GAS ENGINE FOR DRIVING D.C. GENERATOR.

The method of fixing the piston on the piston rod is also a Galloway patent. The boss is deep and is fixed between coned nuts on the piston rod. This permits of longitudinal adjustment of the piston on the rod, so that the piston rings may work exactly edge to edge with the ends of the liner when running.

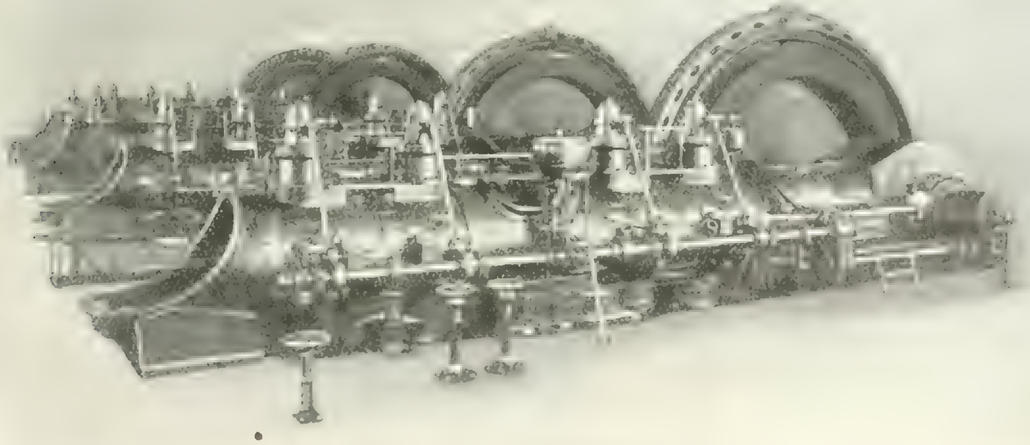

FIG. 8.—LARGE GAS ENGINES DRIVING ALTERNATORS.

The pistons and rods are water-cooled, water under pressure being led into the hollow piston rods, thence into the pistons and out again by the rods. The water enters and leaves by rocking pipes connected with the coupling between the front and back rods. The improved metallic packings introduced by Galloways, Ltd., for the piston-rod glands are characterised by great simplicity and high efficiency. The cast-iron segmental rings which bear on the rod, the spring rings behind them and the rings which locate them axially, while leaving the packing free to follow any slight deflection of the rod, are carefully ground to size, and the rings of each form are strictly inter-changeable. Assembly of the parts is thus easily effected. The complete packing can be withdrawn as a single unit for inspection and cleaning, no special guide box being necessary.

CRANKSHAFT.

The crank-shaft is of the sweep crank type. The crank webs and crank pins, and as a rule the balance weights also form a single steel casting, secured to the shaft by shrinking.

VALVES AND VALVE GEAR.

Improvements in the valves and valve gear have been in the direction of greater simplicity without sacrifice of efficiency. The valves are of the mushroom type. The inlet valve spindle at each cylinder end carries a main inlet valve and a gas inlet valve, the latter being spring mounted so that even if the distance between the valve seats should change by wear or otherwise, both valves may still seat tightly. The exhaust valves are not water cooled in spite of their large size. The patented exhaust valve box (Fig. 5), however, consists of separate inner and outer casings and valve seat, all of which are carefully water-cooled. An improved patented arrangement of the joints between the valve box and cylinder and between the inner casing and the valve seat has also been introduced, by which should leakage of gas or water occur, it at once becomes evident. The detection of a gas leak, in particular, at the former joint is important, as if unchecked it may cause the cylinder to crack.

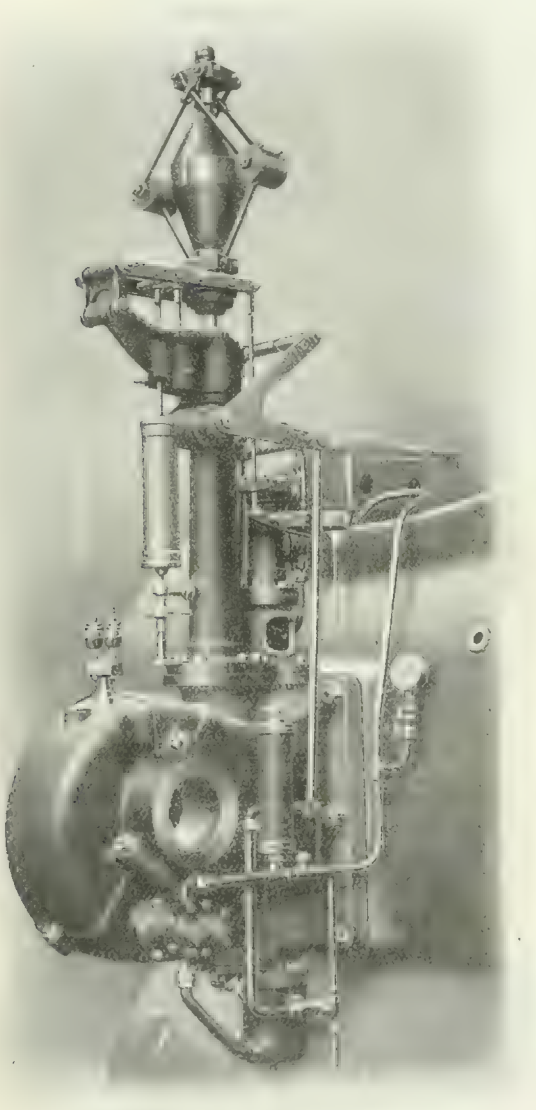

FIG. 9. SERVO MOTOR GOVERNOR.

The valves are operated by four cams keyed on a longitudinal cam shaft, which is driven from the crank-shaft through a lay-shaft and cut gears running in oil baths (*see* Fig. 6). Each cam operates both the inlet valve and exhaust valve at one cylinder end. The valve rods are connected directly to the valve levers, and the whole gear is very simple and smooth working. It is quite unaffected by expansion of the engine.

GOVERNING ARRANGEMENTS.

The governing arrangements are simple and effective. Governing is effected by throttling the air and gas supply at points near each inlet box. The gas and air throttles are so linked that at light loads the gas is more throttled than the air, thus the quality as well as the quantity of the charge is altered. The governor gear is free from trip devices and quite independent of the valve gear. Air and gas are supplied during the whole of the suction stroke at all loads. For operating the throttle valves a governor of the servo-motor type has been adopted by which great power is obtained, and, at the same time, friction is almost completely eliminated. A comparatively small centrifugal governor is employed to operate a small balanced valve which controls the supply of oil under pressure to one end or the other of a relay cylinder. The oil pressure on the piston of the relay cylinder provides ample force to move the throttle valves. The oil pressure is maintained by a gear wheel pump driven from the camshaft. The piston of the servo-motor cylinder (Fig. 9), and consequently the throttle valves connected thereto through a system of links follow immediately and proportionately the movements of the governor sleeve. Ignition is effected by ignition plugs of the low-tension make-and-break type, three of which are provided at each cylinder end.

STARTING.

The starting of the engines is effected by compressed air usually at 220 lbs. per square inch pressure. A distributing valve operated from the camshaft controls the admission, cut off, and release of the air. The starting gear is in action only during starting, being easily disconnected when the engine has started.

The Galloway gas engine has been installed with great success both for electric-power generation and blast-furnace blowing. The operation of the engine shows that these engines are quite as reliable as good steam engines, and parallel running of alternators is satisfactorily accomplished.

Given clean gas (with modern gas cleaning plants the dust contents may easily be reduced below 0.01 gm. per cubic metre) successful runs of six to twelve months (day and night) without overhaul have been made, and examination at the end of these periods has shown the tool marks still visible on the cylinder liner, the piston rings and pistons in excellent condition, the carbon deposit on the cylinder covers and piston faces not more than 1-16 in. thick, and the crank pin, crosshead, and main journals in excellent condition.

The heat consumption of the Galloway engine does not exceed 10,000 B.T.U. per B.H.P. hour at normal full load, and by the use of boilers heated by the exhaust gases still higher thermal economy can be realised. The water consumption of gas engines in comparison with that required for steam condensing plant is low, being 7 to 10 gallons per B.H.P. per hour.

Much remains to be done in the economical utilisation of coke oven and blast furnace gases with the consequent elimination of coal-burning plant. The capabilities of the large gas engine for this purpose should not be overlooked, as the modern tendency is definitely towards fuller exploitation of available sources of heat supply, even in spite of increased capital expenditure.

The Application of the Electric Locomotive to Main Line Traction.*

By Lieut.-Col. H. E. O'BRIEN, D.S.O.

EFFECT OF HISTORY AND LOCALITY ON LINES OF DEVELOPMENT.

At the present time there are about 1,200 electric locomotives in service on the railways of the world Development naturally was first on lines of using two motor-car bogies with a superstructure containing electric equipment. Motors were thus placed in superstructure and connected to wheels by linkage rods, or with the motor armatures carried direct on the axle. Improved design of direct-current motors has led to a tendency to revert to the use of the geared direct-current motor. Desire for simplicity in the construction of the locomotive, a much extended knowledge of the design and manufacture of gears (the average life of the gears on the Liverpool and Southport line has been 300,000 miles, and of the pinions 200,000 miles), and the necessity for preserving space in the superstructure for control gear, has also inclined designers in this direction.

It has become general practice, owing to oscillation, to provide high-speed electric locomotives with carrying axles fore and aft, whereas practice has shown that for goods locomotives no carrying axles are necessary. Excessive wear on curves due to the low centre of gravity of the motor bogies of suburban electric coaches has led to a desire to raise the centre of gravity of the bogie, and incidentally of the whole locomotive. This can be done by tilting the motor at 45 deg., but this design is comparatively untried and little is known about its maintenance costs. As, however, the electric locomotive is designed with a 58-in. wheel for better adhesion form of tooth in gear, and lower journal speeds, this raises the centre of gravity of the motors by 8 in. as compared with the usual motor bogie design for suburban services in which a 42-in. wheel is the maximum diameter used.

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* Abstract of a Paper in the "Journal" of the Institution of Electrical Engineers.

The use of bogies carrying motors, so far as high-speed electric locomotives are concerned, is an undesirable complexity for any 4-motor unit. Where it is desirable to use 6-motor units, an articulated 2—6 + 6—2 design will be cheaper to build and give better results in running than a similar design with a loose superstructure carried on bogies.

Higher speeds on up grades can be maintained with the electric locomotive without increase in the maximum draw-bar stresses imposed on the train couplings, and as the maximum draw-bar horse-power of a typical British steam locomotive does not exceed 900 H.P., it may be safely assumed that for many years no electric locomotive exceeding 1,500 draw-bar continuous horse-power will be required on English railways, if the assumption so often made is correct that the wagon draw-gear is stressed to a maximum by the existing steam locomotive haulage. It may be further assumed that no motor exceeding 250 H.P. is likely to be required for British railways.

It is impossible to enter fully into the details of design, but electrical designers delight in small screws which can be and are twisted off with a powerful screw-driver or spanner; no set screw or bolt in the electrical portion of the apparatus should be less than $\frac{3}{8}$ in. in diameter, and preferably $\frac{1}{2}$ in.; except for control and lighting cables all conductors should either be bar with bolted joints, all insulation being carried out by mica sleeves and sound mechanical clamps, or where movement is essential multi-strand cable of extreme flexibility. The outward form of most electric locomotives leaves much to be desired, and the convenience and clear view of signals of the driver has to be compromised with accessibility of the gear. The author suggests that the trend of present-day design indicates that all the requirements of British main-line work could be met by one standard geared motor of 250 H.P., one standard wheel 58 in. in diameter, four standard gear ratios 4/1, 3·3/1, 2·6/1 and 1·9/1, and four standard wheel arrangements 0—8—0, 2—8—2, 0—6 + 6—0 and 2—6 + 6—2.

OPERATION.

The advantages of the electric locomotive are: (1) Mechanical efficiency is constant for any given tractive effort throughout the life of the locomotive, while that of the steam locomotive diminishes; (2) no coal and no water has to be carried; (3) the mechanical efficiency is higher; (4) the tractive effort is more even; (5) the repairs are smaller; (6) no washing out of boiler or removal of ashes required; (7) less cleaning is required; (8) less lubricant is required; (9) no detentions due to lack of steam; (10) less failures, causing interruption of traffic; (11) more rapid shunting movements; (12) regenerative braking possible; (13) no turn-tables required; (14) cheap and efficient supply of electricity for lighting, cranes, &c.; (15) roads now used by engines going to and from shed to turn, for water or for coal, are available for traffic purposes; (16) more than half the wagons now used for locomotive coal would be freed for other traffic; (17) owing to the more continuous use made of the locomotives, and the consequent smaller number, at least 33 per cent. of the locomotive sheds and shed yards could be devoted to other purposes; (18) the electric locomotive within the standard minimum load gauge of the British Isles can be made 50 per cent. more powerful than any existing steam locomotive. Any necessity for strengthening bridges to meet the needs of more powerful locomotives could be obviated by a general electrification; (19) double heading with a single train crew is possible; (20) automatic increase of torque with reduction in speed enables tonnage loading to be maintained over variable grades without reduction in schedule.

The disadvantages are:—(1) Liability of hold-up of all trains due to failure of current supply; (2) difficulty in heating existing carriage stock; (3) difficulty in controlling acceleration in shunting operations; (4) difficulties incidental to electric operation arising from presence of a trolley wire of third rail and the collection therefrom; (5) difficulty in arranging locomotive and stock workings to give the locomotives the continuous use of which they are capable; (6) assumed higher cost per ton of electric locomotive as compared with a steam locomotive of same maximum horse-power.

The third rail is a serious obstruction to the ordinary maintenance of the track and intolerable in sidings where much shunting is done; in these latter places, however, the objection can be modified by flooring the spaces between the tracks with wood at a level only an inch or two below the level of the top of the third-rail guarding. The probability is that in main line electrifications the third rail will be used where track complications are not great and where little shunting is done; the trolley elsewhere. The locomotive will therefore have to be equipped with both bows and shoes. With locomotive operation of heavy trains, continuity of contact will be essential; at junctions, gaps occur in the third rail which the shoes of the locomotive will not span; this gives rise to severe jerks on the train. Overhead wires must therefore be installed at these points. The trolley wire where installed must be at least 2 ft above the loading gauge; the bow must therefore either rise automatically wherever encountered, and fall automatically on leaving it, or if the bow is permanently up, all points where it might foul the load gauge must be equipped with trolley wires.

In Great Britain to-day there exists two types and three positions of the third rail, three direct-current voltages and one alternating voltage. The question of the most suitable voltage of supply has been frequently discussed, but remains undecided. The author does not consider that the existence of the comparatively few suburban electrifications at 600 volts or 1,200 volts should militate against the adoption of a standard 1,500 volts. The use of 1,500 volts for electric traction is solely desirable for the sake of future main-line electrification work; as this field is practically untouched the first extensive electrification carried out is likely to standardise both voltage and third-rail position.

The cost of electric locomotives is undoubtedly high, but the author suggests that this high cost is due to the experimental natures of the designs and the small numbers built. The cost of an electric locomotive built in large quantities and to standardised designs should not exceed that of a steam locomotive capable of doing the same work by more than 50 per cent. at the highest. Any comparison made, to be of value, must be based on draw-bar horse-power.

FINANCIAL ASPECT.

In dealing with the financial aspect of the substitution of electric for steam locomotives, various writers have drawn deductions favourable to electrification from general figures applying to the whole of the railways of Great Britain or the United Kingdom. The author suggests that even as indicating tendencies only such figures must be taken with caution. In the Paper he considers the financial aspect of electrifying the Lancashire & Yorkshire Railway as a whole, a total of 1,600 miles of track. The salient points arising from these rough estimates are the very large proportions of the total capital expenditure debited to the transmission (11·2 per cent.), track (40 per cent.), and locomotives (25 per cent.), and the very clear indication given of the substantially greater return on capital expenditure which would be obtained by retaining operation by those services on which the expenditure per mile for fuel and repairs was low. If electrification is to be regarded from the point of view of economy in operation denser traffic areas must be sought than are offered by the whole Lancashire and Yorkshire system, dense as is its traffic compared with the average for England and Wales. On the other side of the scale are the improved facilities offered for the movement of traffic and the possibilities of increased revenue. It appears probable, therefore, that immediate electrifications will be limited to densely trafficked sections of the main line when a maximum continuous use can be obtained from both locomotives and track equipment.

The Baudot Printing Telegraph System.

The issue of a second edition of the "Baudot Printing Telegraph System," by Mr. H. W. Pendry, is fully justified by the extension of the use of that system in this country, the improvements made in the apparatus, and the general adoption of the first edition as a class manual.

The descriptions and diagrams of somewhat intricate instruments and connections are so clear that it is possible to obtain a good knowledge of the system from the book alone, without (as is so often the case) the necessity of seeing and using the instruments before the information in the book can be said to have been usefully assimilated.

Of the new matter introduced the most notable is that treating of the Murray phonic motor and of the Gulstad relay. The chapters on Duplex Baudot and Baudot repeaters has been enlarged. The number of illustrations and diagrams has been increased from 72 to 94. It is to be regretted that in a few cases worn blocks have been used for the illustrations; fortunately the photographs in question are those showing the exterior form of the apparatus and are, therefore, unimportant.

The author introduces a short note on the necessity for co-operation between those in charge of the circuits at stations to obtain the best results with some diffidence, on the score that a remark on the human factor in a treatise devoted to the exposition of a system of machine telegraphy might be considered irrelevant.

In our opinion, this note is not only relevant but might have been considerably amplified. However good a high speed system may be, the advantages may easily be nullified by the employment of inefficient or ill-trained operators-in-charge, and therefore, any matter tending to assist in diminishing the length of, or obviating stoppages and promoting smooth working is not out of place in a book of this type.

What I Think About the Year 1920.

By "ELECTROCYNIC."

The year with which we have just unregretfully parted has not, I think, been a very satisfactory one for any class of the community. Even the profiteer has been forced to disgorge some of his ill-gotten money by the slump which is endangering the prosperity and, in some cases, the stability of every industry in the country. Inspired by a kind of moribund malignity, the last few weeks of the late unlovely have spread financial chaos and unemployment throughout the world; and it is, perhaps, small consolation to the millions who are within a dry crust of starvation to know that some of the fur-coated gentlemen who supplied the British artillery with dud shells during the war are at the moment just a little less wealthy than they were at this time 12 months ago.

I have a personal grudge against the year. It has brought to naught a cherished plan, and in so doing has made me look rather ridiculous in the eyes of those who are acquainted with my domestic ambitions. For many years I have been imbued with the true spirit of the electrical zealot, and it has always been my fixed and expressed intention that, whenever I should be in the happy position of requiring and acquiring a house of my own, it should be replete with every sort of electrical convenience and luxury. I felt that I could teach even Mr. Arnold Bennett and Mr. Beauchamp a thing or two on the subject of domestic electrification.

The Opportunity.

The opportunity of realising my boyish dream came to me in the early spring of 1920. From the high-perched and circumscribed enclosure of brick and wood, which for many months had afforded shelter to my family, my eager ears caught whispered rumours of a wonderful garden city to be established by a group of public-spirited men in the Hertfordshire hills, about 20 miles from London. I made inquiries, and found the project an exceedingly fascinating one. The houses were to be arranged on labour-saving lines and equipped with all manner of modern conveniences. But the most attractive feature was the fact that anybody who had bespoken a house well in advance could, to a very large extent, determine the interior arrangement. That is to say, he could decide what he wanted in regard to such matters as the hot-water system and the cooking, heating and washing equipment. Whatever one desired, so long as it did not conflict with the general structural design, could be carried out.

An Acceptable Privilege.

This privilege was very acceptable to me and, having booked a house about nine months in advance of the time when I should require it, I obtained a plan and, with the help of my wife, set about the task of organising an electrical home. I had, of course, been informed that electricity would be available, and as the Garden City was within the North Metropolitan supply area, and only a mile or so from a small town which already draws current from the mains of this enterprising company, there seemed no reason to suppose that my scheme would prove either difficult or expensive.

The standard house, as designed by the Garden City authority, was not conspicuously electrical; indeed, the only "other application" contemplated by the designers was electric ironing, for which purpose an additional pendent lamp-holder was to be provided in the kitchen. However, I was given to understand that this meagre wiring was necessary in order to keep the total cost within the Government's subsidy regulations, and that the garden city people were very keen on domestic electrification, and intended to encourage it in every possible way. The prospective tenant could, of course have as many points as he wished on payment of the extra cost.

What About the Price?

At the time of these negotiations I could not obtain any definite idea as to the price which would be charged for electricity. The North Metropolitan Supply Company couldn't tell me, because they were not going to supply direct, but in bulk to the garden city, who would retail the current to residents. The Garden City authority would not give me a definite figure, but said that the charge would be as low as possible. This was seven or eight months ago. I was, however, too keen on realising my electrical ambition to be deterred by lack of a little information, so I proceeded with my plans.

The kitchen was to be equipped with an electric cooker and copper, while there was to be a radiator in every room except the living room. The water supply was to be heated electrically. As the supply pressure was 220 volts alternating, I considered it desirable to specify certain elaborations, such as a separate double-pole switch control for all heating and cooking points. Every piece of apparatus would also have to be earthed. This was especially necessary as all floors on the ground floor of the house were either tiled or made of patent composition.

A Beautiful Dream.

It will, of course, be understood that the use of electric cooking, water heating and fires would affect the actual construction of the house, since there would be no need of a kitchen range, chimneys, fireplaces, &c., except in the living room.

With the feeling that I was at last on the high road to electrical happiness, I sent in a list of what I wanted, and entered upon a period of patient waiting for the consummation of my hopes. Although it is now several months since these matters were arranged, and only two months before my house is supposed to be finished, I am still without the definite information which I lacked at the beginning. The other day I wrote to the secretary of the Garden City and asked whether they had yet decided upon a price for electric current. In reply I was told that they couldn't very well do this until the place was a going concern, and they were in a position to assess the probable load. They were even uncertain as to when the supply would be available, since they had not yet obtained the cable necessary to connect up with the North Metropolitan network.

A Terrible Quandary.

Here was I in a terrible quandary. I had eliminated the kitchen range and fireplace in favour of electricity, which would in all probability not be available for a considerable time, and only then at a charge which might be absolutely prohibitive. Dare I chance it? Could I ask my wife to take the risk? I could not fall back on gas, the usual *pis aller* of the electrical enthusiast, because there would be no gas supply for perhaps a year. (Needless to say, this matter was also in the hands of the Garden City, and my only consolation lies in the fact that the gas supply has been handled even more incompetently than the electric.) I had to make a decision quickly, because my house was growing daily, and would soon be too far advanced for the fundamental alterations to which every cruel circumstance was driving me. On the last day of the old year I made up my mind, and telephoned to the Garden City people asking them to put in the coal range and all the other obsolescent equipment with which I had vainly imagined I could dispense. My house is now like the other houses in the neighbourhood, and its only title to the epithet "labour-saving" will lie in the absence of a whitened threshold to the front door.

My Triple Sacrifice.

Perhaps I lacked courage, but I think it needs more than the ordinary human allowance of this divine quality to enable one to face with contented equanimity the possibility, if not the probability, of having to live for weeks or months without any means of light or warmth or food preparation, and subsequently of paying an exorbitant price for a belated supply of electricity.

Not only have I had to sacrifice a long-cherished ambition and the comfort, convenience and cleanliness of my new home, but, worse than all, I have lost the respect of my friends and relations. Foolishly, perhaps, I had talked a good deal about the electrical delights of my future home, and had even exhibited illustrations of some of the appliances which I proposed to install. And now, when I am asked how my house is getting on (the question is as frequent as "How are you"?), and whether the electric cooker, &c., are installed, I have to confess that my ingenious schemes have fallen through, and that my anxious thoughts are at present engaged in the attempt to solve the problem, with which I shall soon be at painfully realistic grips, of frying the morning bacon without the aid of gas or electricity. The subject of coal accommodation has also acquired a sudden and sinister interest.

Old King Coal.

My wife is in a sort of "I told you so" mood, and has reminded me several times that she had always thought that electric cooking was a snare and a delusion, and that we should be much wiser to employ the traditional means of fug and food-spoilage.

In the circumstances I can hardly be expected to do otherwise than curse the recently-departed year, which has brought ruin and ridicule upon my dearest schemes. The drama opened pleasantly enough in the spring, and the curtain was finally rung down upon the tragic scene on December 31st. I have entered upon the year 1921 with a faint contempt in my heart for former enthusiasms (this attitude is the only cure for disappointed ambition), and a determination to emulate the spirit of that sooty sovereign who, in spite of his dark associations, has always been considered the very type and embodiment of irresponsible merriment. For are we not assured that

"Old King Coal was a Merry Old Soul"?

His pipe was not a gas pipe, and it is perfectly clear, both from internal and external evidence, that his bowl had no connection with scientific lighting.

The Physical and Optical Societies' Annual Exhibition.

(*Continued from p. 80.*)

CREED & COMPANY, LTD.

Very great interest was taken in the stand of Messrs. CREED & COMPANY, who exhibited a complete working set of their high-speed printing telegraph system. This consisted of a Kleinschmidt perforator for preparing the punched Wheatstone slip, a Creed motor-driven transmitter, a Creed receiver of new design, not requiring compressed air, together with the latest pattern of Creed printer, which was shown working at speeds up to 200 words per minute.

At 8 p.m. on both evenings of the exhibition the apparatus was shown printing the public news message sent out by radio telegraphy from the Admiralty radio station at Horsea Island, near Portsmouth. A small aerial had been erected on the roof of the Imperial College, and the received signals, after being amplified by six triode valves, were made to actuate a Carpenter relay of 800 ohms resistance, and the relayed current from a local battery was caused to operate an ordinary P.O. relay and Creed receiver in cascade. The demonstration was completely successful; the received punched slip on being passed through the Creed printer revealing a complete absence of errors.

As the Creed set was also used for demonstrations of the reception at high speeds of locally-transmitted signals, advantage was not taken of the highly ingenious triggering system due to Captain L. B. Turner, as difficulty has been experienced in making this arrangement operate satisfactorily at high speed; the sensitivity of the Carpenter relay employed being sufficient to make it unnecessary to employ very great modification, as would have to be done when a P.O. relay of sufficiently low inductance is used in its place.

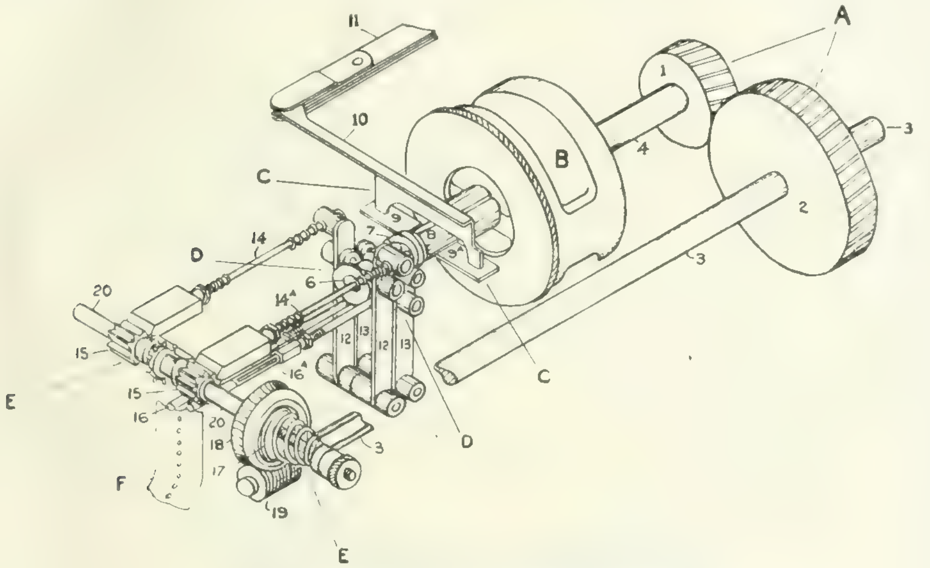


FIG. 4.—DIAGRAM OF NEW CREED RECEIVER.

We shall now give a detailed description of the various apparatus exhibited

KLEINSCHMIDT PERFORATOR.

The Kleinschmidt perforator is an instrument of American manufacture, with the standard typewriter layout, thus admitting of its ready operation by anyone familiar with the typewriter keyboard. The depression of a key actuates a single solenoid, whose movements perform both the punching and tape feeding operations. The touch is very light, and a demonstration was given by a Fleet-street telegraphist of punching at 70 words per minute.

THE CREED-WHEATSTONE TRANSMITTER.

The Creed motor-driven Wheatstone transmitter is designed for use where a steady uniform speed with easy adjustments is of prime importance. There are three changes of gear—viz., low, medium and high. The low gear admits of a variable range of speeds from 25 to 50 words per minute; the medium, 45 to 90; and the high, 80 to 200 words per minute. A rheostat mounted on the soleplate provides for 16 different speeds on each gear.

There is a direct positive drive on the medium gear, and changes to the other gears are quickly effected by unlinking the motor coupling and sliding the body of the transmitter to the right or left in its mounting, until the required gearing is in a position to be linked up.

THE NEW CREED RECEIVER.

The 1920 design of Creed receiver is the outcome of continued research on the part of Mr. F. G. Creed, with a view to developing a perforator which can be relied upon to reproduce punched slip at a high speed without the use of compressed air. It is more simple in construction than its predecessor. It consists of five principal units, and a reference to the adjoining skeleton diagram (Fig. 4) will make it clear how these various units function in relation to one another. They are (A) the driving shaft and spur wheels, (B) the friction clutch, (C) the detent mechanism, (D) the punching and correcting devices, and (E) the tape feed mechanism.

The clutch shaft spur wheel (1) is driven from the main shaft spur wheel (2). Fixed to the clutch shaft (4) is a simple adjustable friction clutch, *B*, one plate of which rotates the cam shaft (6). Revolving with the cam shaft (6), and sandwiched between the cam (7) and the clutch, is a detent (8), whose movements are controlled from the receiving relay (not shown) by means of the armature extension (11), yoke piece (10) and two detent plates (9, 9A). These detent plates permit the cam (7) to revolve in one direction for one half revolution at a time, the inner edge of either detent plate (9 or 9A) being advanced to engage the detent (8) and hold it, thus causing the plates of the friction clutch to slip. This it continues to do until the current reverses in the relay and the armature is attracted to the opposite pole, carrying the yoke piece (10) with it, and permitting the detent and cam to make another half revolution. Thus it will be seen that any irregularities imparted to the movements of the relay armature resulting, for instance, from interruptions in the line current such as the Morse code might create, will be communicated in turn to the yoke pieces and detent plates, and set up corresponding irregularities in the sequence of half revolutions.

The cam (7), which turns with the detent (8), is double grooved; the front groove controlling the movements of the corrector rods (14, 14*a*) and the rear groove controlling the movements of the punches (16, 16*a*). Before the paper strip *F* can be punched it is necessary that its forward feeding motion should be momentarily arrested to avoid tearing. To effect this, the cam grooves are so designed as to admit of the corrector rod (14 or 14*a*) being advanced into engagement with the corrector wheel (15) before the punch (16 or 16*a*) touches the paper, and to remain in engagement until the punch is cleared.

"DOT" AND "DASH" MECHANISM.

In the case of the "dot," the armature is attracted to the opposite pole, carrying with it the yoke and detent plates, thus releasing the detent and cam for one half revolution and recording the marking perforation on the slip; when the marking impulse ceases the armature and detent plates are returned by a spacing impulse, and the second half revolution takes place and records the spacing perforation on the slip. In the case of the "dash," the armature is attracted and held for a longer period, during which time the centre-holed slip is feeding forward; consequently, assuming the speed of the slip to be in correct ratio to the line speed, the spacing perforation recorded on the return of the armature will be correctly punched opposite the next centre hole to that facing the marking perforation. The tape-feed spindle (20) is made to revolve in correct ratio to the clutch shaft (4) by means of gears (1 and 2), driving shaft (3) and worm gear (18, 19). A small adjustable friction clutch (17) situated in the worm wheel (18) is caused to slip when a corrector rod engages a corrector wheel and stops the feed.

Accurate synchronism between the Wheatstone transmitter and the new receiver is not absolutely necessary. So long as the detent and cam are revolved at a speed which admits of two successive half revolutions being completed somewhere within a period equivalent to that of a complete "reversal" the conditions for accurate reception up to any speed within 200 or 220 words per minute may be said to exist. It is necessary for the centre hole in the slip *F* to be as nearly as possible in line with the corrector rod at the moment of engagement. An error of 20 per cent. is, however, permissible, and this is taken up by the corrector rod sliding down the face of the V-groove in the corrector wheel and "correcting" it either forward or backward.

The New Creed Printer.

The old type of creed printer, known as the compressor printer, which is the instrument most familiar to telegraph engineers, was shown on the stand, but was not in operation. The disadvantage which attaches to this instrument is that its maximum speed (about 120 words per minute) compared very unfavourably with the maximum speed of the Creed receiver. Consequently on lines where the working speed exceeded 125 words per minute it became necessary to install two printers in order to keep pace with the traffic. The new printer has been designed with a view to raising the maximum speed to that of the receiver, and it was very evident from the repeated demonstrations of the working of the machine that this attempt had been wholly successful, for speeds of 200 words per minute were easily attained, and 150 words per minute seemed a comfortable working speed.

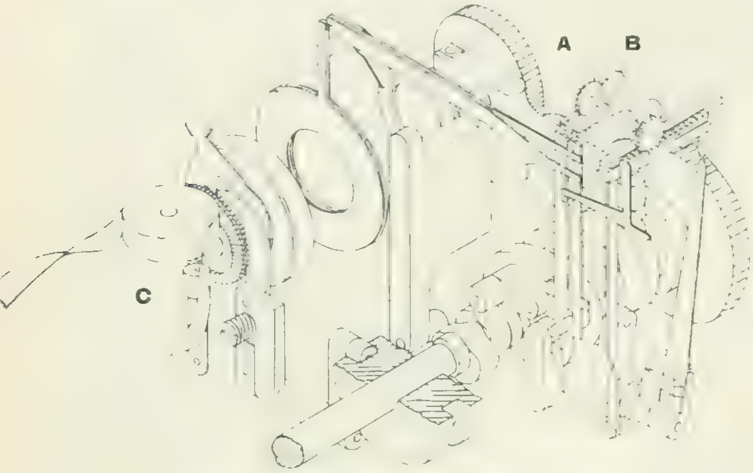


Fig. 5.—Diagram of New Creed Printer.

The present design of printer embodies many new features, the most important of which is the raising of the maximum working speed. The accompanying diagrammatic sketch (Fig. 5) will explain the action of the instrument.

The received perforated slip is passed into the printer at A and out at B; while the slip on which the printing takes place is drawn round a rubber-faced platen at C. The perforated tape is fed forward letter by letter in a guide-way over a series of ten pairs of selecting needles or "selectors." Each selector operates a combination disc or comb through the medium of a horizontal actuating lever, and the twenty combination combs are mounted side by side on a drum or body, upon which they are permitted to turn the fraction of an inch in one direction only.

Each of these combination combs is slotted on its edge with a different arrangement of slots, and can be made to occupy one of two positions, one of which, in combination with other selected combs, opens a longitudinal slot in the whole series of twenty combs, and permits a spring-controlled latch, or "bellcrank," to drop in.

Passing through the axis of the drum is a spindle which continually rotates the type-head and "stop" through a friction clutch. When the selected combs open a longitudinal slot and admit a bell-crank the outer end of the latter is projected into the path of the "stop," thus momentarily arresting the rotating type-head and causing the clutch to slip. A cam on the main shaft is timed to actuate a "hammer" when the type head ceases to revolve, and thus cause it to strike the back of that particular type directly opposite the paper ribbon, and so record an impression. There are 53 bellcranks occupying 53 radial positions round the circumference of the 20 combs. Similarly there are 53 typebars radially distributed round the typehead, each one of which can be stopped opposite the paper by causing its particular bell-crank to project and arrest the "stop."

After the operations of selecting and printing are completed the bellcranks are restored by a suitable cam motion and the "stop" and type-head continue to revolve until the next letter is selected.

The perforated slip is fed forward by a star-wheel fitted to a small spindle carrying a toothed wheel, which is rotated as required by the movement of a cam controlled rack. This rack is given a forward motion for feeding purposes, but is disengaged from the toothed wheel on its return so that the slip is always fed in one direction.

The extent of the forward movement of the rack is limited by the distance to the first space signal, that is to say, the length of a letter. To provide for this limit there is a group of ten space levers or "space-stops" normally in the path of the rack, and preventing its backward movement. Each space-stop is also in the path of one pair of selectors and when either needle of a pair passes through a perforation in the slip the corresponding space-stop is moved out of the path of the rack. Hence, with any letter or figure of the International Morse Code there is a clear backward path for the feed-rack until it reaches a space signal or a portion of the perforated slip bearing centre-holes only, in which case the space-stop is not moved. It will thus be seen that the length of the forward feeding movement is controlled by the distance the rack travels back to the first unmoved space-stop.

The ten pairs of selectors are moved in a downward direction with every revolution of the cam-shaft by means of a returning bar, and are then released and allowed to rise to the paper under the action of small spiral springs (not shown). Consequently, those selectors which correspond to the perforated signal presented by the slip are permitted to pass through the holes and complete their maximum movement, the remainder being held back against their springs by the paper and thus prevented from moving the combination combs in any way.

The printer, of which a view is given in Fig. 6, is mounted upon a polished wooden base containing a drawer for accommodating a coil of tape upon a reel. A motor of 1/10 horse-power will be found to be sufficient for all speeds; the driving spindle should turn in a clockwise direction.

The types are inked by a small ink-roller vertically mounted upon an adjustable pin and caused to revolve by the motion of the type-head itself.

The Carpenter Relay.

The Carpenter Relay plays an important part as a first link between the amplified wireless impulses and the Creed receiver. The principle of this relay, which has been adopted as standard for all Creed receivers and radio transmitting keys, will be understood by reference to Fig. 7. On extensions NS of the cores of a field-magnet are threaded packets of laminations PN, PS, forming the polepieces between which the laminated armature *A* is pivotally mounted. This armature is embraced by the signals coil, which is fixed and does not move with the armature. When the armature

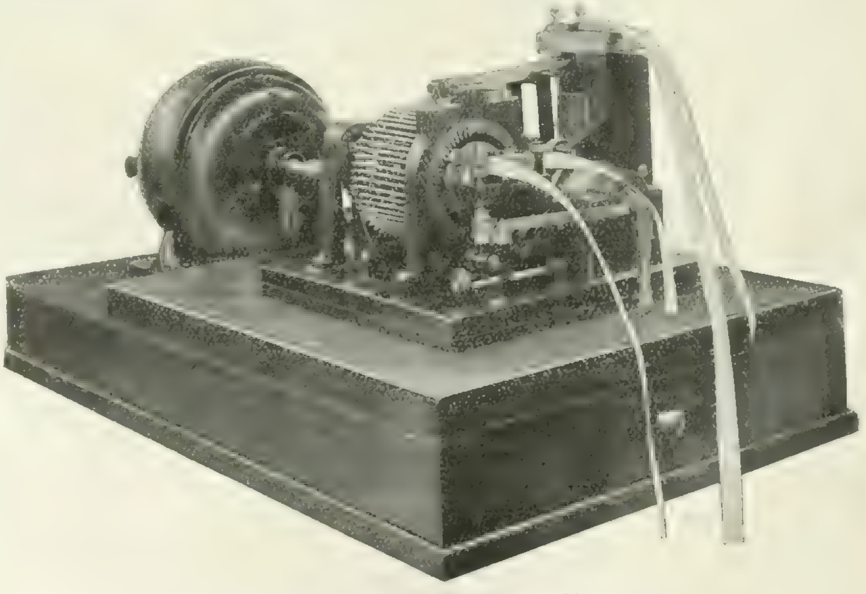


Fig. 6.—View of New Creed Printer (1920 design).

is at rest some of the flux goes straight across the polar gaps as at *BC*, *DE* Fig. 7*a*. A proportion, however, will travel via the path *XY*. It will thus be seen that the adjacent polar faces of the field-magnet and armature have more flux than the distant faces, and that the armature will be held over even though the signalling current which placed the armature in that position has ceased.

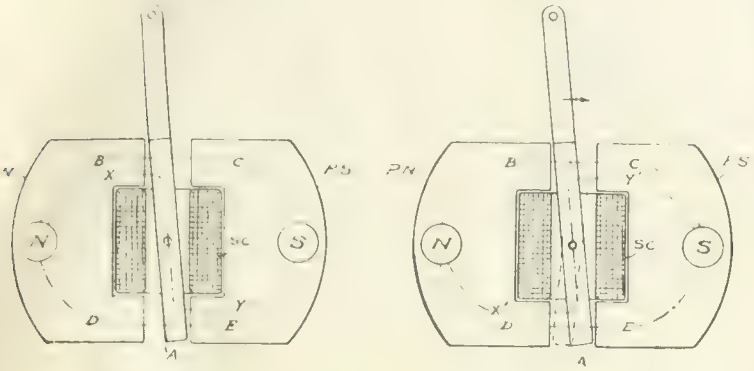


FIG. 7A.

FIG. 7B.

FIG. 7. DIAGRAMS OF CARPENTER RELAY.

On the setting up of a signalling current in the opposite direction, a sufficient magneto-motive force is provided to annul the flux *XY*, and to set up a flux *X′Y′* (Fig. 7*b*) in its place; thus the distant polar faces then have more flux than the adjacent faces, and the armature experiences a torque which moves it as indicated by the arrow.

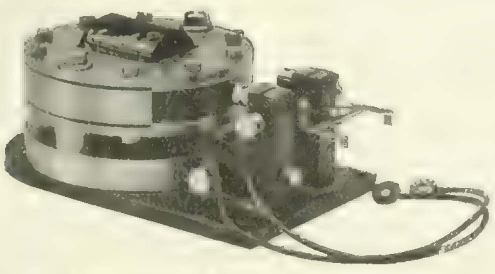


FIG. 8. VIEW OF CARPENTER RELAY.

No difficulty has been experienced in causing the relay to operate at 100 words per minute on a double current circuit, with a current of 0.5 milliampere, and a signals coil wound to 50 ohms resistance.

Fig. 8 shows the relay adapted for use on the Creed receiver.

THE CREED UNDULATOR.

The Creed undulator consists essentially of a trailing syphon recorder. When no current is flowing through the galvanometer portion or "head" of the undulator, the trailing ink syphon merely draws a straight line on the centre of the paper ribbon, but when a signal is received the syphon is displaced laterally by an amount depending upon the strength of the current and on either side of the centre line according to the direction of the current. Thus a time-current "graph" of the signals is recorded on the tape. Hence, in the event of bad signals making their appearance on the perforated tape, it is only necessary to switch in the undulator in place of the Creed receiver for a few moments, when a glance at the "slip" will at once show whether the line signals are satisfactory.

MARCONI-OSRAM VALVE COMPANY.

The MARCONI-OSRAM VALVE COMPANY showed a beautiful selection of triode valves. We also noticed that the Research Laboratories of the General Electric Company exhibited a number of valves with a new type of filament. This filament runs at a very much lower temperature than the ordinary tungsten filament in the types of valves in general use. The advantages so gained are of considerable importance. In the first place, the life of the valve is much longer, since at the lower temperature there is little or no disintegration of the tungsten. Secondly, the watts required to heat the filament are reduced to about one-sixth of the usual values for the same diameter of filament. The advantage does not end here, however, for the increased strength resulting from lower temperature permits the use of finer filaments, the watts for heating these being only about one-twentieth to one-fortieth of usual values. Thus it is possible to work a six valve amplifier with a current consumption of half an ampere from a single accumulator cell. Characteristic curves for these valves are very similar to those of existing types in use for Wireless Telegraphy.

ELLIOTT BROS., LTD.

Messrs. ELLIOTT BROTHERS showed a selection of their well known instruments. Among innovations we noticed a demonstration millivolt meter reading to 150 millivolts and provided with shunts for 1½ and 15 amperes. Such instruments are useful for lecture purposes, and we believe they have not hitherto been manufactured in this country. Messrs. Elliott have also now undertaken the manufacture of small high class double current motors suitable for driving whetstone telegraph apparatus. They are series wound and especially made to give the required range of speed. This firm have also opened another new line, namely the chemical engraving of name plates and diagram plates. A number of excellent samples of these plates were shown.

(*To be continued.*)

Correspondence.

A QUESTION OF NOMENCLATURE WIRE RADIO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In view of the fact that new developments are frequently given unsuitable nicknames at an early stage which stick to them afterwards, General Squier's letter on this subject in your issue of December 17th is very opportune.

The system of telegraphy and telephony to which General Squier refers employs high-frequency currents along special conducting wires between the transmitting and receiving stations. The word "radio" is, however, reserved for the transmission of energy by electromagnetic waves employing systems the particular feature of which is that *no* special conductors connecting the stations are necessary. The introduction of the term "wire-radio" is thus giving to "radio" a new meaning, equivalent to "high frequency currents" or "a system employing high-frequency currents," and is objectionable for this reason.

The German term "high-frequency telephony and telegraphy" appears to be the most appropriate of those at present in use, provided that the English term "high frequency" can be given a definite meaning. At present this term is ambiguous, and may mean a frequency of one hundred or one million, depending upon the context.

If the ambiguity of the term "high frequency" is unavoidable, I suggest that this system should be known as the "MF system," the "F" standing for "frequency," the "M" for the usual prefix "mega," and the combination indicating a system employing frequencies in the neighbourhood of a million cycles per second.—I am, &c.,

Greenwich, C. L. FORTESCUE.
Jan. 17, 1921.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The suggestion of your correspondent, Maj.-Gen. George O. Squier, on nomenclature in your issue of December 17th last, brings up a very important point which deserves to be taken up at this time.

According to the older theory, which some believe alone deserves to be characterised as Maxwellian, a "closed" circuit even if oscillating at radio frequencies can never radiate energy *per se*. This is because the electric and magnetic field energies are wholly recoverable as such. Such transfer of energy as does take place is due to that important factor which Maxwell designated as the mutual induction. In other words, if energy is lost to the circuit at all, it necessarily takes place wholly by virtue of the magnetic field component; for it by no means follows that energy must be continuously transferred as in the case of electromagnetic waves.

From this point of view, it would be better, in the matter of nomenclature, to keep to the idea of "frequencies of the order of radio," as the Germans have done, rather than to suggest a Poynting radiation phenomenon dependent for energy transfer (or rather energy divergence) on a coincident E and H in the field in proper time phase and space phase.

However, if we are to believe, in accordance with certain interpretations of the Lorentzian deferred potentials, that a capacitance alone can radiate energy (Bennett), or that an inductance alone can radiate energy (Dellinger), then the suggestion of Maj.-Gen. Squier would be in order. Perhaps for the sake of euphony the designation "wired radio" would then be better than "wire radio."—I am, &c.,

Washington, D.C., Jan. 6. A. PRESS.

UNDERGROUND TIE LINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice that in the discussion at Glasgow on Mr. Woodhouse's Paper, reported in THE ELECTRICIAN of January 7th, Mr. N. C. Bridge is reported as having said that he thought there was no advantage to be gained in power transfer lines, because, firstly, the line might not be used except once in a way for a period of a year, and, secondly, the amount of generating plant necessary for the passage of the energy through the tie line must be kept available at both stations.

It is true that for both stations to get the full advantage of the tie line the obligation must be reciprocatory, but this does not necessarily involve that the smaller station should always have the requisite amount of power lying idle, because it does not follow that the time of the year at which the other station requires the power will necessarily coincide with the maximum demand on the smaller station.

The point, however, which I would like to emphasise is that if tie lines of this nature are being considered, and if the standing charge on these tie lines is worked out in terms of so much per unit, the figure necessarily comes very high, because the total number of units passed over the tie line is so low. If, however, the standing charge on the tie line is divided by the total number of units supplied by the generating station, and not by those supplied over the tie line, a comparison is then obtained in terms of per unit with the total costs of the said generating station; and without going now into details, I believe, for example, that it will be found that on a tie line 30 miles long, and capable of transmitting 30 per cent. of the output of the generating station, or, say, 30,000 k.v.a., the cost of the tie line would not add more than 3 per cent. to the cost of the unit as turned out by the generating station.

If this be so—and I believe it is capable of demonstration—then surely that is a much smaller handicap on the generating station than even the normal fluctuation in the price of coal or wages, and may be looked upon in the nature of an insurance, in return for which one may save the whole of the generating plant from being seriously overloaded for a period, it may be of some months, resulting, no doubt, in a considerable shortening of its ultimate life; or, alternatively, one may take on 3 per cent. additional consumers (and thus pay for the insurance) without appreciably diminishing the 30,000 k.v.a. required to be available. What one would really do would, of course, be to put in the tie line for 33,000 k.v.a., so as to get the 30,000 k.v.a. after the 3,000 k.v.a. for the new consumer has been deducted.

Where transformers of the suitable pressure already exist at both stations, the supply and running of the cables should surely be a work involving *greatly* shorter periods of time to carry out than the putting down of new generating plant, and affording great opportunities for the utilisation of rough labour, which in the present state of the country's finances would seem to be a good investment.—I am, &c.,

Birmingham, A. M. TAYLOR,
Jan. 14th. Major.

SELF-EXCITING MERCURY RECTIFIER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There appears an article in the November 19, 1920, issue of THE ELECTRICIAN, page 583, entitled "Self-Exciting Mercury Rectifier," in which a small auxiliary rectifier is maintained in the rectifier for the purpose of continuous excitation. We are pleased to advise you that on our series mercury arc rectifiers used in the United States, it has been our practice to have the tubes self-exciting, and there is a small auxiliary rectifier at the lower part of the tube for the purpose of obtaining continuous excitation. Rectifiers embodying this device were put in service in the Fall of 1905, since which time we have supplied over 2,000 rectifiers, most of which are still in service, and furthermore, we are still building them. The auxiliary arc is started by shaking the tube, in early outfits by hand, though later we developed an automatic shaking device which continuously shakes the tube when the alternating current voltage supply is on and the rectifier is not operating. The bulk of these rectifiers are rated at 50, 75, and 100 lights capacity on the basis of 90 volts per lamp, including line losses, which would give an output voltage of 4,500, 6,750, and 9,000 volts, and running amperage of 4, 5, and 6.6 amp. They have been built for varying frequencies, from 25 to 140 cycles, primary voltages up to 13,200, and are generally used for operating magnetite arc lamps on a series circuit.

So there can be absolutely no question but what it is possible to build self-exciting, so-called, mercury rectifiers.—We are, &c.,

West Lynn, Mass, GENERAL ELECTRIC CO., U.S.A.
Dec. 27. *per* C. M. GREEN.

VARIABLE SPEED ROLLING MILL DRIVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On page 523 of your November 5, 1920, issue in an article entitled "Variable Speed Rolling Mill Drives," by Mr. W. E. Swale you publish a diagram entitled "Fig. 3, Scherbius Milch System." Unless we are mistaken, this diagram is intended to show the system covered by the writer's U.S. Patent No. 1,306,594, figure 11. The writer also described this system in an article presented in June, 1920, at a convention of the American Institute of Electrical Engineers, and a diagram of the same system is shown in Fig. 12 of the writer's article. In Fig. 3 of Mr. Swale's article the electrical position of the shunt winding and of the regulating transformer have been interchanged.

In the Milch system covered by U.S. Patent No. 1,085,511 the frequency changer when used as an exciter for a polyphase commutator regulating machine supplied the entire field excitation while in the writer's system the frequency changer exciter is made much smaller and supplies only the resistance drop of this field winding in conjunction with the rheostat, while the reactance drop of the field winding is supplied from the regulating transformer.

We trust you will pardon our calling your attention to this error.—I am, &c.,

Schenectady, N.Y., JOHN I. HILL,
Dec. 29. Induction Motor Dept.,
General Electric Co., U.S.A.

THE ENGINEERS' CLUB.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is extremely encouraging to see the efforts that are now being made by Mr. Hill and his colleagues to form an Engineers' Club in London, linked up with other proposed Engineers' Clubs in provincial cities, including naturally the pioneer of them all at Manchester.

Considering the fact that our city is justly acclaimed as the centre of the majority of the World's human activities, and that civilisation in its material expression is mainly the work of engineers, there should be no special pleading required to obtain a generous moral, intellectual and material support for this enterprise.

It is therefore to be hoped that engineers will get into touch with Mr. Hill's provisional committee at the earliest possible moment to ensure that the scheme may be launched with the least possible delay, and that in the near future engineers may have the finest club in the country available for recreation, social intercourse, professional discussion, together with feeding and sleeping facilities on a level with those to be found at a first-rate hotel.

This scheme should interest not merely the 3,000 engineers in the city who are called for, but at least 30,000, and, perhaps, many more! I am, &c.,

London, Jan. 17. RAYMOND J. MITCHELL.

A CHRISTMAS TRAGEDY

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Beauchamp, in his letter in last week's ELECTRICIAN, takes a very extraordinary line of criticism. He condemns me, not for any inaccuracy of specific statement or general conclusion, but, in effect, for daring to lay sacrilegious hands upon the spluttering "ark" of electrical progress. It appears that I have been guilty of profanation.

Now, although I have no intention of recanting (except upon reasoned evidence) the opinions expressed in the article which has incurred Mr. Beauchamp's wrath, I must certainly confess that I did not expect to be taken so seriously. I had supposed that the purposely extravagant tenor of my writings and the use of the somewhat comic *nom-de-plume* "Electrocynic," would have preserved me from the critical attentions of the serious and lofty-minded. In the circumstances, there is something ironical in the fact that I should have drawn the fire of one of the heaviest guns in the electrical profession.

I am, it seems, an electrical "'candid friend,' a difficult person, although well-meaning, and no doubt useful to the world." It is gratifying to know, on Mr. Beauchamp's authority, that I am useful to the world; but I would rather have been assured that my existence and work were faintly beneficial to the *unworldly* cause of electrical development.

The stinging gist of his letter is in the second paragraph, wherein he makes the extraordinary assertion that an electrical paper is not the proper place for the adverse criticism of electrical apparatus, because such a paper may be read by people outside the industry. This extraneous circulation must be quite inconsiderable; but, in any case, I am sure that the vast majority of engineers would dissent from Mr. Beauchamp's startling proposition. Where *are* we to argue and dispute if not in our own professional journals?

Mr. Beauchamp suggests that the proper course to take, should one desire to draw attention to constructional defects, is to inform the individual manufacturer. Of course, if one were buying a kettle or fire, and found evidence of bad workmanship, one would naturally point it out at the time. But what if I want to criticise without attempting to buy, or to indict a system or a class of appliances? How, in such cases, can I avail myself of Mr. Beauchamp's procedure? Few manufacturers would listen to disinterested criticism, unless made by a personal friend or by someone of high standing and repute in the industry. In any case, it is obvious that widespread abuses can only be tackled by wholesale methods (*i.e.*, through the Press), and are entirely unsusceptible to piecemeal treatment.

I am ready and anxious to be convinced that my allegations of unworthy manufacturers were too sweeping, in which case I shall be pleased to array myself in the white garments of penitence; but I am by no means prepared to admit that the subject is too sacred, or is otherwise unsuitable, for discussion in the electrical press.

As to the effect of my lucubrations, I think Mr. Beauchamp takes an unduly pessimistic view. If they discourage the abuses which they castigate, then surely their predominating influence is on the side of the angels, even if they do, in isolated cases, damp the enthusiasm of prospective buyers. I can assure Mr. Beauchamp that one of the things most to be feared by the industry is the possibility that propaganda may outstrip manufacture, and may encourage the general use of unsatisfactory apparatus—a result which would be seriously detrimental to the best interests of electrical development.

Mr. Beauchamp is carrying on a very difficult task in a highly admirable manner, but he is not the only Richmond in the field. Many other people, including myself, are just as enthusiastic as he is for the progress of the electrical industry. We do not, however, all work on the same lines, and I trust that Mr. Beauchamp will try to look upon my serio-comic method of helping things along with a kindly tolerance which, I regret to say, was absent from the final sentence of his letter, wherein "*persons* like 'Electrio Cynic'" are appealed to "to see that the benefit of their energies and of their experience is applied to the industry in such a way that it cannot possibly do harm . . ." By the by, how can a benefit be harmfully applied?—I am, &c.,

"ELECTROCYNIC."

MR. E. F. W. ALEXANDERSON ON WIRELESS TRANSMISSION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The analogy of Alexanderson's Rocking Boat in the issue of December 3rd last is good.

It is in keeping with the New Thought idea that if you run fast enough you can catch up with your earlier days. Henceforth the "Greatest Electrical Corporation on Earth" declares the efficiency of a condenser for radiation is to be measured by its cubical contents. Is it not true that the "electrical displacement" is measured by the area of the separated surfaces multiplied by the height? However, in view of the recent radiating inductance in the form of a loop why have a condenser at all? Does not each prove that the other is unnecessary?

That authorities should discover new thought ideas is to be expected, but they really ought to consult with each other before "improving" the public mind.—Indeed, I am, Sir, &c.,

A FORMER PURVEYOR OF TRIFLES.

THE TELEPHONE CRISIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the general outcry on the subject of the telephone charges the private house owner does not seem to be as vocal as the business man. A few years ago when the Post Office took over the telephones there was a canvassing campaign to practically all private houses, and though I cannot profess to know whether this service pays its way or is a charge on the system it may be well to consider the private users' case in provincial districts.

Individually, I live 1 mile and 1 furlong from the market place of a provincial town, but the exchange is at least another furlong the other side of the market place. In the past I have paid £6. 10s. per annum for 500 calls and have as a matter of fact never been charged for more, so I presume I have always used less. Under the proposed new rates so far as I understand them I shall have an initial charge of £7. 10s., plus 2 furlongs at 25s., making £10 in all, before I have had a call at all, and assuming I use only 400 calls per annum, that means a further 50s., so that my telephone instead of being a convenience, becomes a luxury. Instead of the Post Office telephoning me any telegrams, they will have to send them up to me by hand and, as this is at present a free service, and I have a fair number of telegrams every year, they will have some little addition to their costs on that score, besides losing my small fee for the telephone. It also seems to me that if a large number of subscribers in provincial and scattered districts decide they cannot afford to go on using the telephone, the shopkeepers, who use their instruments largely for replying to customers' orders and calls, will also find that they will not need their instruments.

The middle classes, who, I believe, contribute rather more than their share to the National Exchequer, are in thousands of cases looking for means to economise and quite apart from any question of "boycott" will certainly fix on this item as one they can cut out of their expenditure though admittedly at some inconvenience.

We are as a nation gradually learning to *do without* those little extra comforts many of us have found nice, and are slowly, but I fancy surely, returning to the more primitive conditions of living, and though this movement is, perhaps, not very apparent yet in some circles, it must spread more and more rapidly unless the world returns to a clearer appreciation of the shallowness of its purse in the very near future.—I am, &c.,

London, Jan. 18th. M. J. E. TILNEY.

[We regret we have had to hold over some correspondence. —ED *E*.]

New Wireless Station at Northolt.

The new wireless station which is being erected by the Post Office at Northolt, is quite close to London, lying half-way between Uxbridge and Harrow. The aerial system will consist of a triangular network, each side of which will be 650 ft. in length. The aerial will be supported by three Elwell wooden lattice towers, each 446 ft. in height. The earth system will consist of a network of copper strip connected to metal plates buried at the bottom of the excavations made to receive the stay wire anchorages, and tower and building foundations. The transmitting equipment, both primary and secondary, will be Elwell-Poulsen arc generators fitted with remote control. It is interesting to note that the decision to install these arc generators was reached after alternative tenders had been obtained for valves and alternators. In the near future a valve set employing the latest practice in valves, viz., the high-power Mullard silica valves will also be installed. When this has been done comparative tests will be made to ascertain which system is the more economical and reliable in commercial operation. The specification calls for a minimum output of 50 amps. in the aerial, and arrangements are being made for the emission of a single wave when transmitting, and the complete suppression of radiation when spacing, instead of the usual de-tuning.

We believe that this will be the first arc station of any size to operate commercially on this principle. It is unnecessary to state at length the many advantages gained by being able to stop radiating when spacing, such as the saving in power, and the freedom from jamming which will result. Although the output to the aerial is quite considerable, the station will be operated directly from the Central Telegraph Office, London, at speeds of about 60 words per minute, but provision has been made for the installation of high-speed signalling at more than 100 words per minute.

The whole of the wireless equipment and masts have been placed in the hands of Mr. C. F. Elwell, who is at present also completing the two Imperial Wireless Stations at Oxford, and at Cairo. The object of the new station is to give direct working to Central Europe, and the rates per word will be the same as the existing telegraph rates. The service should be vastly superior, however, as the use of lines passing through many different foreign countries will be eliminated.

Severn Barrage Scheme.

We understand that the whole question of the Severn Barrage Scheme is shortly to be discussed in Birmingham at a combined meeting of civil, mechanical and electrical engineers. As a contribution to the history of the proposals, the following letter addressed by Sir John Snell to Mr. G. L. Addenbrooke early last year will, therefore, be of interest.

Electricity Commission,
Gwydyr House,
Whitehall, S.W. 1.
Feb. 24, 1920.

SEVERN TIDAL SCHEME.

Dear Mr. Addenbrooke,—

As I daresay you will have seen from the papers, the Chairman of the Great Western Railway Company the other day spoke of a bridge proposed to be constructed across the Severn, one abutment of which would, I understand, be on the Beachley Peninsula. Sir Philip Nash and Sir Alexander Gibb. of the Ministry of Transport, have seen me about this, and I have told them broadly of the proposal of your self and your colleagues. Sir Alexander Gibb, who is the Director General of the Civil Engineering, would very much like to have an opportunity of reading the evidence which Mr. Meik in particular gave, as there is an earnest desire if it is at all possible to take into account the proposals which you have laid before the Water Power Resources Committee. I feel I am not at liberty as Chairman of the Committee to authorise the passing of this evidence to Sir Alexander Gibb without your consent, although I know that he would treat the evidence as confidential. I think it would be to your advantage, or at any rate it would not be to your disadvantage in any way if Sir Alexander might read this evidence. May I have your assent thereto ?

You will have a communication from the Secretary in a few days inviting Mr. Meik and yourself to attend a meeting of the Water Power Resources Committee on Thursday the 11th proximo, at which meeting Sir Philip Nash and Sir Alexander Gibb will both be present, with a view to discussing the broad aspect of this question, and to see whether it is possible to delay the construction of the Severn Bridge until such time as the further investigation into the tidal scheme can have been made.

Yours very truly,
John Snell.

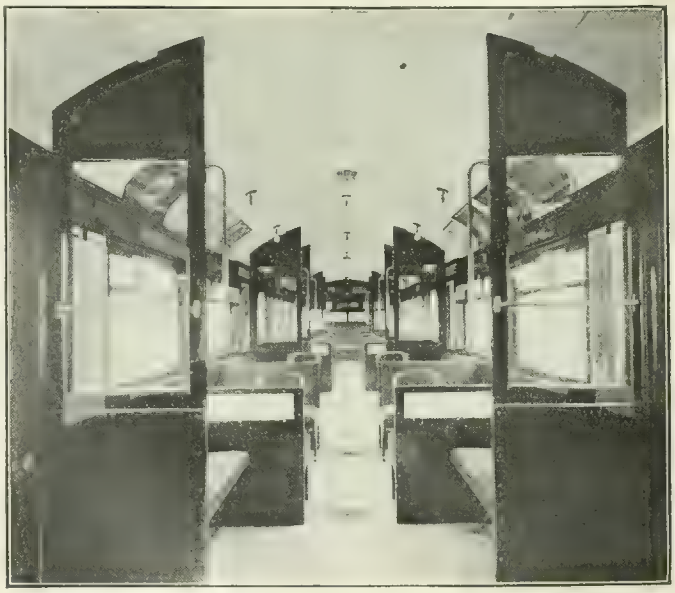
G. L. Addenbrooke, Esq.,
35, Holland Villas-road,
Kensington, W.

New Type Metropolitan Railway Trains.

City workers and travellers generally will learn with relief of the big effort of the Metropolitan Railway to bring their traffic facilities up to post-war needs. Hitherto the barrier to all accelerative measures has been the difficulty of expeditiously entraining and detraining passengers, but with the sweeping yet logical reforms carried into effect in a new train recently brought into service, this drawback will be largely overcome.

In this train, which is an instalment of a number actually under construction, the Company have taken the bold step of entirely dispensing with the end vestibule, and are utilising the space thus saved to give added seating accommodation, and providing in lieu three sets of wide double-doors evenly distributed along the car. The cars, of which we show an interior view, may justly claim to represent the acme of travel-comfort and embody numerous improvements of sterling merit. Each contains seats for 50 passengers, arranged traversely on both sides of a spacious aisle with here and there a double seat set compactly between. Strap-hanging has been completely abolished, and in its place "steadying rails" are conveniently placed at the height of the average man's hand-shake.

Another welcome innovation is the provision of a glass screen flanking each door, which, in addition to giving passengers immunity from draught, has the happy effect of breaking the car up into a series of semi-compartments. The heating ventilation and smooth running show a marked improvement on previous types, and the graceful "dome" roof and softening of lights obtained by the use of opal reflectors leave nothing further to be desired.



View of the Interior of the New Metropolitan Train.

Further interesting points in connection with the new cars are that the three sliding doors will allow a saving of some seconds in time at each station in the detraining and entraining of passengers. The elimination of end vestibule will give more seating accommodation, and steel being largely used in the construction of new cars and all woodwork being specially treated against fire, risks on this account will be reduced to a minimum.

Delivery of further cars will be made at regular intervals, and from now onwards there will be a gradual approach to the company's objective of increasing the present seating accommodation by 20 per cent which, based on present traffic, will approximate over 100.000 additional seats daily.

A youth named Leslie Harrison, employed by the Shropshire, Worcestershire & Staffordshire Electric Power Company, was accidentally killed while carrying out electrical repairs recently. Harrison was sent to the works of Messrs. James Grove & Sons, Halesowen, to do certain work in a cubicle, and he was warned that there were live wires in the cubicle. Later a cry was heard, and Harrison was found bending over the wires, having received a fatal shock. The work had been completed, and the foreman said he thought Harrison must have returned to the box to have another look at it before it was inspected. The Coroner said it was possible that the youth slipped and fell on ot the live wires.

Joint Electricity Undertakings.

The latest draft scheme for electricity supply to be published is one that has been prepared by Leeds Corporation for the constitution of a Joint Electricity Authority for the West Riding (Aire and Calder) Electricity District. We learn that other schemes are in course of preparation by neighbouring local authorities, so that the Electricity Commissioners will have more than one alternative proposal to consider at the local inquiry. The area dealt with is the same as that defined by the Electricity Commissioners and in its main outlines the scheme is somewhat similar to the proposals put forward for the West Lancashire and Mersey and the North Wales and Chester Districts. It is divided into three parts, dealing with administration, technical and financial details respectively, and though probably it may not be held to comply with the full requirements of the Commissioners as foreshadowed in their memorandum on the reorganisation of electricity supply which was issued in July last, it is at least a serious attempt to deal with the requirements of one of the most important industrial areas in the Kingdom.

Details of the Proposed Authority.

The proposed authority is to consist of 19 members only, and it is to be representative of (*a*) all authorised undertakers and distributors, and (*b*) of all local authorities having the right to purchase any electricity undertaking within the district. The basis of representation is the number of units of electricity supplied per annum, one vote being given for every 60,000 units. The period of office is three years, and the constitution can only be altered by an order of the Electricity Commissioners or by a special resolution passed by a majority of at least two-thirds of the members of the Authority and approved by the Commissioners.

Powers of the Authority.

The powers of the Joint Authority are substantially those conferred by the Electricity (Supply) Act. It may own and manage such "capital" stations and transmission lines as may be vested in it; it will acquire the purchase powers of local authorities in the district; and it is also suggested that the Authority may, at any time after the expiration of 42 years, purchase the undertaking of the Yorkshire Electric Power Company, according to the terms of Sec. 2 of the Electric Lighting Act, 1888. Apart from any opposition by the Company, a difficulty will arise from the fact that the latter's area of supply extends into adjoining electricity districts, but, no doubt, the Commissioners would be equal to this task by readjusting the boundaries of the districts or by adopting some other device.

Technical Details.

Naturally the scheme for improving the organisation of electricity supply in the area will be carried out in stages. It is proposed to interlink the existing stations at Leeds, Bradford, Batley, Thornhill and Wakefield to a control station to be installed at Morley, with extensions from Bradford to Shipley and Keighley, from Wakefield to Barnsley, and from Batley to Dewsbury. At a later date the linking-up to Morley will be extended to embrace Halifax and Huddersfield, and still later to connect to the proposed third "capital" station at Knottingley. The system of supply to be adopted will be 3 phase 50 periods; the main transmission pressure is to be 33,000 volts, stepped up from the generating pressure of 6,600 volts, and it is probable that the transmission pressure between Morley and Knottingley will be 66,000 volts. Intermediate pressures of 6,600 and 11,000 volts will be used in certain cases in order to take advantage of existing cable networks. From Leeds to Morley six 2-sq.-in. 3-core cables will be laid, three similar ones from Bradford, Thornhill and Wakefield, and two from Batley to Morley. Particulars of the extensions as well as of cables required to deal with the load in 1935 are also given. It is proposed to erect a new capital generating station in Leeds on the banks of the Aire and a second station at Wakefield, to be in commission by 1933. The ultimate capacities of these three stations will be, at Leeds and Wakefield six 25,000-kw. generators, and at Knottingley eight 35,000-kw. sets. Suitable capacity in transformers will have to be provided, and it is proposed to put in units varying from 2,500 k.v.a. to 10,000 k.v.a. Generating plant of 64,000 kw. is already on order for Leeds, Bradford, Halifax and Thornhill.

Until the first capital station is in commission, all existing stations will be required, but when the capital station at Leeds is sufficiently advanced to deal with a continuous load of 50,000 kw. the stations at Batley, Wakefield and Barnsley can be completely shut down; and, in addition, during the summer the stations at Keighley, Shipley and Dewsbury will cease to operate. Also in the summer time the amount of power generated at Bradford, Halifax, Huddersfield, Leeds and Thornhill will be considerably reduced. The total of the maximum loads of the 11 generating authorities concerned is 105,000 kw., and it is anticipated that in five years' time this will be 180,000 kw. There is installed engine plant of 188,000 kw. and boiler plant of 150,000 kw. capable of dealing with a load of 120,000 kw., but in five years the boiler plant will be 205,000 kw., which, allowing for reasonable spares, will deal with 165,000 kw., leaving a shortage of 15,000 kw. It is, therefore, proposed that the Ministry of Transport should proceed forthwith with the erection and equipment of the first section of the capital station at Leeds.

Financial Provisions.

The financial portion of the scheme contains one or two debatable points. For instance, it is proposed that the Minister of Transport shall erect capital stations, and provide and lay all transmission mains for the interlinking of generating stations and also such additional transmission mains as may be necessary for supplying all authorised distributors, together with the necessary working capital for the operation of the capital stations; but the electricity authority is to repay the amount so expended, with 6 per cent. interest, out of the net revenue derived from the working of the capital stations. The expenses of the Authority are to be met out of the revenue from the sale of electrical energy and grants from the Imperial Exchequer. Provision is made for the creation of capital and revenue accounts, for borrowing money, &c.

National Association of Supervising Electricians.

Annual Dinner.

The annual dinner of the National Association of Supervising Electricians was held at the Holborn Restaurant, London, on Saturday last. It was evident that the members were simply out to provide and to partake of an enjoyable evening's entertainment, to refrain from talking "shop" and to cast aside for the nonce all industrial problems. Few chairmen could, therefore, be found so suitable for such a gathering as Mr. J. S. **Highfield**. Mr. Highfield always displays the most charming urbanity, while his eminence in the electrical profession tends to raise the status of such an organisation as the N.A.S.E.

The toast of "The President" was proposed by Mr. R. W. **Whitley**, who said it had been remarked in a leading journal that the people deserved the government they got. If by the same token an association deserved the President it got, the N.A.S.E. was one of the most deserving associations.

The **President**, in thanking Mr. Whitley for his remarks, said that while disclaiming praise for himself personally, it was a fine thing to hold in honour the President of an institution. There was no other way to carry on the work of an association or of a country than by doing what the skipper said.

Capt. F. H. **Masters**, proposing the toast of "The Association," said although he was not a supervising electrician, yet he supervised The Electrician, and the two occupations were not so dissimilar as they might appear at first sight. There was no doubt that the Association would develop in size and usefulness as the use of electricity increased, and that development would be a good thing for the Association, the industry and the world at large. Such Associations as the N.A.S.E. helped the great and useful middle class to present a firm front to movements both from above and below which threatened their existence.

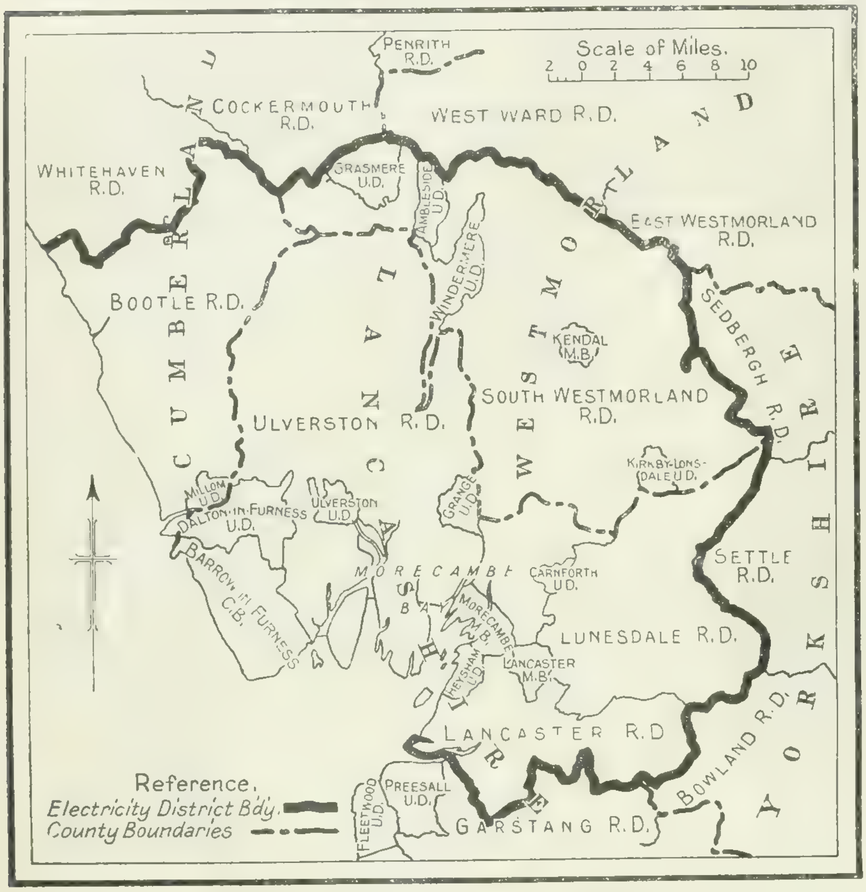
Mr. W. J. **Revell**, replying, said the Association was started entirely as an educational body, but circumstances had compelled it to enter the field of trade unionism. The educational side, however, would never be lost sight of, as it was one of their most sterling assets. Criticism had been made as to supervisors and the higher grades being in the same association with foremen, but he thought it was a good idea, which benefited the industries, for the foreman to be able to come to his superior for advice on technical matters, advice that was always freely given. Their trade union side was regarded as a little unorthodox, but what was unorthodox now would soon be generally orthodox.

Mr. T. **Windibank** gave the toast of "The Press." and, as the Editor of the Association's organ "Contact," enumerated some useful aphorisms for the help of his fellow editors. Becoming more serious, he said he was afraid the electrical industry did not fully realise the debt they owed to the electrical Press, through the impartiality with which it reviewed all their actions and for the educational elements in its columns.

Mr. A. H. **Allen**, in reply, thanked Mr. Windibank on his own behalf and that of his colleagues, and said the electrical Press regarded itself as the servant of the industry, whose interests it sought to foster and cultivate. The electrical Press was nowadays rather a comprehensive term, because there were so many young and thriving journals such as "Electron," "Contact," the "Electrical Power Engineer" the "Contractors' Journal." The older journals, however, had never had to criticise nor find fault with the N.A.S.E., which had always worn "the white flower of a blameless life."

Electricity Districts.

The Electricity Commissioners will hold a local inquiry at Llandudno, on Tuesday, Feb. 15, and following days, with reference to the area to be included in the proposed North Wales and Chester electricity district, and the objections and representations which have been made on account of the inclusion in or exclusion from the said district of certain areas, and to consider the scheme of the North Wales Power & Traction Company for effecting an improvement of the existing organisation for the supply of electricity in the district, and also the scheme of the Corporation of Chester for effecting an improvement of the existing organisation for the supply of electricity and for the formation of a Joint Electricity Authority. Representations or objections with regard to the schemes should be addressed to the Secretary, Electricity Commission, Gwydyr House, Whitehall, London, S.W. 1, by Tuesday, Feb. 8, and a copy of such representations or objections should at the same time be sent to the North Wales Power & Traction Company, Ltd., or to Mr. J. H. Dickson, Town Clerk of Chester, as the case may be.



N. Lancs. and S. Cumberland Electricity District.

The accompanying map shows the area of the North Lancashire and South Cumberland Electricity District, which has been provisionally defined by the Commissioners.

The Electricity Commissioners have extended the time within which representations may be made in regard to the area of the North-West Midlands Electricity District until March 31st, or for the reorganisation of electricity supply in the area.

Trade Journals at Olympia.

At the Efficiency Exhibition, which will be held at Olympia, London, from February 10th to 26th, inclusive, Benn Brothers, Limited, have secured a prominent position in the Main Gallery (just above the Main Entrance), and have arranged for an attractive display of their numerous trade and technical journals, trade directories, and diaries; their numerous scientific, technical and commercial books will also be included. Representatives will be in constant attendance ready to deal with all enquiries concerning the firm's publications, and advise and help visitors on trade matters covered by the Benn organisation. Our readers are specially invited to call at the stand when visiting the Show.

Labour Movements.

By ARTIFEX.

The National Union of Railwaymen name 16 Parliamentary Labour candidates in the official list issued last week.

At a meeting of the executive of the National Union of Railwaymen, held in London last week, proposals for working short time on the railways, were rejected.

Practically every large firm in the Black Country is working short time. The number of workers affected is at least 50,000. There is considerable distress in the district.

The Trade Union side of the dispute in the Tramways Industry will be put before the Industrial Court at its first meeting on Wednesday, January 26. The inquiry will be held in public.

It has been decided by the Clyde district Committee of the Federations of Engineering and Shipbuilding Trades, to ask all men in their area to agree to a voluntary levy in support of the shipyard joiners, now on strike.

The manufacturers engaged in the patent fuel export trade of the Bristol Channel Ports are applying for a reduction of 20 per cent. in wages. A joint meeting was held at Cardiff on Monday last to consider the demand.

The Rt. Hon. J. R. Clynes, discussing the decision of the Joint Labour Conference on unemployment, said he did not think any unconstitutional action could be helpful, and he believed that was the feeling of both leaders and workers.

The threatened strike of transport workers in the Midland areas has been averted, on the advice of the London Executive of the Vehicle Workers, by accepting a 4s. advance offered by the employers. The claim was for an advance of 12s.

It has been decided by the Scottish Miners' Union, at a special conference held at Glasgow, to defer the fixing of a date for the introduction of the 5-day week in the Scottish coalfields, until the annual conference in May next.

Representatives of the Iron and Steel and Kindred Trades' Federation for the North East Coast, at a meeting held at Newcastle last week, unanimously carried a resolution in favour of providing an unemployment fund for the trade, to which employers and men should contribute equally.

A special committee appointed by the Joint Conference of the Parliamentary Committee of the Trade Union Congress, and the Labour Party Executive, to inquire into the question of unemployment and formulate a scheme, is now sitting daily. It will present its Report to the National Congress on January 27th.

As the average selling price of Hematite Pig Iron (Bessemer mixed numbers) was £14 10s. 2d. per ton for the four months ended December 31st, the Cumberland and North Lancashire blast-furnacemen's wages rise accordingly by 18¼ per cent. under the West Coast sliding scale. This is 275 per cent. above standard.

Addressing a meeting of railwaymen at Cardiff on Saturday, Mr. J. H. Thomas, M.P., said it was their province to share in the control of the undertakings in which they work. Speaking later at Pontypridd, he said it would be madness to assume that a general strike would help unemployment.

Engineers' Club.

We are informed that a provisional committee for the proposed Engineers' Club will be constituted as follows, with the addition probably of one or two other names. This committee is to meet early in February, and its first duty will probably be to appoint a strong executive committee to go generally into the question of the formation of this institution:—

Mr. A. H. Allen (Electrical Press), Mr. Llewellyn B. Atkinson, President, Institution of Electrical Engineers (Cable Makers Ass.), Mr. H. E. Blain (London Underground Railways), Sir Dugald Clerk, K.B.E., D.Sc., F.R.S., (Vice-President, Institution of Mechanical Engineers), Mr. A. C. Cramb (Croydon Borough Electrical Engineer), Mr. R. W. Hughman (Electrical Press), Sir Robert Hadfield, Bart., D.Sc., D.Met., F.R.S. (Steel); Mr. Edmund L Hill (Federation of British Industries), Mr. G. Layton (Electric Incandescent Lamps), Mr. G. H. Mensforth, C.B.E. (Director-General Contracts), Brig.-Genl. The Lord Montagu of Beaulieu, K.C.I.E., C.S.I. (Motor Cars), Mr. S. Thornley Mott (Engineers and Contractors), Mr. E. Manville, M.P., M.I.E.E. (Motor Cars), Mr. Ben H. Morgan (Consulting Engineer), Mr. H. J. S. MacKay (Stirling Boilers), Mr. Edwin L. Orde (Shipbuilding, &c.), Mr. F. Handley Page (Aircraft), Mr. P. C. Pope (Motor Cars), Mr. W. Prescott, B.Sc. (Federation of British Industries), Sir W. Peter Rylands (Iron and Steel Wire), Mr. J. D. Siddeley (Motor Cars), Mr. H. T. Wilkinson (Electric Fittings and Manufacturer), Mr. C. H. Wordingham, C.B.E. (Past President Institution of Electrical Engineers), Mr. W. Walker (Consulting Engineer), Mr. David Wilson, C.B.E. (Babcock & Wilcox Boilers), Mr. W. J. U. Woolcock, M.P. (Chemicals).

Something About Electronomy.

At the Institute of Marine Engineers, London, on Tuesday, January 11, Mr. W. Brooks Sayers delivered a lecture on "Electronomy." There is a pleasant nautical geniality about the premises of this Institute, its personnel and the officials, and an entire absence of that austerity which characterises some other institutions. The polite ex-mariner, as we imagine him to be, at the door, makes one feel at home on entry, and the click of the billiard balls which is audible during the proceedings suggesting that the Institute provides for relaxation as well as for education. It is a little difficult at first sight to see why such a subject should appeal to marine engineers, but apparently they go on the principle that a change of occupation is in itself recreation. The lecturer emphasised this view to some extent by playing to the audience a voluntary on the violin which he did very well.

The object of the lecture was to show that the whole phenomena to which human beings are accustomed, such as sunshine, the moon, the movement of the heavenly bodies, the weather and the atmosphere, were all manifestations of the actions of electrons. Mr. Sayers attributed to Lord Kelvin the statement that if the atom were considered as being of the size of the earth the size of an electron would be about that of a pea to a cricket ball at the outside. Kelvin had ascribed solar activity to powerful electric charges, and it was probable that the sun was sending out streams of electrons which he thought possibly carried gases with them, the gases constituting our atmosphere. He suggested that we were not breathing air that had been on this earth for ages, but new air recently made by the sun. Electrification might also be the explanation of the fact that the moon always turned the same face towards the earth owing to the fact that there was always an electric stream flowing towards the side that was away from us. Lightning might also be caused by the arrival in the higher regions of the atmosphere of an electric charge from the sun; and certain phenomena connected with water spouts and plant growth might be ascribed to the same cause.

Commercial Topics.

New Zealand Trade in 1920.

The value of the imports into New Zealand during the quarter ended Sept. 30 last was £18,980,970, compared with £6.516,602 in the corresponding quarter of 1919, the United Kingdom contributing £9,896,416, against £2,465,550. The principal increases were in electrical machinery, iron bar sheets, motor vehicles, boots and textiles. The figures for the nine months show that British imports represented 46·9 per cent. (against 40·7 per cent.), but the United States trade dropped from 26·1 to 17·6 per cent. These records seem to be satisfactory, as they indicate that Great Britain is re-capturing the trade lost during the war.

* * * *

Spanish Export of Electrical Supplies,

According to the "Manchester Guardian Commercial" the Catalonian manufacturers of electrical apparatus have formed a union called the Associacion de Industriales Electristas y Anejos de Cataluña. The principal offices of the Asscoaition are at Barcelona, and one of the main objects will be to obtain facilities from the Government for the export of their products. Catalonia is one of the most industrialised portions of Spain which contains some important hydro-electric works, but hitherto most of the plant and apparatus required have had to be imported, principally from America and Germany in the pre-war times. One of the results of the war has been an endeavour to make the country independent of foreign supplies, and some engineers have established works for the manufacture of electric motors, fittings, &c.

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Trade with the Netherlands East Indies.

British manufacturers and exporters who seek to develop trade in the Netherlands East Indies, one of the most lucrative markets in the world and one that is by no means over-supplied and over-developed should be interested in the announcement that the second Netherlands East Indies Fair is to be held at Bandoeng (Java) from September 19 to October 9 of this year. The fair will be international in character and will offer manufacturers an opportunity of exhibiting wares of all kinds. Everything appertaining to industry, commerce and agriculture will be represented and a motor vehicle and tractor exhibition will be held simultaneously. The British Chamber of Commerce for the Netherlands East Indies, 38, Dover-street, W. 1, will supply particulars.

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Italian Electric Cooking and Heating Developments.

With the object of constructing electric cooking ranges of the "accumulator type" and of all other thermo-electrical apparatus for household and industrial purposes, the following concerns have become partners in a company known as the "Società Italiana per l'Accumulazione Termoelettrica," of Milan, recently formed with a capital of 5,000,000 lire: Banco Klein, Cominotti & Company, Società Generale Italiana Edison di Elettricita, Imprese Elettriche Conti, Metallurgica Italiana, Ferriere Fratelli Redaelli, Società Lombarda per distribuzione Energia Elettrica, Soc. Elettrica Alta Italia (Turin), Soc. Generale Italiana dell' Adamello, Soc. Anon. Imprese Elettriche Piemonte Orientale (Turin), Soc. Generale Elettrica della Sicilia (Palermo), Soc. Ligure Toscana (Genoa), Soc. Varesina per Imprese Elettriche (Varese), Soc. Elettrica Bresciana (Brescia) and the Soc. Elettrica Suburbana Milanese. Unless otherwise stated the firms belong to Milan.

Electricity Supply.

On extensions of mains the Bradford Electricity Committee proposes to incur an outlay of £10,000.

Crewe Council has referred to the Electric Supply Committee a demand for the municipal wiring of houses.

The salary of the borough electrical engineer of Burton-on-Trent, Mr. T. Hall, has been raised from £650 to £900 per annum.

The Aberdeen Electricity Committee recommend extensions of the electric supply undertaking, at an estimated cost of £210,540.

Cheltenham Corporation has received sanction to a loan of £7,500 for extending the electric supply mains to the new housing estate.

The Ashford (Kent) Urban Council has instructed the gas manager to prepare a report and estimates of the cost of an electric lighting installation at the gas works.

Barnoldswick Urban Council is considering the question of taking a bulk supply of current from Nelson Corporation if satisfactory terms can be arranged.

The Electrical Distribution of Yorkshire, Ltd., proposes to apply for a special order to authorise the distribution of electricity in the Hemsworth rural area.

The Deal & Walmer Gas & Electricity Company has asked the Dover Corporation for a bulk supply of three-phase current, but the latter can only supply a single-phase at periodicity of 100.

Gillingham Urban Council has decided to apply for sanction to borrow £10,000 for electric supply purposes. Of this sum, £5,000 is required to cover an overdraft, and £5,000 for services during the next three years.

In consequence of the amalgamation of Leith and Edinburgh, claims for compensation by Leith officials for loss of appointment have been made and these include a claim of £6,500 by the burgh electrical engineer, Mr. A. P. Rutherford.

The Town Councils of Macduff and Banff are carrying on negotiations about an electric supply scheme. The Macduff Council, which is anxious to get Banff to co-operate in a joint scheme, will apply for authority to give a supply in the district.

Stepney (London) Council has referred back a recommendation that the salary of Mr. A. J. Squire, deputy (commercial) manager of the electricity undertaking, be increased as from June 1st last to £700 per annum, rising, by annual increments of £25, to £750.

The Bourne End and District Electricity Corporation, Ltd. has applied to the Electricity Commissioners for a Special Order to authorise the Company to generate and distribute electrical energy in Wooburn, Little Marlow and Hedson, Cookham and Bisham.

Ammanford Urban Council is applying to the Electricity Commissioners for a Special Order authorising the Council to generate and supply electricity for public and private purposes in Ammanford, to collect rents and charges for the sale or use of machines, lamps, meters, fittings, &c.

Ellesmere Port Urban District Council has applied for an extension of time to carry out the provisions of its provisional Order, and the Ministry of Transport has been asked to get the Mersey Power Company to expediate the negotiations with a view to an early supply of electricity being available in the district.

The annual dinner of the electricity department of Rhondda Urban Council took place on Saturday evening under the presidency of Councillor Mark Harcombe, chairman of the Gas and Electricity Committee. Mr. H. H. Reed, chief clerk of the electricity department, was presented with a cruet stand.

Wiltshire County Council has held an inquiry into the application for the Downton Parish Council for a loan of £650 for public electric lighting. Providing the Council finds the mains, &c., the Southern Tanning Company offer to supply current free of cost for the first five years, and then at half the cost paid for petrol gas.

The Burnley Electricity, Cleansing and Gas Committees recommend that the land and buildings now occupied by the Cleansing Committee in Aqueduct-street be transferred to the Electricity Department. The electrical engineer (Mr. J. E. Starkie) reports that the present generating plant amounts to 5,250 kw., and additional plant on order would increase this to 8,250 kw., whilst a further 8,000 to 10,000 kw. would be necessary to meet the next five years' probable demands.

Subject to the consent of the Electricity Commissioners, the Walsall Electric Supply Committee propose to enter into an agreement with the Birmingham Canal Navigation, under which the Corporation will pump water from the level of the canal into another level, sufficient to meet the company's requirements, and utilise the water for condensing purposes at the generating station. The company will be relieved of certain pumping work now carried out by it, and is to pay the Corporation £3,000 per annum. The scheme involves an expenditure of £24,000, of which £14,000 is included in the £119,500 which the Corporation is authorised to spend in the completion of the generating station.

Despite the advice of their consulting engineer, Mr. C. H. Wordingham, the Skegness Urban Council has applied for an extension of time to carry out their provisional order. Mr. Wordingham strongly recommended the erection of electricity works at an estimated cost of £44,450. The estimated cost of running and maintenance was placed at £6,510, and the revenue for the first few years at £6,607, thus allowing a small net profit. That there is a demand for current is shown by the fact that there are at present 11 small installations and 18 consumers in the town, and no doubt these users would dismantle their plants and take the town supply if it were provided.

Blackburn Electricity Committee have approved revised estimates, amounting to £850,000, for the completion of the new electricity generating station. The Council are applying to the Commissioners for sanction to borrow £600,000, being the difference between the amount already sanctioned and the amount of the new estimate.

At a recent meeting of the Corporation to consider the unemployment problem, Mr. Sutcliffe said they had work in the electricity department which would provide full-time employment for about 400 men if they could get a sufficient number of cable jointers. Nearly 300 houses wanted electricity, but they had not men to carry out the work.

An inquiry was held at Sheffield on the 12th inst. into the application of the Corporation for sanction to borrow £200,000 for a new refuse disposal scheme. Technical details were supplied by the cleansing superintendent (Mr. P. Priestley), who said it was hoped to dispose of a considerable quantity of the dust for fertilising purposes. The fine cinder would be mixed with binding material and manufactured into a fuel briquette, and the coarse cinder, after washing, could be used for the generation of steam to be utilised for driving the works and charging the electric vehicles. During the past 12 months the whole of the cinder produced by the experimental plant had been used for steam-raising at the public baths, with excellent results At one of the baths a saving of £15 per week had been made. The public baths would absorb the whole of the large cinder, and this would save about 4,000 tons of coal. The proposed screening plant would be driven electrically, and would only involve a rate of 4½d., or a saving of 7¾d. compared with the present methods. The total saving by the new scheme would be, after paying all capital charges, at least £14,000 on last year's costs.

Mr. Geo. Cadbury, jun., has come forward with a scheme for helping Birmingham Corporation out of its financial difficulties so far as the extension of the Nechells station is concerned. In his communication Mr. Cadbury points out that it is of vital importance to the city that the electric supply undertaking should be developed if the city is to prosper in the future. He suggests that a special electric supply loan be inaugurated and that any funds subscribed should be definitely allocated to the development of the Nechells station. The loan should be at 6 per cent. on the usual terms for Corporation stock. An appeal could be made to manufacturers, because a manufacturer proposing to develop his business would have to face the problem of either getting additional current from the Corporation, or putting down his own plant. As a central supply is cheaper to equip and run than several individual plants it should be possible to obtain a given supply of current at a considerably less capital cost by subscribing to such a loan, and the price per unit ought to be less by taking Corporation current. As a safeguard to manufacturers who invest in the scheme, the Corporation should obtain powers to enable them to co-opt one representative to be nominated by the Chamber of Commerce, and one representative to be nominated by the Electrical Trades Unions. The advice of those two persons would prove extremely valuable to the committee.

Electric Traction.

The chairman of Nelson Electricity and Tramways Committee estimates that the recent application for advances in wages by the tramway employees would involve £1,296 per annum and increase the yearly loss on the undertaking to £2,046. The track also wants renewing at a cost of about £37,500,

Several of the more important clauses of the Manchester Corporation Omnibus Bill were rejected at the town's meeting on the 12th inst., and it is probable that a poll of the ratepayers will now be taken. The rejected clauses included those authorising the purchase of the Stretford gasworks and the making of by-laws to regulate the street traffic and to make every vehicle halt at compulsory tramcar stopping places.

A well-attended meeting of Liverpool electors was held on the 6th inst. to consider the Omnibus Bill which is being promoted by the Corporation. Several of the clauses relating to the construction of tramways were defeated, including those relating to lines along Calderstanes-road and Allerton-road, Woolton and Wavertree, and other lines in Allerton and Garston.

In order to relieve the present traffic congestion and to give increased travelling facilities in the city, a special sub-committee of the Glasgow Tramways Committee recommend the erection of a bridge across the Clyde at Oswald-street and the construction of a tramway line from Cowcaddens, down Hope-street and Oswald-street, to the bridge. Parliamentary powers for both these undertakings were obtained in 1914, and the cost is put at £400,000.

The local branch of the United Vehicle Workers has protested against the decision of the Bradford Tramways Committee to abolish the practice of collecting fares on car platforms, and offers to submit the question to the National Joint Industrial Council for a decision.

The tramways manager has been instructed to ask the Ministry of Transport for their consent to the use of railless trolley vehicles on the Eccleshill, Idle and Thackley tramway sections. The estimate of the cost of renewal of the lines on these sections is £168,919.

A special meeting of the Durham County Council was held last week to consider the promotion of a Bill to authorise the construction of a network of tramways in the county at a cost of £1,631,473, the main items being: Construction of tramways and tram-roads, £847,122; electrical equipment, £397,777; tramway rolling stock, £120,000; trolley vehicles, £143,000. There was some opposition owing to the heavy expense involved, and one or two members suggested motor omnibuses. Ultimately, a motion to proceed with the Bill was carried by 46 votes to 13, but as this was not an absolute majority of the whole Council another meeting to deal with the subject will probably be held.

Institution Notes.

Members of the Scottish Centre of the Institution of Electrical Engineers wishing to attend the conversazione on Feb. 3 are requested to apply for tickets, not later than Wednesday, Jan. 26, to Mr. R. B. Mitchell, of the Glasgow Corporation Department.

We regret that in our account of Mr. A. M. Taylor's remarks in the discussion on Mr. W. B. Woodhouse's paper, which appeared on page 51 of The Electrician for Jan. 7, 1921, the losses in unarmoured cable with single-phase current were given as being 62 per cent. greater than with continuous current. The correct figure is 12 per cent.

At a meeting of the Midland branch of the Association of Mining Electrical Engineers on Saturday a paper was ready by Mr. H. M. W. Royce on "Electrical Control Gear for Collieries." Mr. A. W. Williams, Mansfield (president), was in the chair, and an interesting discussion followed.

At last week's meeting of the Institution of Electrical Engineers the President, Mr. Ll. B. Atkinson, announced that the Council had considered what steps could be taken to encourage research workers and inventors to bring their discoveries and inventions to the Institution for publication, and had decided to invite, for publication in the "Journal," Papers describing discoveries and inventions. Such Papers would be given priority with a view to early publication. The Council were of opinion that Papers of that kind would considerably increase the value of the "Journal."

It is proposed, if a sufficient number of candidates make application, to hold in London in April, 1921, an examination for Associate Membership of the Institution of Electrical Engineers. Arrangements will also be made for the examination to be held at local centres in the United Kingdom and abroad. Applicants desiring to sit for the examination should send their Entry Forms and examination fees in time to reach the Secretary of the Institution, 1, Albemarle-street, London, W.1, not later than March 1, 1921. Entry forms and copies of the examination regulations may be obtained on application to the Secretary.

Catalogues, Price Lists, &c.

A leaflet containing some particulars and prices of the "Hand" dry battery has been issued by Messrs. R. B. Hand & Company, Ltd., 63, High Holborn, W.C.1.

Booklet No. 660 has been issued by Messrs. L. G. Hawkins & Company, 116, Charing Cross-road, W.C.2. on their Universal electric radiator and electric cooking and domestic appliances.

Recent literature emanating from Messrs. Alfred Herbert, Ltd., Coventry, includes leaflets describing the features of their No. 16 patent single pulley vertical milling machine and their No. 4 capstan lathe Delivery of these can be made from stock.

A batch of ten leaflets have been prepared by the Midland Electric Mfg. Company, Barford-street, Birmingham, which give illustrated particulars of some of the company's standard manufactures. The leaflets relate to switches, fuses, fuse-boards, cutouts, &c.

The General Electric Company, Ltd., 67, Queen Victoria-street, London, E.C. 4, have issued a new showcard illustrating their magnet pedestal electric heater. Copies of the showcard, which is a handsome production in colours, will be supplied to the trade on request.

The Edison Swan Electric Company, Ltd., have issued in separate form the pages of their instrument list which deal with their moving coil switchboard type of instruments for direct current. Illustrated particulars of the design and construction, with prices and other information regarding the instruments, are included.

In a list recently issued by the Hart Accumulator Company, Ltd., of Stratford, technical particulars and prices are given of the M.E. and other types of Hart Ignition batteries. The cells are specially designed for ignition work in motor cars and motor boats, and they are also largely used for carriage and motor car lighting. A stock of all sizes is kept ready for immediate delivery. The M.E. batteries have been designed to give the maximum efficiency combined with the necessary mechanical strength and general suitability for their special applications. The company has also issued a folder which gives particulars of the various sizes of Hart batteries suitable for replacing existing batteries for starting and lighting on the various types of American cars which are at present on the market in this country.

At the present time a great deal of attention is being given to water power development both at home and abroad and those occupied with this important subject will be interested to learn that Messrs. Sir W. G. Armstrong, Whitworth & Company, Ltd., have recently issued four leaflets giving some illustrated particulars of the water turbines and other products manufactured by them. Leaflet No. 51 is devoted to the Armstrong-Jensen impulse turbine, No. 52 is on Armstrong-Jensen Francis turbines, and No. 53 on Armstrong-Jensen spiral Francis turbines, which are manufactured by Messrs. Armstrong & Main, Ltd., of Glasgow, or at the company's Openshaw works. The fourth leaflet gives brief information regarding the products and contracts handled by the civil engineering and contracting department, 8, Great George-street, Westminster, S.W.1.

Calendars and Diaries.

We have received from the Keighley Gas and Oil Engine Company, Ltd., a daily tear-off date remembrancer, mounted on a cut-out representation of one of the Company's imperial engines.

Messrs. C. Isler & Company, Ltd., artesian well engineers, Bear-lane, S.E.1., send us a large sheet almanac, on which appear illustrations of a few of the operations performed by the Company's plant.

Miscellaneous.

The regular meeting of the Kelvin Lodge will be held at Mark Masons' Hall, Great Queen-street, W.C. 2, on the 28th inst. at 4 p.m.

A Royal Commission, with Sir Perceval M. Laurence as chairman, has been appointed to inquire into provisions for the avoidance of loss by fire, including regulations dealing with construction of buildings, dangerous processes and fire risks generally, extinction of outbreaks, &c.

On Friday evening, the 7th inst., the London Office staff of Messrs. Boving & Company, Ltd., and Electro-Metals, Ltd., together with their friends, were entertained to dinner at the Holborn Restaurant by their directors, this being followed by a musical programme and dancing.

On the 5th inst., the second of a series of socials was held in the Bristol showrooms of the Edison Swan Electric Company, under the chairmanship of Mr. Fifield. A varied programme of songs, dialogues, recitations and a display of conjuring made the evening a complete success.

It has been pointed out that a misdescription was given of Fig. 2 in an article on "Standard A.C. Geared Winding Equipments" which appeared on page 38 of our issue of Dec. 31, 1920. This illustration should be described as a "Rotor Contactor for the Control of a Three-phase, 40 frequency, 500 volt, 390 revs. per min., 100-150-H.P. motor driving a 7 ft. by 5 ft. cylindrical drum winder at Messrs. Priestman's Axwell Park Colliery.

The Birmingham & District Electric Club held the first meeting of the new session on the fifth inst, when the president (Mr. A. C. Wynne) gave his presidential address, in which he dealt with the present position of the electrical profession and industry. He claimed that the time was more than ripe for those engaged in the business of electrical engineering to consider some means of setting and insisting upon a standard of fitness and efficiency and thus form a means of protecting themselves and the public from the results of the ignorance and malpractices of those who ought never to be allowed practice in a business of such supreme importance to the community as electrical engineering. The Club meets on the second Saturday in each of the winter months at the Grand Hotel, Colmore-row.

In order to recognise their 50 years of service with Messrs. Vickers, Ltd., of Sheffield, presentations were made to Mr. Wm. Marshall and Mr. W. G. Mann on the 12th inst. Mr. Marshall is chief accountant, and received from the staff under his control a silver tea service and an illuminated album containing the signatures of 240 subscribers, while the managers and foremen presented him with a canteen of cutlery and plate and a silver salver. Mr. Mann, who is in the secretary's department, was presented with a clock from the staff, and the managers gave a silver salver. Mr. Wm. Clark, the master cutler and local managing director of the firm, presided over a large gathering when the presentation was made by Mr. Douglas Vickers, M.P., chairman of the company.

Following their policy of sending out specially-trained representatives to report on markets, investigate trade prospects, assist local arents and appoint others for the sale of A. G. E. products where arrangements in this connection are not yet completed and generally expand the Company's activities, the Agricultural and General Engineers, Ltd. (whose head offices are situated at Central House, Kingsway, London) notify that the following are now handling their interests :—In South America, T. H. Dryden, Calle Victoria, 450, Buenos Aires ; in the Balkans, Hugh Ledward, care of The British Legation, Bucarest ; South Africa, Gordon Lyall, P.O. Box 630, Port Elizabeth ; New Zealand, T. W. Cranch, 5, Cameron-street, Devonport, Auckland ; Australia, J. W. Godfrey, Beacon Grange, Eastwood, Sydney. Mr. Sergent has also been appointed for similar duties in Northern Africa, and is at present in Morocco.

The annual dinner of the British Ignition Apparatus Association took place on the 12th inst., and Col. W. H. Bristow urged the need for safeguarding our key industries, of which magnetos were one. He pointed out that the German ascendancy in the manufacture of magnetos was a real menace in the early stages of the war. In the year preceding the war we imported from Germany 300,000 magnetos, but the supply dwindled early in 1914, and completely stopped three months before war was declared. Thanks to America, we were able to obtain supplies to enable us to carry on till our own inventive and manufacturing resources were mobilised. To-day British magnetos had no superior, and they had helped to achieve world's records.

Mr. Peter F. Bennett, who presided, mentioned that right up to the outbreak of hostilities the War Office was specifying Bosch magnetos for all standard vehicles. The Government had promised to include magnetos in the Key Industries Bill to be introduced next session.

The large steam yacht "Beryl," of the late Lord Inverclyde, has been converted into a Cable-laying Steamer by the Commercial Cable Company. The vessel, which has been re-named "George Ward," will be employed mainly in keeping in repair the eastern end of the Commercial Company's cables, off the coast of Ireland, and also the cables in the Bristol Channel and the English Channel. The work of converting and equipping the vessel has been carried out at the Clydeside Repair Works of Messrs. Barclay, Curle & Company, under the superintendence of Mr. John M. Gilchrist. In view of the special nature of the work on which the vessel will be engaged, extra stiffening had to be put in, especially at the bows and under the large cable-laying winches, of which one is fitted forward and one aft. Two large cable tanks have been constructed, and the vessel is equipped with sounding machines, direction-finding instruments, wireless telegraphy apparatus, &c. Commodious state room, dining and smoke rooms have been provided for the officers and staffs.

Imperial and Foreign Notes.

The accounts of the Wellington (N.Z.) municipal tramways department for the year ended March 31 last show revenue £277,087, compared with ££222,892 in previous year, and a net profit of £21,825 (£10,146), and in the power supply section the revenue was £26,669 (£22,462), and the net surplus £1,573 (£2,233). The revenue of the electric lighting department was £103,993 (£94,418), and the net profit £23,925 (£29,862).

In order to deal with the increasing traffic at the Port of Algiers two large electric cranes are to be installed, together with 24 smaller ones.

A meeting was recently held of representatives of electrical enterprises in Argentina to discuss a proposal to form an association to represent the enterprises in their relations with Government and municipal authorities and others, to create educational establishments for the training of personnel for electrical undertakings, to compile statistics, &c. A committee was appointed to draft the constitution and bye-laws,

H.M. Chargé d'Affaires at Port-au-Prince reports that the Haitian Government has entered into a contract with a firm at Jacmel for the erection of a hydro-electric works. At the generating station there will be two 100 kw. three-phase generators and Pelton wheels. Current will be generated at 600 volts, 42 cycles, and the power will be transmitted to the town sub-station by an overhead line at 8,000 volts, the consumers' voltage being 220.

The hydro-electric works at Tange, Jutland, stated to be largest electricity station in Denmark, was opened on the 8th inst. There are six turbines of 6,000 H.P. supplied by a Swedish firm, and three electric generators manufactured by a Danish company. The generation voltage is 10,000, but energy is transmitted to Aarhus and Skive at 50,000 volts. The h.t. transmission lines and transformers were supplied by Messrs. Brown, Boveri & Company.

According to reports from Moscow, which we need scarcely say must be received with very great reserve, there is great activity in electrical circles in Russia. The Putiloff electric stations have been restarted, and the "Makhonin electric train has made its first journey with passengers from Petrograd to Lubau." The work of electrification in the Crutea is said to be proceeding energetically. A large electric station is to be erected for utilising the power obtainable from the mountain rivers. Special attention is also being paid to the use of electro-medical apparatus in the Crimean hospitals and the provision of Röntgen rays, electric baths and electric massage.

Business Items, &c.

On and after the 3rd inst. the offices of the Parsons Marine Steam Turbine Company, Ltd., and Messrs. C. A. Parsons & Company, Ltd., will be at 56, Victoria-street, S.W. 1.

Wm. Nassau Walters and Wm. Wallace Wilson, trading as the Hampshire Electrical Company, 83, High-street, Gosport, have dissolved partnership. Debts by Mr. Wilson.

The address of Messrs. J. Tylor & Sons, Ltd., is Oakleigh-road, New Southgate, London, N. 11. Telegrams : Tylengic Newsouth London ; Telephone, Palmers Green 623-5.

Cyril Kay Hanbury and Thos. Hy. Wilson, electrical contractors, 3b, Padiham-road, Burnley, have dissolved partnership. Debts by Mr. Hanbury, who continues the business in his own name.

Edwd. Alex. Newall and Harold Ira Couchman, electricians, &c., Westerham, Kent, have dissolved partnership. Debts by Mr. Newall, who continues the business.

Edwd. Chapman and Geo. Louis Williamson, trading as the Wensleydale Dairy & Electrical Supply Company, Hawes, Yorkshire, have dissolved partnership. Debts by Mr. Chapman, who continues.

Messrs. Rich & Bundy, specialists in electric heating, 11a-13, New-road, Ponders End, N., have established a repair department and they state that they are in a position to undertake all classes of repairs, renewals, rewinds or conversions to any type or make of electric heating or cooking apparatus.

The Belfast branch of the Sunderland Forge & Engineering Company, Ltd., is now at Sydenham-road Works (off Queen's-road). Telephone, No. 5036 ; telegrams, "Marr" Belfast. New offices, stores and workshops have been erected, and all departments will be concentrated at the above new address.

The agency of Messrs. Hogan & Wardrop, 2, Gresham-buildings, Basinghall-street, E.C. 2, who have hitherto represented the Midland Electric Mfg. Company, Ltd., in London and district, has been extended to cover the whole of the South Eastern Coast from the Wash, and the Southern Coast to Chichester. M.E.M. gear of the latest type is being stocked.

Bankruptcies and Liquidations.

Claims against the Cannon Motor and Electrical Works, Ltd. (in liquidation) are to be sent by February 8, to Mr. P. G. Clegg, 10, Cannon-Lane, Brighton.

The first meeting of creditors of David Suchostawer, engineer, 1, First-avenue, Acton, Middlesex, will take place on Jan. 26 at 14, Bedford-row, London, W.C.1., and the public examination on Feb. 8 at the Court House, Half Acre, Brentford.

Claims against the Lowa Engineering Company, Ltd. (in. vol. liq.) are to be sent by Jan. 29 to the liquidator, Mr. A. J. H. Shay.

Wm. Drysdale, electrician, 24, Paxton-street, Barrow-in-Furness, has been adjudicated bankrupt. The first meeting of creditors will take place on Jan. 26 at 16, Cornwallis-street, Barrow-in-Furness, and the public examination on Feb. 11 at the Magistrates' Court, Barrow.

Tenders Invited and Accepted.

Camberwell (London) Council require tenders by Feb. 7 for the supply of stores, including electric lamps and fittings. Forms of tender from the Borough Engineer.

Middlesbrough Corporation require tenders by Feb. 9 for laying a double line of tramways in Grange-road West. Specification from the Borough Engineer and Surveyor.

Lurgan Urban Council invite tenders for supply and delivery of four-core l.t lead-covered and armoured cables. Specifications, form and tenders to the clerk (Mr. F. W. Pollock) by noon Jan. 29.

Tenders are required by Feb. 3 for 12 months' supply of lighting fittings, lamps, switches, cables, meters, tubes, &c., to Halifax Electricity Department. Forms of tender from the offices,

Great Yarmouth Corporation invite tenders for the supply and erection of h.t. switchgear. Copies of specification from the engineer, Mr. Gordon Bryant. Tenders to the Town Clerk by Feb. 11.

Tenders are also wanted by February 3 for 12 months' supply of stores to Halifax Tramways Department, including lighting fittings, insulating materials, cable, wires, trolly and overhead line material, castings, oils, &c. Forms of tender from the Tramways Engineer.

The London County Council invite tenders for wiring the Bethnal Green weights and measures office, &c. (87 switch and 89 lighting points). Specifications from the County Hall, Spring Gardens, S.W.1, and tenders by 4 p.m., Jan. 31.

The Commissioners of His Majesty's Works, &c., require tenders by Feb. 1 for six months' supply of switches, fuses and fuse boards, Forms of tender, &c., from the Controller of Supplies, King Charles-street, Westminster, S.W.1.

Hammersmith (London) Borough Council invite tenders for single and three-phase transformers. Specifications from the engineer and manager (Mr. G. G. Bell), and tenders to the Town Clerk, Town Hall, Hammersmith, W., by 4 p.m. Jan. 26.

The Victorian Railway Commissioners (Melbourne) want tenders by Feb. 2 for various requirements, including axle generator train-lighting material and accumulator cells (contract 33,750) and miniature electric staff instruments (contract 33,694.)

Aberdeen Corporation invite tenders for supply and erection of electric pumping machinery capable of delivering 6½ million gals. per 24 hours, including transformers, motors, pumps, &c. Specifications from the Water Engineer, 41½, Union-street, and tenders by Feb. 21.

Pretoria (Transvaal) municipality require tenders by March 10 for one 20 ton overhead crane, six boilers to evaporate 18,000 lb. an hour each at 350 lb. pressure; three 3,000 kw. steam turbo-generators, condensing plants, five 750 kw. converters. Specification from Town Clerk.

The Electricity Commissioners of Victoria (Australia) invite tenders for the supply of plant and material required for the Morwell Power Scheme, including 25,000–12,500 kw. turbo-alternators, 600 kw. turbo-alternators, transformers, switchgear, cables, transmission steel towers, steel telephone poles, &c. Tender forms and specifications can be obtained from the Agent-General for Victoria, Victoria House, Melbourne-place, Strand, London, W.C.2, and drawings can be seen at the offices of Messrs. John Coates & Company, Ltd., consulting engineers, at the same address. Tenders by noon, Feb. 24, to Mr. R. Liddelow, secretary, Electricity Commissioners, 673, Bourke-street West, Melbourne.

The Electricity Commissioners of Victoria also require tenders by noon, March 31, for telephone wire (specification 45) and pin type insulators (specification 46) in connection with the Morwell Power Scheme. Specifications can be seen at the offices of Messrs. John Coates & Co. and tender forms, &c., obtained from the Agent-General.

Tenders are invited up to Feb. 23 for the supply and delivery to the Postmaster-General's Dept., State of South Australia, of electric lamps (Schedule 561); up to March 21 for the supply and delivery to the Postmaster-General's Dept., State of New South Wales, of telephone and telegraph apparatus, testing instruments and switchgear parts (Schedule 814); and also up to March 29 for the supply to the Postmaster-General's Dept., State of Western Australia, of telegraph materials (Schedule 333). Tender forms, specification, &c., from the office of the High Commissioner for Australia, 406, Australia House, Strand, London, W.C.2.

The contract for wiring 26 houses on the Long Sowerby site has been placed by Carlisle Corporation with Ellison Bros., at £507.

Burnley tramways committee have accepted a Belgian tender for steel tyres at £37 10s. a ton. The nearest British tender was £59, compared with a pre-war price of £19 a ton. This is the second contract of a similar character which has been placed abroad within a month, and it is a matter for the serious consideration of both manufacturers and workers.

An important Transformer Contract has been secured by the Metropolitan-Vickers Electrical Company from the Manchester Corporation. For the Barton power station the company will supply six 19,500 k.v.a., three-phase, 50-period, 6,600/32,000 volts, O.I.F.C. transformers, three 1,250 k.v.a., three-phase, 50-period, 32,000/420 volts, O.I.S.C. transformers and one 2,500 k.v.a., three-phase, 50-period, 6,600/50,000 volts, O.I.S.C. transformer. For the Stuart-street station six 2,833-⅓ k.v.a., one-phase, 50-period, 32,000/6,600 volts, O.I.S.C. transformers, and for the High-street sub-station nine 2,833-⅓ k.v.a., one-phase, 50-period, 32,000/6,000 volts, O.I.S.C. transformers.

Personal and Appointments.

Exeter Council is recommended to increase the salary of the city electrical engineer (Mr. H. D. Munro) from £700 to £760, as from Oct. 1 last.

Mr W. G. Watson, managing director of Messrs. W. G. Watson & Company, Ltd., electrical engineers, of Sydney, N.S.W., who has been on a business visit to this country, will return to Australia on the 29th inst.

Mr. W. M. Acworth, on whom the King has authorised the Viceroy of India to confer the honour of Knight Bachelor, is a well-known authority on railways, and a director of the Underground Electric Railways of London and other companies.

Mr. T. H. Mottram has been promoted to the position of Chief Inspector of Mines. Mr. Henry Walker has also been made Deputy Chief Inspector for Mines; Mr. John Masterton a Divisional Inspector, and Mr. Edgar H. Frazer a Senior Inspector of Mines.

We are asked to state that, in accordance with a rearrangement of the organisation of the Cable Makers' Association, Mr. Llewelyn B. Atkinson, M.I.E.E., who took up the secretaryship of the Association during the war, will in future act and sign as director. The secretary will be Mr. W. G. Stiles, F.C.I.S., who has been assistant secretary for some time.

Mr. E. A. Uttley, M.I.E.E., M.I.Mech.E., and Mrs. Uttley returned to South Africa by the "Kenilworth Castle" last Friday en route to Rhodesia, where Mr. Uttley will resume his post with the Government as chief construction and electric inspector. He volunteered for war service in 1917 and was appointed to the Ministry of Munitions and has been with the Admiralty for the last three years as an electrical engineer at H.M. Dockyard, Portsmouth.

Patent Record.

SPECIFICATIONS PUBLISHED.

Complete Specifications.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

132,244 Roedel. Hooks for electrio-platng. (4/9/18.)
138,354 Norske Aktieselskab for Elektrokemisk Industri Norsk Industri-Hypotekbank. Suspension of electrodes in electric furnaces. (28/1/19.)
138,610 Brillouin. Telephonic transmission by high-frequency currents. (31/1/19.).
139,476 Siemens & Halske Akt.-Ges. Electric contact devices. (9/3/18.)
143,210 Scintilla. Arrangement of the distributor brush-holders in magneto-ignition apparatus for internal-combustion engines. (15/5/19.)
143,509 Giles. Electric valves or safety devices for the discharge of excess potentials (1/5/20.)
143,542 Siemens Schuckertwerke. High-tension electric depositing plants. (31/3/16.)
143,551 Western Electric Co. Telephone exchange system. (22/7/18.) (Divided Application on 130,329.)
143,908 Western Electric Co. Telephone exchange system. (22/7/18.) (Divided Application on 130,329.)
143,910 Scintilla. Short-circuit terminals for the magneto-ignition apparatus of internal-combustion engines. (28/5/19.)
144,251 Heerd. Magneto-electric ignition apparatus for explosion engines. (30/5/19.)
145,481 Siemens Schuckertwerke. Installations for rectifying alternating currents. (10/6/16.)

APPLICATIONS FOR PATENTS.

July 9th, 1920.

20,031 B.T.-H. Co. Means for obtaining unidirectional potential differences of constant value. (22/12/15, U.S.)
20,033 B.T.-H. Co. Generation of high-frequency oscillations. (3/6/18, U.S.)
20,034 B.T.-H. Co. Electron discharge apparatus. (28/10/15, U.S.)
20,035 B.T.-H. Co. Electron discharge apparatus. (29/10/13, U.S.)
20,036 B.T.-H. Co. Electron discharge apparatus. (29/12/13, U.S.)
20,048 Angereau. Device for closing electric circuit by magnetic induction. (1/8/16, France.)
20,058 Aufranc. Switches. (13/7/18, France.)
20,145 Allgemeine Elektricitats Ges. Choking coil. (10/7/14, Germany.)
20,153 Allgemeine Elektricitats Ges. Driving system for a.c. meters. (14/1/19, Germany.)
20,226 Huth Ges. (Dr. E. F.) & Loewe. Telephony. (31/12/15, Germany.)
20,227 Huth Ges. (Dr. E. F.). Telephony. (28/11/16, Germany.)
20,228 Huth Ges. (Dr. E. F.). Vacuum tubes. (30/3/18, Germany.)
20,229 Huth Ges. (Dr. E. F.). Aerial conductors for wireless telegraphy. (1/7/15, Germany.)
20,230 Huth Ges. (Dr. E. F.). Wireless messages. (21/10/14, Germany.)
20,231 Huth Ges. (Dr. E. F.). Arrangement for carrying wireless stations. (30/10/13, Germany.)
20,232 Huth Ges. (Dr. E. F.). Reels, &c., for winding and unwinding aerial conductors. (16/1/18, Germany.)
20,233 Huth Ges. (Dr. E. F.). Reels, &c., for winding and unwinding aerial conductors. (6/5/18, Germany.)
20,234 Huth Ges. (Dr. E. F.). Sources of electrical energy for use in aircraft. (1/2/16, Germany.)
20,236 Huth Ges. (Dr. E. F.) & Loewe. Method of tuning the sending connections for wireless telegraphy. (18/9/15, Germany.)
20,237 Huth Ges. (Dr. E. F.). Aircraft stations for wireless telegraphy.(4/12/14, Germany.)
20,238 Huth Ges.(Dr. E. F.). Coils for high-frequency purposes. (29/11/16, Germany.)
20,263 Soc. anon. Constructions Electriques de Belgique. Contact fingers for controllers. (18/3/19, Belgium.)
20,264 Soc. anon. Constructions Electriques de Belgique. Electric traction. (24/5/19, Belgium.)
20,279 De Soissan. Electric heating apparatus. (19/12/13, Belgium.)
20,288 Kohler Co. Electric generating systems. (20/3/19, U.S.)
20,308 Day. Electric signalling. (17/9/16, U.S.)
20,335 Huth Ges. (Dr. E. F.) & Loewe. Wireless receiving apparatus. (20/12/15, Germany.)
20,338 Soc. Industrielle des Telephones. Telephone and telegraph cables. (4/4/19, France.)
20,343 Lorenzals. Generating continuous currents. (13/2/19, Germany.)

Companies' Reports, &c.

EDISON SWAN ELECTRIC COMPANY, LTD.

At the meeting of the Edison Swan Electric Company, Ltd., on Monday the chairman (Mr. C. J. Forde) was able to give a good account of the progress and expansion of the company's business. After giving particulars of the debenture stock redeemed, of the investments in other companies, &c., he referred to the arrangement with the Philips Glowlampworks, Ltd., of Eindhoven, who were (he claimed) the largest manufacturers of electric lamps in Europe, with world-wide connections. During the last few years the firm had paid especial attention to the manufacture of gas-filled lamps, which were largely superseding the old type of tungsten drawn-wire lamp, particularly as it had been found possible to manufacture it with a comparatively low candle-power, making it available for ordinary household use. The manufacture of the lamp was attended with many difficulties, and they found great difficulty in producing a satisfactory lamp in large quantities on an economic basis. That was largely due to the fact that during the war their lamp staff were engaged on special Government work and, in consequence, unable to concentrate on lamp development. The Philips' Company possessed methods, processes and novel labour-saving plant far in advance of that in the works of other manufacturers. They were now turning out lamps, particularly gas filled, in large quantities, equal in every respect to those manufactured by Messrs. Philips in Holland, and they were obtaining a ready sale for them.

New Company Formed

It was necessary to provide a large amount of capital, and they had made an arrangement with Messrs. Philips for the formation of a new company, the Ediswan Lampworks, Ltd., the capital being provided in equal shares by themselves and Messrs. Philips. Their lampworks would be leased to the new company, except the portion recently erected, together with the machinery and plant. The outcome of the arrangement would be that they would not have to put up any cash, the whole of that being provided by Messrs. Philips. Mr. Anton F. Philips and Dr. G. L. F. Philips would be on the Board of the new company, and had undertaken to give the benefit of the whole of their knowledge and experience, with particulars of all new processes, plant and machinery which might be in use at their own works. At the date of the balance-sheet the new system of manufacture had only been working for a short time. The change over from one process of manufacture to another, the installation of the new plant and the initiation of the staff into the new methods, restricted the output for the time being and reduced the profits. He was glad to say, however, that their output of lamps was now on a satisfactory basis. Another matter which had adversely affected the profits from the lamp side of the works was the frequent rises in wages which had taken place during the year. The increased capacity of the factory to turn out lamps on a more economical basis would doubtless help the company to bear the higher charges for wages.

Electricity Meters.

They had arranged with the Sangamo Electric Company to co-operate in the manufacture of meters at Ponders End, and they had taken orders for some few thousands of those meters, manufactured in the United States. Having satisfied themselves that the meters were of the highest efficiency and that there was a very large demand for them, and also that they could be produced at a figure which would enable them to compete with any similar article, they found that if they could be manufactured in this country and disposed of as English manufacture there would be a large business done in them. They had erected buildings at Ponders End works, which were being equipped with the necessary plant and machinery, capable of turning out those meters on a large scale. Their American friends made it a condition that they should be interested in the manufacture, and, in conjunction with them, they were forming a company, in which they would be largely interested, for carrying out those arrangements in the future.

Financial Position

The Board came to the decision to pass the ordinary dividend after careful consideration and with great regret. The solution of the difficulty was additional capital, but at present it was impossible to provide it in consequence of the prevailing financial and industrial unrest, and the Board were strongly averse to making any further issue if it could be avoided; but they were hopeful that within the next six months the position might become more liquid. In the absence of further capital it had become absolutely necessary to husband their cash resources, and, although a substantial profit had been earned, it would have been a suicidal policy to have dipped into those resources in the payment of even a dividend of 5 per cent., which would absorb about £50,000. If they could see their way to pay an interim dividend before the end of the financial year at June 30 next, they would do so. The business was proceeding satisfactorily; the sales were increasing, and up to the present they had not been affected by foreign competition.

The report and accounts were adopted, and at a subsequent extraordinary meeting a resolution was passed altering the articles of association so as to empower the company to increase its capital.

The Eastern Extension Australasia & China Telegraph Company, Ltd., announce that the interest on their 4 per cent. mortgage debenture stock for the half year ending 31st inst., due on the 1st prox., will be paid by warrant on Feb. 1 next.

The Dublin United Tramways Company, Ltd., has declared a final dividend of 3½ per cent. on the ordinary stock, making 5½ per cent. for the past year, after adding £30,000 to renewals fund, writing £2,000 off investments and carrying forward £13,331.

The British Trusts Association has purchased from the Tramways, Light & Power Company £200,000 8 per cent. five-year notes at 95½, less a commission of 1 per cent. The public are not invited to subscribe for the issue, but particulars of it and some details regarding the Tramways Company are being advertised in order that permission to deal in the notes may be obtained from the Stock Exchange. The notes are part of a total amount authorised of £375,000, and are redeemable at 105 on Jan. 7, 1926. The company owns and operates six electric power and traction undertakings in the Midlands. The net receipts in 1919 were £43,900, and for 1920 are expected to have been £55,000, while those for the present year are put at £80,000.

The Costa Rica Electric Light & Traction Company, Ltd., report that the net earnings in Costa Rica for the year ended June 30, after charging all expenses, were £24,519, compared with £14,328 for the previous year, an increase of £10,191. The net profit was £12,691, against a loss of £2,549, and reduces last year's deficit of £13,022 to £330. The gold premium averaged 160 per cent. during the year, against 315 per cent. in the previous year, and 112 per cent. (the normal equivalent of the gold "Colon") in the year (1913-14) before the war. The difference between the current and normal exchange represents a loss of £5,544. Payment in cash of the 5 per cent. debenture interest was issued on June 30, 1920, and the interest due on the 1st inst. was also paid in full.

The directors of W. T. Henley's Telegraph Works Company, Ltd., are inviting applications for an issue of 250,000 £1 ordinary shares at the price of £1 4s. per share. The capital of the company is £1,000,000 in 800,000 £1 ordinary and 200,000 £5 4½ per cent. cumulative preference shares, of which 400,000 ordinary and 200,000 preference shares have been issued, and there is also an issue of £150,000 4½ per cent. first mortgage debenture stock. The company's business has been developed for many years by means of undistributed profits without increasing the debenture or the share capital, and in 1918 the company capitalised the sum of £200,000, part of the amount standing to the credit of reserve, and distributed 200,000 ordinary shares by way of bonus among the ordinary shareholders. For some years the turnover has been increasing year by year, and the present turnover greatly exceeds in value and quantity that of any previous year. The new capital is required to finance this increased business and to provide for additions to the works to meet future demands. The company is in the first rank of cable manufacturers, and the directors anticipate that in the near future there will be a great extension in the use of electricity for the development of cheap power by the means of super power stations, for the electrification of railways, for the increased use of telephones, and for other purposes, and that there will thus be a steady and increasing demand for the Company's productions.

At the annual meeting of the Adelaide Electric Supply Company, Ltd., on Wednesday, the directors reported that the gross revenue for the year ended August 31 last amounted to £238,764, compared with £185,908 for the previous year, an increase of 28 per cent. After payment of management and general expenses in Adelaide and London, and after providing for interest and sinking fund on the five per cent. debenture stock and for interest on the six per cent. consolidated debenture stock, the directors wrote £4,000 off the cost of issue of the "A" preference shares, placed £5,000 to reserve for income tax and corporation tax, and £5,000 to general reserve, which left a balance of £71,638. Deducting the two half-yearly preference dividends paid in March, 1920, and the interim dividend of 5 per cent. actual on the ordinary shares paid in June, the available balance was £40,354, which was applied in paying the half-yearly preference dividends to August 31 last and a final dividend of 7 per cent. actual on the ordinary shares, making 12 per cent. (free of British income tax) for the year. The balance of £2,104 with £18,360 from the previous year, made a total of £20,464, which was carried forward.

The capital expenditure during the past year was £133,400, and after deducting amounts written off, the net expenditure at 31st August, 1920, was £1,158,603. At the end of the year the Company had 29,475 consumers (against 25,049 in 1919); the total connections were 34,469 kw. (20,658 kw. for lighting and 13,811 h.p. of motors) against 30,247 and the units sold were 14,434,514 (against 11,239,069). The area of the districts covered by the Company's statutory powers is 155 square miles, with an estimated population of 224,000, and electric supply is now available in 525 miles of streets, an increase of 25 miles during the year. There was an increase of 17 per cent. in the number of consumers, of nine per cent. in the power supply, and of 14 per cent. in the total connections. The total units sold and the gross revenue both showed an increase of 28 per cent. Good progress is being made with the preliminary works necessary for the construction of the new power house at Osborne, Port Adelaide, and orders for the first 20,000 kw. of generating plant have been placed.

For some years past the increasing burden of double taxation both in England and Australia had pressed heavily on the Company, but the great efforts made to induce the authorities to adjust the burden equitably met with inadequate success. With a view to relieving the Company and its shareholders of this burden an extraordinary general meeting was held to consider resolutions providing for the control and management of the Company being transferred from London to Adelaide and vested in a new Board of directors to be resident in Adelaide. The resolutions, which had been unanimously approved at a specially-convened meeting in Adelaide of the Australian shareholders, were approved.

New Companies.

C. A. BESLEY, BAILEY & COMPANY, LTD. (172,282).—Private company, registered Dec. 28. Capital [illegible] £1 shares. To take over business of C. A. Besley, Bailey & Company, [illegible] Cardiff, and to carry on the business of electrical, telephone, heating and general engineers, &c. Directors are: F. Morgan, A. Jones, C. D. Esnouf and V. A. Bailey (managing).

CONTROLS, LTD. (172,218).—Private company. Reg. Dec. 23. Capital £1,000 in £1 shares. To carry on the business of makers of and dealers in flexible wire and rod controls, throttle and ignition controls for internal combustion engines &c. W. M. Rolph is permanent governing director. [illegible] L. S. Thompson. Reg. office: 66, Piccadilly, W.

ENNIS GAS AND ELECTRIC SUPPLY COMPANY, LTD. (5,094).—Reg. in Dublin Jan. 3. Capital £5,000 in £1 shares. To supply electric light to the town of Ennis. First directors are: A. Knox, J. O'Dea, J. Brevin, P. Cahn, D. McInerney, M. McInerney and M. McMahon, all of Ennis.

E. & C. GATES, LTD. (172,187).—Private company. Reg. Dec. 22. Capital £3,000 in £1 shares (2,700 10 per cent. cumulative preference and 300 ordinary). To take over the business of an electrical engineer and electrician, carried on by C. Gates as "E. & C. Gates," at Norwich. First directors are: M. C. Warren (chairman), and C. Gates. Reg. Office: Arcade-street, Norwich.

Forty Years Ago.

(THE ELECTRICIAN, JANUARY 22, 1881.)

Royal Institution.—Mr. Warren De La Rue [illegible] his discourse on "The Phenomena of the Electric Discharge with 14,400 Chloride of Silver Cells."

The Telephone [illegible] Negotiations are understood to be still going on between these parties. It does not appear that the threatened appeal against the recent judgment is being proceeded with.

The Electric Light [illegible] the Brush Electric Light Company to lay down the necessary wires underground from their factory, Vine-street, York-road, Lambeth, along Stamford-street, &c., for the lighting of various city streets, as arranged with the Sewers Commission.

[illegible] the newspapers report that several of the jurymen at a recent inquest, held in Westminster upon George Seamar, aged 41, a pianoforte maker, expressed a strong opinion that the "application of a battery" to the patient, who was suffering from severe injuries in the head, was a highly improper proceeding on the part of the Charing Cross Hospital surgeons. At the Coroner's suggestion, however, a verdict of accidental death was ultimately returned.

Prices of Metals, Chemicals, &c.

TUESDAY, Jan. 18.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£79 0 0	—	£3 0 0
Electro Wirebars ...	,,	£82 0 0	—	£1 10 0
H.C. wire, basis ...	per lb.	1s. 0[illegible]	—	$\frac{3}{16}$d.
Sheet ...	..	1s. 2[illegible]	—	—
Phosphor-bronze [illegible]				
Phosphor-bronze wire, basis	..	1s. 4[illegible]	—	[illegible]d.
Brass (60/40)—				
Rod, basis ...	..	0s. 9½d.	—	—
Sheet, basis	..	1s. 2d.		½d.
Wire, basis	..	1s. 1½d.	—	½d.
Pig Iron—				
Cleveland Warrants	per ton	£11 7 6		—
Galvanised steel wire, basis 8 SWG	,,	£34 0 0	—	£3 0 0
Lead Pig—				—
English ...	..	£25 0 0	—	£1 0 0
Foreign or Colonial	..	£23 5 0	—	£0 15 0
Tin—				
Ingot ...	..	£191 10 0	—	£19 0 0
Wire, basis ...	per lb.	2s. 7d.	—	3d.

Salammoniac.—Per cwt. 100s.-95s.

Sulphur (Flowers).—Ton £16 5s.

,, (Roll-Brimstone).—Per ton £16 5s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £38.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 10½d.

Sodium Chlorate.—Per lb. 4½d.

Rubber.—Para fine, 1s. 0½d.; plantation 1st latex, 1/2 lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

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Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics."—"Speed and Endurance of the Rigid Airship," by E. H. Hewitt; and "International Aeronautical Maps."

"The Cabinet Maker."—"The Decoration of Furniture: Waved Moulding"; "Practical Polishing"; and "Unemployment at High Wycombe."

"Chemical Age."—"Ammonia Oxidation Limits for Sulphuric Acid Plants," by Wilfrid Wyld, and "Development of the Polish Chemical Industry."

"Farm and Home."—"The Spring Outlook"; "Hackney Breeding in 1920"; and "The Farmer and his Work."

"The Fruit-Grower."—"Profiteering in Apples"; "Lessons of the Commercial Shows (II.)"; and "Fruit Imports in 1920."

"Gardening Illustrated."—"Camellias Casting their Buds"; "Lilacs for Present Planting"; and "Potatoes in a Heavy Soil."

"The Hardware Trade Journal."—"The Coming Hardware Show at Birmingham"; "Hardware in the Making, VI.: The Manufacture of Razors"; and "Paints, Colours and Varnishes."

"Transport World."—"Scope for the Motor Carrier in Country Districts"; "Transporting Trees"; and "Motor Vehicle Insurance."

"The Gas World."—"Conservation of Coal through the Gasworks," by F. W. Goodenough; and "The Export of Sulphate of Ammonia."

Arrangements for the Week.

FRIDAY, January 21st (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 *p.m.* At Storey's-gate, London, S.W. Paper on "The Mechanical Loading of Ships," by Mr. H. J. Smith.

INSTITUTION OF ELECTRICAL ENGINEERS.—STUDENTS' SECTION.

6.30 *p.m.* At Faraday House, Southampton-row, London, W.C. Paper on "Electric Welding," by Mr. H. J. Howard.

INSTITUTION OF ELECTRICAL ENGINEERS.—SOUTH MIDLAND CENTRE.

6.30 *p.m.* At the Grand Hotel, Birmingham. Annual Dinner.

MONDAY, January 24th.

INSTITUTION OF ELECTRICAL ENGINEERS.—INFORMAL MEETING.

6 *p.m.* At the Institution of Civil Engineers, Great George-street, London, S.W. Discussion on "Improving the Usefulness of the Institution." Mr. L. B. Atkinson in the chair. (Refreshments will be served at 5.30 p.m.)

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH EASTERN CENTRE.

7.15 *p.m.* At the Mining Institute, Westgate-road, Newcastle-on-Tyne. Paper on "Some Economic Aspects of E.H.T. Distribution by Underground Cables," by Mr. R. O. Kapp.

TUESDAY, January 25th.

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH MIDLAND CENTRE.

7 *p.m.* At the Hotel Metropole, Leeds. Paper on "The Distribution of Electricity," by Mr. W. B. Woodhouse.

INSTITUTION OF ELECTRICAL ENGINEERS, SOUTH MIDLAND CENTRE· STUDENTS' SECTION.

7.30 *p.m.* At the University, Edmund-street, Birmingham. Paper on "Thermionic Valves," by Mr. J. A. Cooper.

WEDNESDAY, January 26th.

INSTITUTION OF CIVIL ENGINEERS.—STUDENTS' MEETING.

6 *p.m.* At Great George-street, London, S.W. Vernon-Harcourt Lecture on "The Lay-Out and Equipment of Docks," by Mr. F. E. Wentworth-Shields.

INDUSTRIAL LEAGUE AND COUNCIL.

7.30 *p.m.* At Caxton Hall, Westminster, London, S.W. Lecture on "Unemployment—The Best Means of Dealing with It," by Mr. E. W. Petter.

THURSDAY, January 27th.

ROYAL INSTITUTION.

3 *p.m.* At Albemarle-street, London, W. Lecture on "Biochemistry," by Dr. A. Harden, F.R.S. (Lecture II.)

INSTITUTION OF ELECTRICAL ENGINEERS.

6 *p.m.* At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Temperature Limits of Large Alternators," by Mr. G. A. Juhlin.

LIVERPOOL ENGINEERING SOCIETY.

7 *p.m.* At the Exchange Station Hotel, Liverpool. Annual Dinner.

FRIDAY, January 28th.

PHYSICAL SOCIETY.

5 *p.m.* At the Imperial College of Science, S. Kensington, London, S.W. Papers on "The Magnetic Separation of the Neon Lines and Runge's Rule," by Prof. H. Nagaoka; "A Method of Demonstrating the Retro-active Property of a Triode Oscillator," by Capt. E. V. Appleton, M.A.; and "The Quickness of Response of Current to Voltage in a Thermionic Tube," by Dr. D. Owen.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 *p.m.* At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "Fuel Oil," by Mr. W. A. White.

THE ELECTRICIAN

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Notes.

The Kelvin Lecture.

ONE thing stands out clearly from the account we give on another page of this issue of the Kelvin Lecture delivered recently by Sir WILLIAM BRAGG before the Institution of Electrical Engineers. That is investigations seemingly only of theoretical interest which have fascinated and puzzled pure scientists of world-wide repute have produced facts which can be turned to the most important practical uses by electrical engineers. Theoretically, we are still only on the fringe of the subject, but there will be general agreement with Sir WILLIAM BRAGG that we are at least working in the right direction to obtain a true understanding of the great problems of radiation and of material structure. Of the practical applications of this theoretical knowledge we have hardly yet begun to see the start. Yet already we know enough to make it certain that an increase in our theoretical information will be closely followed by a springing up of practical applications and that the Coolidge tube and the thermionic valve are only forerunners of a vast series of useful equipment whose design and manufacture has been made possible by the work of the purest scientists.

Nature's Unit of Electricity.

ANOTHER field for interesting speculation and useful work will, we hope, result from a point raised in Sir WILLIAM BRAGG's lecture. We like to think that electrical science and engineering depend more than any other of the world's activities on accurate measurement based on units which themselves rest on the most fundamental of first principles. And although this may already be so to some extent, Sir WILLIAM BRAGG would have us go further and make the electron our unit of measurement. The way to do this does not yet seem clear and we should welcome some enlightenment on the subject. One thing, however, is evident, that if we can attain such an end we should have a system of units based on the very foundations of our cosmic knowledge. As we said last week, this lecture is one of no ephemeral interest, and besides the points we have mentioned the contents raise so much that is suggestive and useful that it should be studied closely by all those who have cause of true electrical progress at heart.

Lighting Conditions in Cinema Studios.

THE subject of the lighting of cinema studios, which was recently discussed before the Illuminating Engineering Society, presents a number of interesting problems. On the purely electrical side there is for instance the need for studying the design of a sufficiently flexible arrangement of switches and cables. We should also like to see more attention devoted to the avoidance of long lengths of live cable which are apt to cumber the floor in some studios. As a load that can be largely applied during daylight hours such studios have their value to supply companies, but the demand is somewhat intermittent, and producers would be well advised to ensure that local supply companies in country districts can meet their requirements. Doubtless it will generally pay them to obtain current from public mains, but the larger studios may prefer their own independent supply. As regards the lighting itself interest in the discussion centred mainly on the question as to whether the use of very powerful unscreened arcs and searchlights is necessary, and whether such sources may not cause injury to eyesight. The problem is complicated by the fact that some of the lamps used appear to be exceptionally rich in ultra-violet rays. Generally speaking we think that producers would do well to aim at the same conditions of lighting as are approved in ordinary installations, in regard to avoidance of very bright exposed lights, though the order of illumination is naturally far greater (amounting often to hundreds of foot-candles). The view expressed by some that there is no great obstacle to the use of diffused methods of lighting, corresponding more closely with daylight conditions, seems reasonable, especially as the cost of electricity for lighting appears to form only a small proportion of the total cost of production of a film. We notice that the Illuminating Engineering Society proposes to follow its customary practice of appointing a Joint Committee to inquire further into the matter, and we have no doubt that the experience of lighting experts will form a useful supplement to the technical knowledge of film producers.

Electricity Supply in Greater London.

THE problem of reorganising the electricity supply in the Greater London District is so complex that it will need a good deal of both time and skill before those interested find a satisfactory solution. An interesting contribution to the subject has, however, recently been made by Mr. E. M. LACEY, who, in conjunction with Mr. Bruce Dawson and Mr. W. M. Selvey, has submitted to the West Ham Corporation and the Poplar Borough Council a long report on the future development of electricity supply in the eastern metropolitan suburban districts north of the Thames. In the first part of the report which deals with the area defined by the Commissioners, it is recommended that capital generating stations should be erected on the Thames, and that some of the existing stations should be used until the scheme is in full working order. Three-phase generation at 6,600 volts 50 cycles, with transmission at 33,000 volts is to be employed. Any Joint Electricity Authority to be formed would deal with finance and settle broad principles of policy, leaving all executive functions to Divisional Boards, while each of these Boards would in turn have an Advisory Committee consisting of engineers of the existing undertakings.

Details of the Area.

As the reorganisation of supply would be effected in stages, Mr. Lacey and his colleagues have outlined a scheme for dealing with the requirements of the North East of London for some years to come. This area would extend from Grays Thurrock in the east to Shoreditch in the west, and from the Thames on the south to the boundary of the Greater London district in the north. This is the most important industrial part of London, and has a population of nearly 2,000,000. Its present annual consumpton of electricity is over 165,000,000 units, and in about six years this is expected to increase to over 374,000,000 units. The present plant capacity is about 98,000 kw., of which 42,000 kw. is in small and inefficient units, but, as 36,000 kw. is on order, by the winter of 1921-22 there will be at least 92,000 kw. of fairly efficient plant available. In view of the inter-linking of the West Ham, Poplar, Stepney and Shoreditch networks it will be possible at present to deal with a maximum demand of 66,000 kw., but by 1924 this will be increased to 105,800 kw. excluding traction requirements. It is recommended that a large station should be erected at Dagenham, with a capacity of at least 64,000 kw. at the outset. In this station would be erected five 20,000 kw. turbine-driven alternators with 20 water-tube boilers, superheaters, economisers, mechanical stokers, &c., though the station would be designed for an ultimate capacity of 400,000 kw., the total cost of which is put at £2,500,000. The cost of the transmission system for a maximum demand of 72,000 kw. would be £1,100,000. The estimated cost of energy delivered from the main station is given as 0·768d. per unit. No doubt the report will stimulate discussion on a most important subject. Some of Mr. Lacey's views, especially those relating to the functions of the Joint Authority and the position of engineers, may not be looked upon as orthodox by municipal authorities, but, in our opinion, they are sound and some decentralisation of duties such as that outlined will have to be adopted. The great thing, however, is to get an agreed scheme.

Injunctions against Electricity Works.

We are not surprised that the Stepney Borough Council have failed in their appeal against the decision of Mr. Justice P. O. Lawrence in June last granting an injunction to restrain a nuisance caused by the emission of grit and ashes from the municipal electricity station at Limehouse. For in a somewhat similar case, decided by the Court of Appeal in 1895, it was laid down that statutory powers of supply conferred by a Provisional Order do not exempt the undertakers from liability for nuisance created by noise and vibration. The Court of Appeal therefore felt bound by the judgment in Shelfer *v.* City of London Electric Lighting Company, and we understand, therefore, that the present appeal was only brought for the purpose of taking the matter to the House of Lords, the Council desiring to have a decision of the final Court of Appeal as to whether, having regard to their statutory obligations, they had not the right to do what they did do. As the Council have 4,000 consumers of electricity on their mains, it will be realised that the case is most important, but we question, having regard to the nature of their powers of supply, whether they can possibly succeed. At all events the prosecution of the appeal will be a costly proceeding, and as nearly all supply authorities are equally interested, it appears to be a case where the I.M.E.A. and other electrical associations might contribute to the costs, as the decision, whatever it may be, is of the same importance to all. We are not sure, however, that the suggested procedure is the wisest that might be adopted, and as an uninterrupted supply of electricity is now essential the Electricity Commissioners would do well to insert a clause in the new Electricity Bill placing all electricity supply authorities in the same position as railway companies with regard to this matter.

Current Density in the Arc-Crater.

The physics of the arc have long proved a fruitful subject for discussion ever since Mrs. Ayrton announced her well-known results, and additions to our knowledge of the subject are still being made. The latest contribution was made by Mr. N. A. Allen at a recent meeting of the Physical Society. By adopting a special Y-shaped arrangement of suitable solid carbons (two negatives inclined to the positive) Mr. Allen was able to show that the crater area was proportional to the total current, for currents up to 10 amp. and accordingly the current density, was constant at 0·746 amps. per sq. mm. This means that the connecting relation is a straight line passing through the origin, instead of cutting the Y-axis some distance above, as in Mrs. Ayrton's and other previously recorded results. The importance of constancy of current density was pointed out in the discussion by Prof. J. T. McGregor Morris, who recalled that Forrest had found a constant brightness for the carbon arc of from 172 to 174 c.p. per sq. mm. Accordingly if the current is accurately measured we should have in a suitably arranged carbon arc, a source whose candlepower is accurately known, being, in fact, 232 c.p. per amp. It was conjectured that the constancy of the candlepower thus controlled should be within one per cent.—a conclusion that should be of great interest to photometric experts. Doubtless further work is needed to confirm this result, but the arc standard of light seems at least more practicable than at any previous stage.

The Magnetic Analysis of Manganese Steel.

The researches which are now being conducted in many quarters into the magnetic properties of various sorts of steel cannot fail to be of great importance to the electrical engineer. It would therefore be well if a closer study were more generally to be made of what is being done in this direction. For this purpose no better beginning could be made than a consideration of some facts put forward in a Paper read by Sir Robert Hadfield, Mr. S. R. Williams and Mr. I. S. Bowen before a recent meeting of the Royal Society on the "Magnetic Mechanical Analysis of Manganese Steel," in which an attempt is made to correlate some of the magnetic and mechanical properties of this material. The changes in the length of the test rods when subjected to magnetic fields were determined, while the effect on the intensity of magnetisation when the bars were subjected to longitudinal stress was also investigated, it being found that for all field strengths the application of tensile stress increased the intensity of magnetisation of the magnetic specimens. The non-magnetic rods showed no change in intensity of magnetisation when stretched. On the other hand, they exhibited an intensity of magnetisation about one-thirty-sixth of that of the specimens in the magnetic condition. This effect was found to be entirely due to oxidation of the skin of the rods, for on removing a few thousandths the specimen showed no magnetic susceptibility when tested by a hand magnet.

Improving the Usefulness of the Institution.

If the discussion which took place at the informal meeting of the Institution of Electrical Engineers on Monday night is a true reflection of the attitude of members in general towards the present policy of that body, the Council may well be suffused with a genial glow of satisfaction. Though perhaps it would not be safe to take the reluctance of those present to speak as an indication that there is no room for improvement, it shows at least that there is not very much to grumble at. This is confirmed by the speakers' remarks, which were generally confined to a criticism of matters of detail. Thus, such improvements as joint meetings, closer control over election of members, the constitution of committees, the stage management of discussions, the publication and exhibition of inventions, the freer opening of the library, greater publicity, the organisation of popular lectures, a sliding scale of subscriptions, more discussion meetings, the establishment of laboratories and the hour of meeting were all suggested by various speakers, and gave Mr. Atkinson, who spoke at the end of the meeting, a chance to show either that something had already been done, or was being done, to meet the wishes of members. The most important general question that was raised was that of regularising the status of the engineer. It is a point upon which the meeting evidently felt strongly, and we are glad to learn that it is under consideration. For various reasons, it is impolitic to say more than this at the present time, except to add that we hope a wise decision will speedily be reached. The meeting had the secondary effect of calling attention to the useful work which is being done by the Informal Meetings Committee. As a school of debate for young speakers these meetings already play an important part in the affairs of the Institution, and are not unlikely before long to have the desirable effect of enlivening the more formal gatherings.

The Ilford Settlement.

The strike of the members of the E.P.E.A. employed at the Ilford electricity works concluded on Wednesday evening in last week, too late for us to make any comment upon the settlement. Agreement was arrived at as the result of negotiations between the local authority and the strike leaders, it being finally decided to concede to members of the E.P.E.A. salaries at the rate laid down in the recommendations of the National Joint Board for a period not exceeding six months. A rider was added that the Ministry of Labour should be called upon to take steps to form a properly constituted board to deal with the whole wages question, and that the Council would appeal to such Board for revision of such clauses and figures in the agreement which they considered objectionable. The result may, therefore, be chronicled as a victory for the E.P.E.A. We congratulate them on an outcome which is both fortunate and lucky. They were in a tight corner and, though they have escaped this time, we hope that the lesson will not be lost upon them. This is said in no spirit of criticism, but because we heartily agree with many, if not all, of the aims and objects of the Association, and we should, therefore, be sorry to see their usefulness minimised by the adoption of a tactless policy and bad strategical methods.

Reconstitution of the National Council.

The question of the direct representation of thirteen District Councils on the National Council for Electricity Supply appears to be getting complicated. The employers, as a whole, apparently desire such representation, but the Trade Unions are divided. The situation is further obscured by a proposal from the Municipal Employers' representatives on the District Councils to take the matter into their own hands and choose their representatives from a Committee of their members on the District Councils. This means, of course, that the municipal representatives on the National Council will be directly representative of the District Councils. In fact, they can be representative of nothing else. If this arrangement is adopted it is difficult to see exactly how the same privilege can be withheld from the company or Trade Union representatives. To choose one section on one principle and another on another would certainly be inviting disruption.

Rating of Electricity Undertakings.

The great increase in the works costs of electricity supply and tramway undertakings appears to have had a serious effect upon the rateable assessments, for, in many cases, these are now a minus quantity. In a Paper recently read before the Surveyors' Institution on "Rating as Affected by Recent Legislation," Mr. Logsdon points out that the increased charges authorised had not been more than sufficient to meet the higher working expenses, and if the rateable value, which is based upon the annual accounts, is in future to be calculated on hitherto accepted principles, a permanent increase in the statutory charges must be made in order to produce a satisfactory result. We agree that the law and practice of rating, especially of railways, tramways and electricity works, which are highly technical and somewhat involved, should be remodelled in order to make them applicable to modern conditions. The present system of leaving the assessments to overseers, who are not compelled to make periodic revaluations (except in the metropolis), is far from satisfactory. The subject is important, and as post-war conditions have produced many anomalies we hope that the Legislature will soon find time to deal with it. At the same time it is desirable to have a uniform method of dealing with the rating of machinery, which appears to be included in the assessment in some parts of the country but not in others.

The Double Taxation Problem.

We regret to see that the movement for the transfer of the headquarters of Anglo-Colonial companies from London continues, the latest instance being the Adelaide Electric Supply Company. The Australian shareholders of the Company, who are in a majority and who complain of the burdens of double taxation, recently voted in favour of transferring the control of the Conpamy to a new board of directors at Adelaide, and in a circular issued to the British shareholders the directors stated that the proposed transfer would "relieve the Company and its shareholders of the increasingly heavy burdens of double taxation both in England and Australia." Unfortunately, there is no room for gratitude in business or finance. If there were, the Company, which could not have been formed but for the English capital, might well consider the equity of insisting upon the transfer just at present. However, the British shareholders have now put the matter beyond doubt by voting for the transfer which will take place in due course, so that apparently they also do not expect any gratitude.

The Heating of Alternators.

The allied problems of heat distribution in and the temperature measurement of electrical machinery have rightly been receiving a great deal of attention recently. They are not only of essential interest to designers and users of this class of plant, but present-day conditions more than ever necessitate that every kilowatt installed shall perform as efficiently and as economically as possible its duty of providing its share of the electricity supply for the district which it is serving. A broad consideration shows how fundamentally ignorant we have been of what really takes place inside these machines, and once more emphasises the truth of the statement made by Prof. C. F. JENKIN in his Presidential Address to Section G. of the British Association last year, that too much of our design is blind groping rather than an ordered policy directed to a particular end.

THE USE OF EMPIRICAL LIMITS.

An excellent illustration of this thesis is to be found in the work that has recently been carried out in this country, in the United States and on the Continent in the determination of the heat distribution in electrical machinery generally and especially of the distribution of heat that occurs in high speed turbo-alternators. These investigations all show us that we have been too cautious; that from the heating point of view we have been underloading our machines, and in consequence that we have been using more material than was absolutely necessary. As is well known, the temperature limits laid down in the earlier machines were an intimate mixture of empiricism and experience, with the former predominating. There was, however, this excuse for those concerned at that time: that they knew very little about how the temperature was distributed and as little, or rather less, of the effect of heating on the insulating and other materials employed in the machines.

That stage has now been passed and there is now general recognition that we must work on more scientific lines if we are to obtain utilisable knowledge in the form in which we require it; the knowledge, in fact, that will allow us to design machines which, though operating efficiently, shall contain as small a percentage as possible of underloaded material. The preliminary stage is not yet passed, but it should not be long before we can say that it has been reached.

A USEFUL CONTRIBUTION.

A useful contribution to our knowledge of the subject, not so much because it gives us anything new, but rather because it collects what is already known in a readable form is a Paper on "The Temperature Limits of Large Alternators," which was read before the Institution of Electrical Engineers yesterday evening by Mr. G. A. JUHLIN. Mr. JUHLIN rightly stigmatises the timidity of those who agree with the methods of temperature measurement in alternators recommended by the British Engineering Standards Association and yet to a large extent detract from the usefulness of these methods by specifying lower limiting temperatures than those given in the rules, owing to a fear that the insulation will not stand the extra heating involved.

If there is any lingering doubt on this question in any designers' or engineers' minds it should be dispelled by the contents of Mr. JUHLIN's Paper, one of the most useful parts of which, in our opinion, is that which deals with the effect of temperatures of the order likely to be met with in high speed electrical machines on the various types of insulation employed. By using a series of experimental bars similar to those generally employed in the stators of turbo-alternators, Mr. JUHLIN is able to show that the effect of prolonged heating is only slightly to reduce the efficiency of the insulation, and that in every case mechanical failure preceded electrical failure. The tests detailed were made at pressures up to 25,000 volts, at which point they had to be abandoned owing to arcing occurring. Fear of the deterioration of the insulation under ordinary working conditions, even if those conditions involve temperatures much higher than those now customary, therefore seems to be groundless, and our only doubt is whether Mr. JUHLIN's test arrangements sufficiently closely reproduce what would be found in a turbo-alternator when working. We agree that this is probable, nevertheless we should like, if possible, to see the tests extended to an actual machine running in a supply station. This seems to be a chance for combined action by some public spirited manufacturer and supply authority. The information obtained would well repay any trouble or expense.

METHODS OF MEASUREMENT.

Having decided that much higher temperatures can be used in turbo-alternators, the point next arises how these temperatures can most effectively be measured. On this subject Mr. JUHLIN does not throw very much new light. It is common ground, for instance, that the subject is complicated by the variety of materials used in the construction of turbo-alternators, by the difference in the methods of their treatment, and by the fact that there is no known connection between the surface temperature and that which may be reached by some part inside the machine. It therefore follows that the old method of measuring temperature of the outside of a machine by a thermometer is being rightly discarded as unsuitable in current engineering practice. The best that can be said for it is that it is a more or less accurate approximation similar, as Mr. B. G. LAMME once pointed out, to trying to determine the voltage at the power station by measuring the pressure at the far end of a transmission line. The method has, of course, the further objection that it cannot be used until the machine becomes stationary, and as in high speed machinery this is always some considerable time after the steam has been shut off, results which are actually erroneous may easily be obtained.

DRAWBACKS OF THE RESISTANCE METHOD.

The resistance method, though more accurate than the thermometer method, also only gives average results, which may be very misleading, especially where hot spots are likely to occur. Its application also is comparatively limited. Everyone, therefore, will agree with Mr. JUHLIN that the best method to use is the embedded thermo-couple, which has the great advantage of occupying only a small space in the machine and therefore practically indicates the temperature at a point instead of the temperature over a more or less wide area, as is the case with the other two methods. Its one disadvantage is that though easily applicable to the measurement of stator temperatures, it cannot be so easily used for measuring the temperature of rotors, a point with which Mr. JUHLIN does not specially deal. The important points to notice are, however, that the insulation and other material used in the construction of our machines can stand a higher temperature, and that we now have a method whereby these higher temperatures can be easily and accurately increased and their effect therefore equally closely studied.

FUTURE POLICY.

If, therefore, we are to take, as we must take, full advantage of the capabilities of any machine, the time has come when the temperature limits laid down by the British Engineering Standards Association must be and can be increased with safety. Mr. JUHLIN suggests that 160°C. should be adopted as the limit for the maximum permissible temperature, this temperature being measured by an embedded temperature detector for the stator winding and by the increase of resistance method for the rotor winding. It should be possible to do this without difficulty, as we have never heard it stated that the specifications of the British Engineering Standards Association are as unalterable as the laws of the Medes and Persians, nor do we think that the Association itself would be opposed to a very desirable change. There is this great argument in favour of alterations in this particular case:

that everyone, with the exception of a few ultra-convertists, agrees that the present methods of temperature measurement, which are to some extent legalised by the specifications referred to, are unsatisfactory. To remain as we are is, therefore, to perpetuate a system which, though it once had its uses, has now become out of date.

The Loading of Ships.

Mr. H. J. Smith was a little unfortunate in choosing such a broad title as "The Mechanical Loading of Ships" for the Paper he read before the Institution of Mechanical Engineers on January 21. The Paper is really restricted to descriptions of four different types of machines for the handling of coal and ore in relatively small quantities, and no reference is made to the most economical method of loading. Furthermore, it should be mentioned that the grab transporter shows to greater advantage for unloading than it does for loading. We admit that it is difficult to find titles for such papers, but "Modern Methods of Handling Coal and Ore" would have been more appropriate in this case.

The Reason for the Use of Machinery.

We should also like to believe with Mr. Smith that such machinery was at first designed to release manual labour for operations requiring more skill. The truth of the matter is that large sums of money are invested in materials-handling machinery with a two-fold object in view. Firstly, to reduce the cost of handling and secondly to minimise unskilled labour. *Incidentally*, the labourer has to become more skilled in order to survive, and in course of time this is beneficial all round.

Although mechanical, or, better still, electrical methods of handling may or may not be more economical than the manual method, the latter, since it necessitates the employment of vast hordes of unskilled men, can be ruled out because, by bitter experience, the lesson is being slowly learnt that bodies of unskilled men are dangerous to the community, the more so since, by the simple expedient of withdrawing their labour, it is possible for them not only to force their will, but also to inflict hardships, upon their fellow men. In manufacturing countries it either is or it should be the privilege of the State to ensure that there is work to be done and, moreover, it should be, and as civilisation advances it probably will be, regarded as a crime for a man to become so degraded as to call himself unskilled. During the last half century appliances for the loading of ships have resulted in far-reaching benefits to mankind; but, let there be no doubt about it, these appliances are not designed with any object other than that of reducing the cost of commodities. Notwithstanding doles, the manual labourer has to work out, and is working out, his own salvation.

A Melancholy Fact.

Returning to the Paper, it is a melancholy fact, and a fact which cannot be ignored, that Mr. Smith describes installations which he has carried out in China, Brazil, Morocco and South Africa. As he rightly observes, the countries mentioned will be competitors in the future, instead of customers as in the past. Is it true that we are behindhand in this matter? If so, a group of papers describing the methods still tolerated in this country would serve a useful purpose. In such papers the bucket-and-shovel method of handling grain, in use at some of our ports, would be dealt with; the truly appalling cost of handling goods on the railways would be investigated, and attention would be drawn to the fact that by the suppression of the canals the railways, without being challenged, have been able to perpetuate their extravagances. Due to lack of imagination on the part of those responsible, coal is moved about the country to-day, as it was more than 50 years ago, in 8-ton trucks. Our competitors, by using 50 and 75-ton trucks and modern methods of handling, are driving us out of markets in which, till comparatively recently, we had a monopoly.

The Emulation of Freak Conditions.

Mr. Smith is suspicious of freak conditions assisting the wonderful performances given from time to time in stray paragraphs in the technical Press, and is of the opinion that in an engineering court of enquiry the number of tons loaded in a year divided by the number of hours work for which the operators have been paid would be considered better evidence. No doubt such conditions do assist, but, equally truly, similar conditions account for boats being held up at our ports for days, and sometimes weeks, at the time of the country's greatest need.

It is common knowledge that the usual time for loading a 10,000 to 12,000-ton boat plying on the Great Lakes, and engaged in the ore-carrying trade, is three to six hours, depending upon the character of the ore and local conditions. To a large extent it is in virtue of this performance that the United States, labouring under extraordinary geographical and physical disadvantages, can compete with us in the steel-plate trade at home. Although we readily admit that loading more than 11,000 tons of ore in an hour and leaving the harbour in 1 hour and 45 minutes, or loading 9,500 tons of ore in 25 minutes may be due to freak conditions, it is, nevertheless, our considered opinion that, quite apart from conditions, such performances are of the kind which it would be to our advantage to emulate. We would welcome a court of enquiry to report on the whole question, but the terms of reference would have to be very much wider than that of the division of tons by hours.

It is not our intention to attempt to belittle what has been done at home. Students of the subject well know that although the records for rapid handling may be held by our competitors the way for these was paved with the work done in this country. In its day the hydraulic tip was an efficient machine and one which, on occasions, has loaded no less than 4,000 tons of coal in about 12 hours, but it would be the height of folly to-day to describe such machines as modern materials-handling appliances, notwithstanding the fact that our ports are literally choked with them.

The Port as a Machine.

In recent years many papers have been read before the engineering institutions on this important subject, and it is fitting that several of these should have been read before the Institution of Mechanical Engineers, because the mechanical engineers' calling largely depends on efficiency in handling. More tardily than we would wish it is being brought home to our port authorities that a port is a machine for the handling of materials, and decadence is the result of inefficiency. The rapid rise and development in recent years of some of the European ports, although it need not give rise to serious anxiety at the moment, is, nevertheless, in our opinion sufficient to justify the closest examination of the facts by those who depend for their livelihood on cheap transport. As Mr. Smith rightly observes, Great Britain must always remain interested in the cheap and rapid transport of the raw materials on which her industries depend, because, without the means to do this work at a low cost, she can neither regain nor maintain the supremacy in production that was once enjoyed.

Two Laboratory Applications of the Triode Valve.

By JOHN SCOTT-TAGGART.

The three-electrode valve has several interesting applications in the physical and electrical laboratory quite apart from its usefulness in radio communication. One of these is its employment for the measurement of high voltages, whether direct or of an alternating nature.

One simple arrangement is to connect a two-electrode valve or one of the three-electrode type with grid connected to anode), across the E.M.F. to be measured. The filament of the valve is heated by current from an accumulator. If the source of E.M.F. is direct, connections are made so that the anode of the valve is made positive. Normally, an anode current would flow through the valve. If, however, we insert a battery of variable E.M.F. and galvanometer in series with the valve, we can adjust this battery until the current through the galvanometer is just zero. The E.M.F. of the battery, if noted, will clearly equal the E.M.F. which it was desired to measure. This method is obviously unsuitable for measuring high voltages. It would, for example, be very inconvenient to have a battery of 1,000 volts or 10,000 volts, and an accurate result would be impossible.

THE MEASUREMENT OF HIGH VOLTAGES.

The present writer, therefore, devised the arrangement shown in Fig. 1, which, doubtless, has possibly been employed previously by others. It will, however, be of interest to those who desire to measure high voltages without employing an aelectrostatic voltmeter, and especially those who desire to measure high-frequency voltages.

A three-electrode valve is connected across the point *Y Z*, the P.D. across which is to be measured. A milliammeter or galvanometer *A* is connected in series with the valve, as indicated. It is now proposed to adjust the grid *G* to a negative potential which just prevents the passage of current through the valve which acts as a voltmeter of infinite resistance. When the sliding contact *S* on the potentiometer resistance *R* brings the current through *A* to zero the voltage on the grid is measured by *V*. The voltage across *Y Z* is directly proportional to the voltage indicated by *V*. To obtain the voltage across *Y Z* it is only necessary to multiply the voltage of *V* by a constant which will be rather less than the voltage amplification factor of the valve.

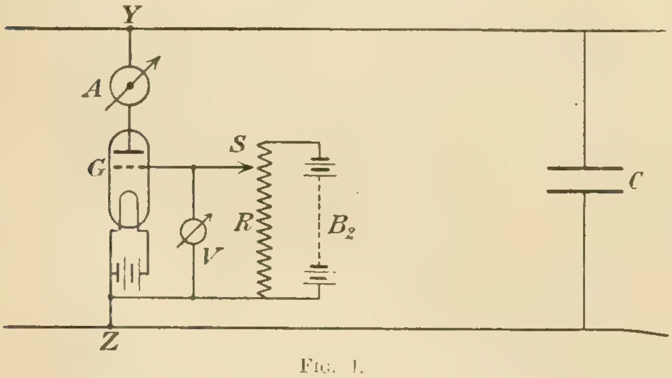

FIG. 1.

In the case of the *ES*4 valve, designed by the writer, the factor is 5·4. The constant may be experimentally determined by placing, say, 100 volts across *Y Z* and adjusting the grid voltage to that value which will produce zero current through *A*. The proportion once established is independent of the E.M.F. across *Y Z* and almost independent of the filament current. When high voltages are to be measured, the valve impedance should be very high and the grid should preferably be a closely-woven mesh of wire. A Marconi " Q " valve is more suitable than any other commercial valve for this particular purpose. If the amplification factor of the valve were 200, the E.M.F. of B^2 would only have to be 10 volts to measure P D 's up to 2,000 volts. If it is desired not to use the voltmeter *V*, the resistance *R* could be calibrated in volts to correspond to the potentials across *Y Z*. In the figure, it is supposed that the E.M.F. across a condenser *C* is being measured. This condenser may be part of an oscillatory circuit or may be across a main source of direct current (say, the direct-current generator of a wireless valve transmitter). If the potentials across *Y Z* are alternating or oscillating, and *S* be adjusted until there is no deflection in *A*, the peak voltage is indicated. In this way, the voltage of high-frequency oscillations may be obtained. Likewise, the maximum high-frequency potential of an aerial may be measured. The reactance of this voltmeter may usually be neglected.

TESTING HIGH INSULATION.

Fig. 2 shows another arrangement which has proved useful for testing condensers and other apparatus for high insulation. In the plate circuit of a triode is a milliammeter *A* and an anode battery *H*. The grid circuit contains a battery *D* (which may be of any voltage up to, say, 50 volts) with its positive side connected to the filament. The grid circuit is broken at the points *Y* and *Z*. The current through *A* is first noted. The condenser or other arrangement whose insulation is to be tested is now connected across *Y Z*, and, after an interval, the reading of *A* is taken again. If the readings are substantially the same the insulation may be considered infinite. The very slightest faultiness of insulation would be indicated by a decrease in the current through *A*. The explanation is simple. If the resistance across *Y Z* is infinite the negative potential of *D* does not affect the grid, the potential of which is that at which the grid current would be zero (usually, about −0·75 volt). If, however, there is a resistance across *Y Z* of finite but exceedingly great value, the grid will attain a negative potential correspondlng to the E.M.F. of *D*, since there is no potential drop in the grid circuit, there being practically no grid current. In this way, the arrangement discriminates between an infinite resistance and one of exceedingly high value. The negative potential communicated through the resistance to the grid causes the decrease of anode current. By such an arrangement, incidentally, the author found very closely the temperature at which glass begins to act as a conductor.

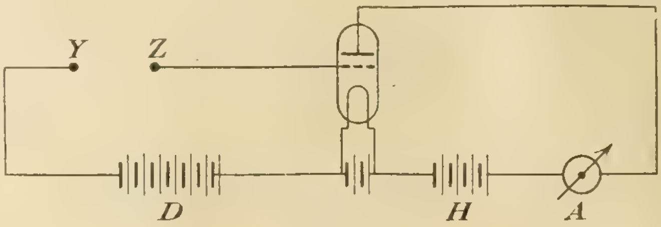

FIG. 2.

A modified scheme of extensions at the Nechells station is being prepared by the BIRMINGHAM Electric Supply Committee. It will be remembered that, owing to the financial position, the extension scheme already approved had to be deferred, and the Committee will now recommend that certain sections of the work be proceeded with on the understanding that the cost is defrayed temporarily from the department's internal resources until such time as it is possible for the Finance Committee to report that capital funds are available. It is proposed to install a 5,000 kw. turbo-alternator set with condensing plant, switchgear, water tube boilers, economisers, chimneys, &c., at an approximate cost of £120,000. This will be ordered at once, so as to enable the Committee to relax the restrictions on manufacturers' supplies, which are so detrimental to the interests of the city. A sum of £30,000 is also urgently required for normal extensions of the distribution system, and the Committee also desire authority to proceed with piling the ground for the foundations. The estimated cost is £20,000. The total estimated cost of the modified scheme is £170,000, of which sum £108,000 forms part of the extension sanctioned by the Council in June last.

Sir William Bragg on Electrons.[*]

In recent years the results of experimental research on the properties of electrons have accumulated with startling rapidity. As knowledge grows, the importance of the part played by the electron in the mechanics of the world becomes even clearer. There are all the right signs that progress is being made along a road that really leads somewhere; we are continually finding that, through some electronic action, phenomena are linked together between which we had hitherto seen no connection. Precision is given to our views: we find ourselves able to express, quantitatively and with confidence, laws and relations which have been matters of vague surmise. Every experiment that is finished suggests others that are promising. The whole world of experimental physics is full of new life, and of the consciousness that after a period of hesitation the tide of discovery is sweeping on again.

Theoretical Activities.

While knowledge grows by experiment, theory is also busy. The attempts to co-ordinate the new discoveries are of singular interest because of their daring, their width and their strength: because they are so often fruitful in prediction: and, not least, perhaps, because they seem so often to be irreconcilable with each other. Just as chemistry has grown and prospered on its recognition of the unit of matter so electrical science has already begun a new life, based on the understanding of nature's unit of electricity. There are many different atoms of matter, but the number of different kinds of electrical atoms is more limited We are clear as to the existence of one, the electron. We suppose that there is a definite positive counterpart, but our ideas about it are much less precise. The electrician will gain when he grasps the fact that electricity is not merely measurable in quantity, but that there is already a unit of nature's choice, possibly no more than one unit. We may say with justice that the most wonderful advances in modern physics are the regard for our appreciation of this truth, and we may hope with equal justice that we are yet far from reaping the full benefit.

Preliminary Researches.

In the long series of researches which finally led to the isolation of the electron and the determination of its properties, there were some that marked definite stages in the forward movement. Examples are the work of Crookes on the electric discharge in bulbs exhausted to a high degree, the observation of the so-called cathode rays, and his theory of a fourth state of matter. Hertz showed that the rays could pass through thin sheets of matter such as aluminium leaf, and Lenard displayed their effects in the air outside. In the latter years of the last century came the great experiments of Wiechert, Thomson, and many other observers who weighed the electron and measured its charge. Since then, the measurements of these quantities have been repeated many times with increasing skill and understanding. They have reached their present high-water mark in the experiment of Millikan at Chicago, who gives us the value of the charge in electromagnetic unit $e = 1{\cdot}591 \times 10^{-20}$, the mass being $0{\cdot}903 \times 10^{-27}$ gramme or 1/1 830 of the mass of the hydrogen atom.

We infer from experiments such as those of Kaufmann and Bucherer, that the energy of the moving electron may be considered to exist wholly in the form of electro-magnetic energy such as is necessarily present when an electrical charge is in motion; and that its mass is in this way perfectly accounted for. But this conclusion sets a limit to the size of the electron and we must assume that its radius, if its form is spherical, is not more than 10^{-13} cm., or about a hundred-thousandth of the radius of any atom.

How the Electron is Measured.

In spite of the all-pervading character of the electrons these measurements have not been made before because until recently it has not been possible to make electrons move fast enough in spaces sufficiently empty of air or other gases. It is speed which gives separate existence to the moving electron: and speed which also betrays its presence to us. For, on its way, the electron here and there chips away another electron from an atom which it is crossing and leaves behind it a separation of electricities which may subsequently influence chemical action or provide a current for the ionization chamber. There is much that is obscure in the whole process. But it gives us a ready means of observation, without which our knowledge of the electron would be far less than it is.

The Arrangement of the Atomic Structure.

These electrons which are so made manifest by speed form but a minute fraction of their whole number. They form one of the elements of construction of every atom; and it is one of the most immediate aims of present research to find in what way they are built into atomic structure. In every atom there are electrons of which one can be removed at the cost of a certain amount of energy, of the order of 10^{-11} ergs. Whether a second electron can be removed at anything like the same cost is difficult to say. There are other electrons with the atom which are intrinsically far more difficult to remove. On the other hand some atoms, for example those of the metals, have each one or more electrons which are little more than hangers on, and are indeed removed with very little trouble. A block of pure metal is full of such loosely bound electrons, so that if an electric potential difference is maintained across the block an electron flow or electric current is produced. The metal "conducts." At sufficiently high temperature all bodies become conductors. At high temperature too, the electrons acquire high velocities as they move to and fro with their proper share of heat energy. At the surface of the hot body the electrons may break away; and hence the "thermionic emission" investigated by O. W. Richardson. So copious is this supply of electrons at the surface of a hot body that if the latter is made negative in potential relative to its surroundings there is a current discharge which may sometimes be measurable in amperes. Of course, such a current can only pass one way, negatively from the hot body, or positively towards it. So we get the basic principle of the "valve": and so Coolidge provides the electrons for projection against the target in the X-ray bulb which he has designed. At this point we find already the adaptation of our new knowledge of electrons to apparatus of extraordinarily great use to mankind.

Breaking New Ground.

If now we plunge a little deeper into our subject we come to certain most fascinating regions of it, where exploration is still in full progress. In one of these we find the most remarkable connection between moving electrons and electromagnetic waves. The one can always call up the other: and the action obeys certain precise numerical laws.

The production of X-rays in a Coolidge bulb is an example of this. If we measure the energy supplied to each electron as has been done in certain experiments of Duane and Hunt, at Harvard University, and if we analyse by the X-ray spectrometer the X-ray radiation that issues from the target, we find that the frequencies of the emitted rays may have a wide range of values, but that the upper limit of the frequencies is always proportional to the energy of the electron, and, therefore, to the potential imposed on the tube. This ratio remains the same no matter what is the intensity of the electron discharge, and no matter what the nature of the target. This ratio of electron energy to maximum frequency is known as Plauck's constant, and is denoted by "*h*." Its value is $6{\cdot}55 \times 10^{-27}$.

The crucial point is that where the energy of an electron is handed over in whole or in part, the frequency of the X-ray waves that take over the energy is determined by the quantity of energy handed over. This explains why there is a limit to the frequency of the X-rays: it is because there are some electrons, though only a fraction of the whole number, which give up all their energy to the formation of X-rays at the moment of striking, before they have lost energy in collisions. The rest of the rays, all those which have lesser frequencies, will come from electrons that have lost speed in this way, or possibly have transferred only part of their energy. The atom of the target is playing the part of a transformer, and does not determine the frequency, so far as these effects are concerned.

A Reciprocal Effect.

All this is wonderful enough; but the marvel is greatly increased by the discovery that the effect is reciprocal. Just as the swiftly-moving electrons excite X-rays, so X-rays when they strike any substance lose their energy, which now appears as the energy of moving electrons. And, again, we find the same variation in the result and the same limit to that variation. Among the electrons so set in motion we find every variety of energy-content up to a certain critical value which is equal to the frequency of the X-rays multiplied by the same constant h.

Not only in the case of X-rays are these effects observed, but also in the case of light. When the light waves produce the electrons we have what is known as the photo-electric effect.

An Important Fundamental Operation.

Exactly how this strange transfer of energy from one form to another takes place, we do not know. Suppose that the target of the X-ray bulb were magnified in size until it was great as the moon's disc, that is to say, about a 100 million times. The atoms would then be spheres a centimetre or so in diameter. But the electrons would still be invisible to the naked eye. The distance from earth to moon would correspond roughly to the distance that ordinarily separates the bulb from an observer or his apparatus. We now shoot electrons at the moon with a certain velocity. A radiation now starts away from the moon which immediately manifests itself by causing electrons to spring out of bodies on which it falls. They may have various speeds; but none exceed, though some will just reach, the velocity of the original electrons that were fired at the moon. That is the process that goes on in and about the X-ray bulb: which is part of a universal natural process going on wherever radiation, electron or wave, falls on matter, and which is clearly one of the most important and most fundamental operations in the material world.

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[*] Abstract of the Twelfth Kelvin Lecture delivered by Sir Wm. Bragg, K.B.E., F.R.S., before the Institution of Electrical Engineers, Jan. 13, 1921.

Keeping these results in mind, we can now appreciate a very remarkable development of electron theory which has been made in the last few years. There is nothing in our older conception of the origin of radiation within the atom to give us a clue as to why differences of frequencies should come into the well-known Balmer formula. If, however, we abandon our preconceptions as to the origin of those lines which we find in the light spectrum and suppose that the energy of an emission of radiation is derived from the energy of an electron, that within the atom there are certain positions or conditions in which electrons *may* be, each postulating a certain energy content for the electron: and that sometimes an electron slips from one position to another of lower energy, and that the difference in energies is transformed into wave radiation according to the same law as before. Thus Balmer's formula is accounted for.

What may these states be? Why not, as Bohr suggests, so many different orbits in which electrons can move round the central positive nucleus in the atom, the nucleus whose sure existence Rutherford has established? At one time if we had presumed the existence of these orbits we should have been inclined to connect them with the direct emission of radiation, and the frequency of that radiation would be the number of revolutions in a second. But now, we assume these orbits to persist without radiation, and that radiation arises where the electron steps from one orbit to another: moreover, the frequency of the issuing radiation is determined by the simple rule, frequency is equal to change of electron energy divided by h.

RECENT MODIFICATIONS.

During the last few years Bohr and Sommerfeld have led an inquiry into the possibilities of this theory which have led to very remarkable results. These are due to a slight modification in the original conception. The different circular orbits which Bohr first pictured have become groups of orbits fixed by laws which are somewhat arbitrary, but not without foundation. A group contains a limited number of orbits in which the electrons may move, and each group corresponds to one of the original circular orbits. Some of the orbits in each group are elliptical. It appears that the energy of the electron would be the same in all the orbits of any one group were it not that when an electron moves in an ellipse its velocity is not always the same. Now a fast-moving electron shows a variation in mass when its speed alters, and this does affect slightly the energy of the orbit. Consequently, the electron that steps from an orbit belonging to one group to an orbit belonging to another group may part with an amount of energy which is not always exactly the same. The frequency of the consequent radiation may, therefore, have two or more values differing slightly from each other: the single spectrum line is doubled or trebled. That is what Sommerfeld calls the "fine structure" of the lines.

ARRANGEMENT OF CARBON ATOMS.

When we come to examine these structures we find atoms attaching themselves to each other through the action of forces which cannot always be considered as acting from centre to centre. For instance, the arrangement of the carbon atoms in a diamond, as recently determined by X-ray methods, is such that every atom is at the centre of gravity of four others, arranged round it in tetrahedral fashion. And we must conclude that there are definite sub-centres of force on the outskirts of the atom: and that in the carbon atoms of which the diamond is composed there are four such sub-centres arranged symmetrically, that is to say, in tetrahedron fashion round the core. Must not these sub-centres be electrons? And if so, must we not take them to be circulating in small orbits about a local centre? Or, perhaps, as Parson has suggested, the electron is ring shaped, the electricity revolving round the axis of the ring. In this way we should have electromagnetic forces to link the atoms together. It is very interesting to observe that in any case the carbon atoms in the diamond are not all oriented in exactly the same way. Taking a cleavage or tetrahedral plane as that of reference, half the atoms will be pointing towards the plane and their neighbours will be pointing away. This ought to make a difference to the X-ray spectra: and it has been looked for at various times, but without success. Lately, however, the improvement in the X-ray spectrometer has been considerable, and there is now no difficulty in finding the expected effect. It is clear that the carbon atom in the diamond is to be represented as to its properties by a tetrahedron: and that the atom has different properties in different directions, or, as the chemist would say, has directed valencies. There can be little doubt that this is so in all atoms. The suggestion is that some of the electrons are tied down to certain regions on the surface, and that not all, if indeed any of them, are at all times revolving round the central core. When atom joins up to atom it is these sub-centres that are at work; and since atom to atom and again atom to atom make in the end the crystal; and since the crystalline structure is the basis of all solid structure, and is fundamentally concerned with the strength of materials and their temper and all their physical properties, it is easy to see how great is this minute study of the electron.

If this conception of fixed electrons seems to clash with the orbital motions of Bohr and Sommerfeld, we must remember that the clash is between two pictures both of which are imperfect. We may expect that on the next occasion when a lecturer tries to describe what advance has been made in the study of electrons some of these contradictions will have disappeared. Whether this is so or not in the attempt to realise the properties of the electron, we are working in the true direction towards an understanding of the great problems of radiation, and of material structure.

Temperature Limits of Large Alternators.*

By G. A. JUHLIN.

It is usual in this country to specify the temperature rise of electrical machinery by thermometer measurement. The limiting temperature rise generally adopted is 40°C., independent of the type of machine and of the class of insulation employed. This limit is not satisfactory, on account of improvements in insulating materials and methods of construction, and changes in the type of machines. Moreover, in modern large alternators, where large masses of material are concentrated in a comparatively small space, the internal temperatures may be far higher than those obtained by thermometer measurement on the external surfaces. Reference may be made to Report No. 72 issued by the British Engineering Standards Association, but comparatively few specifications are based on these rules. Experience has shown that mica insulation as employed in turbo-alternators withstand considerably higher temperatures than those laid down in the rules. Indeed, arguments can be put forward in support of higher limits.

INTERNAL OR HOT-SPOT TEMPERATURES.

In studying this subject it is desirable to consider the temperature distribution obtaining in large generators. We shall for simplicity neglect the influence of the rotor upon the stator temperatures. The sources of heat in the stator are: (1) Losses in the laminations due to hysteresis and eddy current, *i.e.*, iron or core losses. These losses are considered approximately constant and therefore independent of the load. (2) Losses caused by the load current, comprising:

(*a*) Losses in the winding (I^2R) and eddy-current losses in the copper, and

(*b*) Losses in the laminations and iron surrounding them, caused by the load current.

These vary as the square of the load current.

(3) Losses due to windage, and fan losses. These are, of course, independent of the load, except in special cases where external fans are used, and where the volume of air is altered with the load.

The change in temperature of the different parts of the stator with the load is shown in Fig. 1, which is typical of large turbo-generators with long cores. The temperature of the iron increases with the load, due to the greater portion of the losses being generated in the laminations and the surrounding iron, and the losses in the copper itself comparatively small.

Although it is possible to determine the total losses caused by the load, it is practically impossible to ascertain by means of tests the losses in different parts of the machine. Moreover, a part of the heat generated in the winding flows along the conductors in an axial direction to the end windings, where it is taken up by the cooling air. Another part of the heat will flow through the insulation into the iron and will be conducted to the surfaces of the laminations exposed to the cooling air and thus dissipated. The predetermination of the internal temperature is therefore very complicated.

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* Abstract of Paper read before the Institutution of Electrical Engineers.

AXIAL TEMPERATURE DISTRIBUTION.

The axial temperature distribution depends on the system of ventilation adopted. Figs. 2 and 3 show diagrammatically the conditions obtaining with radial and axial ventilation respectively.

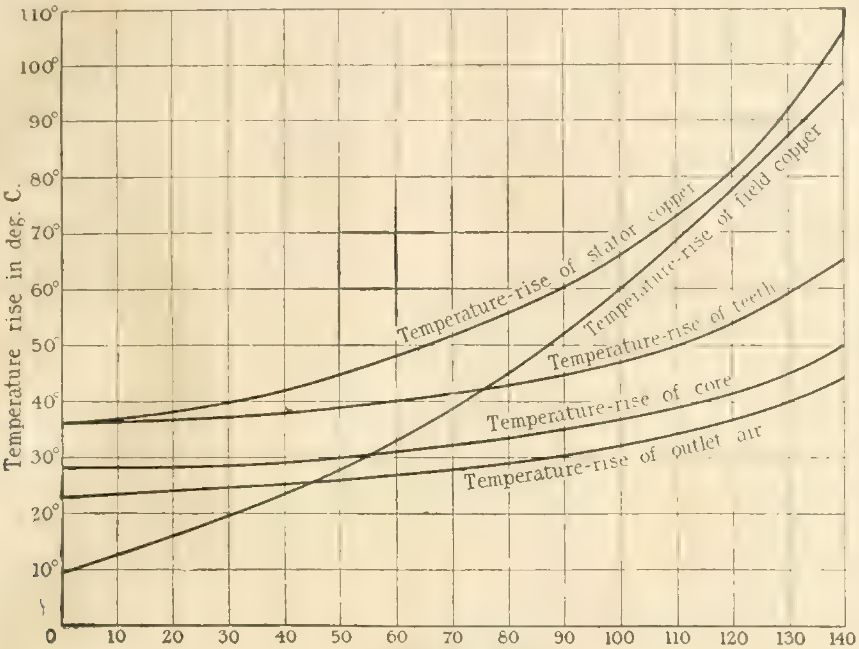

FIG. 1.

The exact location of the hot spot changes with the type of ventilation, but will be located somewhere in the embedded portion of the winding, unless the ventilation of the end windings is abnormally bad. The heat will then flow from the hot spot along the conductors towards the end windings. The amount of heat to be transmitted becomes greater as we move along the conductors towards the ends, and the temperature drop increases rapidly with the length of the conductor. The curves in Fig. 4 show the temperature gradient for varying lengths and current densities (no account being taken of eddy current losses). Such large temperature differences do not exist in practice, as a considerable amount of heat is transmitted through the insulation, but the curves indicate the small amount of heat which can be conducted along the copper without excessive temperature differences.

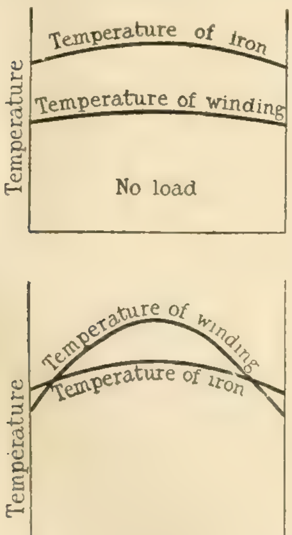

FIG. 2.

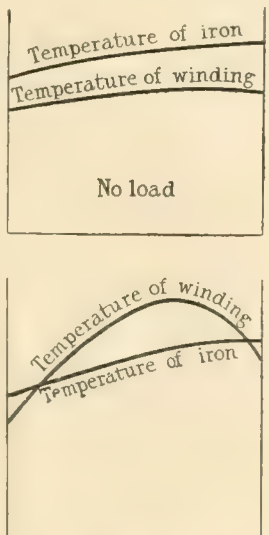

FIG. 3.

HEAT FLOW THROUGH INSULATION.

The amount of heat which will flow through the insulation per unit surface is, as is well known, a function of the heat conductivity and thickness of the material. Tests made on complete machines in actual service show that a thermal conductivity of 0·003 to 0·0035 watt per cubic in. per degree Centigrade may be taken as an average figure. Having fixed the value of th constant, the temperature drop, T, will be obtained by the formula :

$$T = \frac{\text{(Watts per square inch) (Thickness of insulation in inches)}}{\text{Thermal conductivity}}$$

We have still to determine the watts per square inch before it is possible to calculate the temperature drop. It is necessary to include the eddy-current losses in the copper, as these may be large if the winding is not properly constructed. One cannot judge the rating of a machine or ensure a liberal design by simply specifying a limit to current density. The proportions of the slot greatly influence the temperature rise.

To show the magnitude of the temperature drop the author considers a slot of specified dimensions and assumes that all the heat generated in the copper conductors at the centre of the core is transmitted laterally through the insulation. Assuming a temperature rise of 40°C. on the laminations, measured on the surface, it is shown that for a 10,000-volt machine we should obtain a temperature drop of 48°C. through the insulation, and a total temperature of 113°C., *i.e.*, 98°C. above the cooling air. These figures are not excessive for existing machines.

Appreciably higher internal temperatures will be met with in high-voltage machines than in low-voltage ones, if the same surface temperatures are specified. This has, of course, been recognised by the British Engineering Standards Association, and a reduction in the temperature rise of 1 deg. C. for each 1,000 volts or part of 1,000 volts by which the voltage exceeds 5,000 is specified when the thermometer method is adopted.

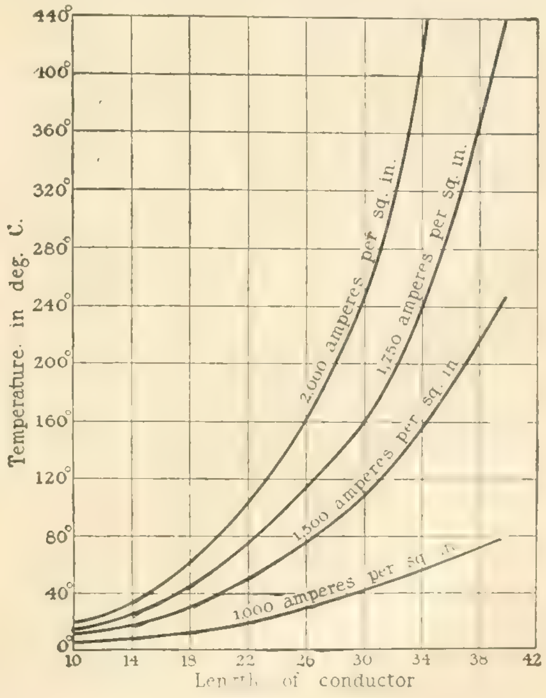

FIG. 4.

The difference in temperature between the iron at the root of the teeth and the outer periphery will clearly depend on the losses in the stator laminations, and on the radial depth of the core and the system of ventilation adopted. The difficulties involved in making allowances in surface temperatures in such cases are obviously very great.

TEMPERATURE MEASUREMENTS.

Temperatures of electrical machinery may be measured by: (1) Thermometer; (2) the increase in resistance of the windings; and (3) embedded temperature detectors.

The thermometer method is, of course, the simplest and, so far as surface temperatures are concerned, the most reliable. But if a body is covered by a poor conductor of heat, considerable variations may be obtained in the readings of the thermometer, depending on the thickness of the covering over the thermometer bulb. Hot pockets may also be created by the pad used, and these may result in false readings. The use of the thermometer is clearly limited to accessible surfaces. An approximation of the true internal *average* temperatures can be obtained by the use of the increase-of-resistance method. This method is readily applicable to windings carrying direct current, but, in the case of alternating-current windings, involves a separate direct-current supply of steady voltage. Moreover, it is necessary to arrange for means of disconnecting the winding from the system.

Embedded temperature detectors have been included in the rules issued by the British Engineering Standards Association as a means for measuring the temperature rise, but have not received much attention in this country. In America this method has been adopted as a standard, and machines are now generally provided with embedded temperature detectors during construction. The advantages of such an arrangement are obvious.

The effect of short time overloads on large turbo-alternators is of importance. Fig. 1 shows how the drop of temperature through the insulation increases very rapidly with the load, while the temperature drop through the iron is also increased to some extent.

The large temperature gradients in the insulation and the iron cannot be measured by thermometers, and one cannot form any judgment by this method as to the internal temperatures. By the use of embedded temperature detectors one can determine closely the actual temperature of the copper, and thus prevent the machine being overheated. When embedded temperature detectors are used, temperature guarantees should be based on total temperature and not on a specific temperature rise based on a given air temperature.

The effect of lower external temperatures during the winter months is of considerable value in augmenting the output of a station at a time of heavy load. By taking a typical example the author shows that in operating on the temperature rise basis 18 per cent. of the output the machine would be able to give if run up to the limiting total temperature is lost.

Basing the increase on the average air temperature throughout the year, the increase in output would probably be not more than 10 per cent., but even at this figure the saving in capital expenditure on a 20,000-kw. set would be very considerable.

There are two types of detectors which have found extensive use for electrical work, the thermo-couple and the resistance thermometer. The thermo-couple has the advantage of being very small and readily placed in the winding. Two methods have been adopted: (1) The E.M.F. of a calibrated thermo-couple is measured direct by a millivoltmeter; (2) a zero current method, *i.e.*, no current flows through the thermo-couple, the E.M.F. of which is balanced against a cell. This makes the reading independent of the resistance of the couple, but it is more complicated.

The resistance thermometers occupy considerably more room than the thermo-couple, and are more difficult to shield from air currents. The author considers that the thermo-couple is the most satisfactory means of measuring internal temperatures, owing to the small space occupied which makes it possible to measure the temperature of any particular spot in a machine. The location of such couples must, however, be carefully chosen.

TEMPERATURE LIMITS.

The determination of the point at which failures of insulation may be expected is difficult and largely a matter of opinion. Insulation which, if not disturbed, would last almost indefinitely, would fail very quickly if subjected to vibration or shocks. Insulation failures may be either (1) mechanical or (2) electrical.

Mechanical failures may be caused by: (*a*) Severe strains which crack or damage the insulation. (*b*) Brittleness of the insulation due to drying out, which causes it to lose its elasticity and break if subject to the smallest displacement. (*c*) Destruction of the binding material used in building up the insulation; this causes looseness and makes it liable to destruction by vibration.

Electrical failures may be due to: (*a*) Direct puncture of the insulation. (*b*) Reduction in insulation resistance.

In the American and British Standardization Rules three different grades of insulation are considered. These are: Class A, consisting of cotton, silk, paper and other similar materials not impregnated or treated with oil, where the maximum temperature to which the material may be subjected continuously is 95°C. If impregnated, the maximum temperature is increased to 105°C. Class B includes mica and asbestos, where the maximum temperature is 125°C, and Class C includes fireproof and refractory materials.

It is generally agreed that the limits fixed for Class A insulation cannot safely be exceeded, and as Class C insulation is not employed in machine construction, except to a very limited extent, only Class B material will be considered. Of the materials which come under this heading mica is the most important. In the original Paper the author describes some tests to ascertain the effect of temperature on mica wraps, such as are employed on the coils of large turbo-alternators. Test samples were made up in bars consisting of three conductors insulated from each other by half-lap layers of mica tape. Bending tests were made on a number of bars in the condition they were in after having been insulated in the wrapping machine in the usual way. Other bars were clamped between iron strips to avoid undue swelling of the insulation, and heated for six weeks at a temperature of 150°C. by means of a current passing through the conductors. They were afterwards subjected to the same test as the bars which had not been heated.

The results of these tests are shown in diagram form in the original paper. A voltage of 11,000 was applied between the conductors and the clamp. In all cases it was found that mechanical failure of the wrap preceded electrical failure.

The tests show clearly that no diminution in the elasticity of the insulation is caused by temperatures up to 150°C. The reduction in mechanical strength of the bars is no doubt due to the fact that the backing used has lost strength.

Dielectric tests were carried out on all samples. There was no difference in breakdown strength of the insulation between the bars before and after heating. All samples failed betewen 30,000 and 35,000 volts, which may be considered satisfactory for the thickness of insulation employed.

THE EFFECT OF HIGHER TEMPERATURES.

Further tests were arranged in order to determine the effect of still higher temperatures. In order to approximate as far as possible to actual service conditions, the samples were placed in semi-enclosed slots of a sector of laminations taken from a standard machine and were heated by passing an alternating current at 25 periods per second through them. Temperatures were measured by means of thermo-couples placed directly on the copper in each slot and kept as near as possible to 200°C. during the whole run. The laminations were kept at a potential of 11,000 volts above the copper during the daytime, or for about half the time of the run, so that any failure of the insulation could be detected. No insulation troubles were, however, experienced.

Dielectric tests were made on the bars after the heat run. Two of the samples failed at 18,000 volts, due to mechanical damage caused by bending. All the other samples withstood 25,000 volts, and no appreciable deterioration of this insulation had taken place. The bars were then removed from the slots for inspection and were found to be in a satisfactory condition. The paper and cambric used for building the mica upon was found to be carbonized, but remained intact on the inside layers. The outside paper covering was destroyed in most cases, but this was done in removing the bars, which had to be pulled out of the slots.

It has long been recognised that the solidity of the wrap is of great importance, and likewise the percentage of mica employed. In order to determine the influence of these factors several sets of bars were made and insulated with wraps containing different percentages of mica varying from 20 per cent. in the old hand-wrapped type, up to practically pure mica in some special wraps.

All these bars were subjected to a temperature of 190°C. continuously for 10 months, or about 7,000 hours. A voltage of 11,000 was applied between the winding and the core each day to ascertain whether any insulation failure had occurred. As shown in the following table the bars withstood considerably higher voltages than this at the conclusion of the test.

At the end of the test the bars were still a good fit in the slot, but the cotton covering on the individual conductors was destroyed. The mica strips between the conductors were, however, in perfect condition.

The tests given on p. 129 confirm the results obtained from a series of similar tests carried out by the Westinghouse Electric and Manufacturing Company, Ltd., at Pittsburgh, U.S.A. In these tests mica insulation such as used in the tests described in this paper was

TABLE SHOWING BREAKDOWN VOLTAGE OF VARIOUS CLASSES OF MICA WRAPS AFTER HEATING FOR 7,000 HOURS AT 190° C.

Descriptive of wraps on the various Samples.	Breakdown Voltage.	
	Minimum.	Maximum.
(1) Empire cloth and mica, hand-wrapped	15,000	26,000
(2) Cambric and mica, machine wrappd	31,000	35,000
(3) Paper and mica, machine-wrapped.	32,000	45,000
(4) Paper and mica, machine-wrapped	47,000	48,000
(5) Mica and shellac only, machine-wrapped	50,000	52,000

subjected to temperatures as high as 300° to 400° C. without any serious loss in dielectric strength.

ROTOR INSULATION.

Temperature distribution in rotors generally is more even than in the case of the stator. The temperature of the end windings is greater than that of the slot portion.

The problem of insulating the rotor winding is not as difficult as that of the stator winding, as practically pure mica can be employed. There is, therefore, no destructible material in the insulation, and it may consequently be classed under heading (5) in the Table given in connection with the temperature tests previously mentioned. Moreover, the margin of safety of the rotor insulation is much greater than that of the stator.

There is no difficulty with regard to the question of other materials than mica being used in turbo rotor construction. Machines are now constructed in which nothing but asbestos tape is used for protecting the coils from dirt, and special asbestos "Bakelite" material is used for any packing blocks and distance pieces. These materials are absolutely unaffected by temperatures considerably higher than those which it is suggested mica insulation may be subjected to.

CONCLUSIONS.

It is not possible to come to a conclusion with regard to the maximum temperature to which mica, used in the insulating of electrical machines may be subjected. But the tests described show conclusively that there is no foundation for the doubt which seems to exist, that the temperature limits laid down by the British Engineering Standards Association are too high. Indeed, they may with safety be increased. As mica insulation of the type employed in the construction of up-to-date alternators is capable of withstanding temperatures up to 200°C. without losing its electrical or mechanical properties.

The maximum temperatures could then be increased to 160°C. based on embedded temperature-detector measurements for the stator winding, and by the increase-of-resistance methodse for the rotor winding. Allowing a correction of 10°C. for the difference between the maximum temperature and the observable temperature, the latter would then be 150°C.

Admitting that no reduction in the margin of safety will result there are considerable advantages to be obtained by adopting the higher temperature limits, namely: (*a*) In the case of machines running at the same speed, those with high temperature rating are cheaper. (*b*) Higher efficiencies are obtainable. (*c*) Larger units can be built, or (*d*) Higher speeds can be adopted for machines of certain sizes. (*e*) Less space is required.

Advantage (*d*) above is of great importance because an increase in speed reduces the cost, not only of the alternator itself, but also that of the turbine. Better steam consumption is also obtained under certain conditions for the high-speed turbines. The increase in the temperature limits is therefore in some cases very far-reaching. There is a distinct tendency among American engineers to accept higher temperatures, and the two largest manufacturing companies have adopted a guarantee of 150°C. for the ultimate temperature of their turbo-alternator rotors, and one of the companies gives this guarantee for the stator windings.

Opinions on the Heating of Buried Cables and Distribution.

A discussion on the Heating of Buried Cables Report, of which an abstract was given in our issue of Dec. 24, 1920, recently took place at Manchester. It was opened by Mr. H. A. **RATCLIFF**, who said he found the report disappointing, since the work accomplished was such a comparatively small portion of the whole. Nevertheless, it was reassuring. In view of the length of the remaining programme, he suggested, that samples of cables should be tested to destruction to determine what they would stand and to fix the conditions under which danger limits were likely to be reached in practice. Since least was known about extra-high-pressure cables, he advocated making a start with these. Mr. Fawssett's report was valuable, especially as in large cities streets were so congested that it was necessary to go to depths of 10, 12 or 15 ft. to obtain room for cables. Three years ago, when desiring to specify 33,000 volt cable, he found little information available, even from cable makers, and it appeared that the limiting factor was dielectric losses. A figure of 60°C. was decided on for the maximum temperature of the conductor, 25°C. being allotted to the cable-makers for the temperature gradient inside the cable. Experimental work was carried out to ascertain the influence of temperature on dielectric loss. As the loss could not be obtained direct, the copper loss was measured and also the rise in temperature of the cable when the dielectric loss was superimposed on the copper loss. The cable was tested under conditions which gave double the normal dielectric loss for a period of 10 hours, this sufficing to give a steady temperature. The dielectric loss was expressed as a percentage of the copper loss, and the figure so determined agreed with the results of tests arrived at thermally at a maker's works.

Mr. C. J. **BEAVER** also expressed himself as being disappointed that the report was an interim one only, nine and a half years having elapsed since he had urged the desirability of this research. While it was desirable that work should be conducted by an independent scientific body, he thought the Committee should be acquainted with progress made at the cable works and suggested that cable makers should be more strongly represented. The work of the Committee should result in a strong basis of experimental evidence on which empirical formulae might be constructed, with suitable factors to take care of different cables and methods of laying. The tendency of investigators had been to convert limited experimental results into physical constants applicable to all kinds of cables and conditions of laying, and the results had not been successful. He foresaw that thermal tests would be embodied in the routine testing of the cable factory, and rightly so. Dealing with minor points, he thought it more important to specify total temperature than temperature rise. Thermal conductivity was preferable as a term to thermal resistivity. He drew attention to vulcanised rubber as a favourable material for dissipating heat. Thermal conductivity of soils varied so much with moisture that tests in three town as proposed would give the information desired.

Mr. B. **WELBOURN** said the report under discussion had been presented, at his suggestion, to obtain the views of cable-makers and users. The final report might not be forthcoming for two or three years. What had been published would, however, render the present scanty literature on cables in the Journal superior to German and American literature.

Mr. S. W. **MELSOM**, in his reply, did not agree with Mr. Ratcliff that cables should be tested to destruction, as they were trying to ascertain the temperature a cable would stand indefinitely without deterioration. He agreed with Mr. Beaver regarding the basing of formulae on adequate experimental data, but this took considerable time to complete. The term "thermal resistivity" had been employed to avoid confusion of electrical and thermal conductivity. With regard to soils, their experience had been that, with 10 per cent. of moisture, any difference disappeared.

Mr. E. **FAWSSETT**, in reply to Mr. Ratcliff, said that, over 4 ft. in depth, there was little increase in temperature. Tests were being conducted on a wide variety of soils under all kinds of weather conditions, the figures varying from 8 to 40 per cent.

E.H.T. DISTRIBUTION BY UNDERGROUND CABLE.

No representatives of the cable-making firms took part in the discussion at Manchester on January 11th on Mr. R. O. **KAPP'S** Paper on "Some Economic Aspects of Extra-High Tension Distribution by Underground Cable." The burden of critical examination was, in fact, mainly borne by the supply engineers, who, as anticipated, considered the Paper interesting in its theoretical aspect, but of limited value in its practical applications.

Mr. S. J. **Watson**, in a vigorous contribution, considered that the author had not differentiated sufficiently clearly between transmission and distribution The author had suggested as an example 40,000 k.v.a. in a supply area of 5 square miles. This Mr. Watson thought very concentrated. The load demanded a transmission system, the area a distribution system. In an actual case, a load of 75,000 kw. at 11,000 volts over an area of 400 square miles would have required a capital expenditure for distribution of £9 per kilowatt transmitted, the cost per unit with a 30 per cent. load factor working out at 0·012d. at the station and 0·108d. 10 miles away. The author's figures of £4 per kilowatt transmitted, he thought inadequate. He failed to understand the statement that overhead line work was under certain conditions not as cheap as underground cable, and the opinion respecting cable protective gear. He thought the ring main scheme ideal where possible, but it was impossible to develop without the herring bone system. In a town of star shape, in which the industries were located along main roads radiating from a centre, the space between the points being agricultural land, it was less costly to construct a dulpicate main system than to connect the rays of the star by ring mains. The cable cost was increased, but the cost of excavation and reinstatement of the road was the same. He considered it undesirable to diminish the section of a ring main, and could not understand why so small a section as 0·075 sq. in. was advocated for 6,600 volts cable.

Mr. J. **Williams**, for Mr. Romero, stated that it was misleading to consider capital costs and to ignore ohmic losses, as the author had done. He quoted figures for illustrative cases to show the significance of such losses compared with capital cost. A standby feeder would save almost as much, by diminishing C^2R losses, as the outlay involved. It was unwise and unsafe to run cables to the temperature limit, and he thought engineers would prefer extra copper and safety, as, for instance, a heavy fog might convert a peak-load into an all-day load, and upset the calculations. He considered excessive the capital cost of £4 per kilovolt-ampere of peak load for distribution costs. Since Mr. Watson had criticised the figure as insufficient, with statistical evidence to support his case, the author was happily situated in replying on this point.

Mr. H. A. **Ratcliff** congratulated the author on the valuable information in the Paper, but thought much of it Utopian. Commenting ironically on the "Euclidean town" of the author, having length without breadth, he said that in practice the difference between the centre of gravity and the centre as determined by the model was of no importance. It was of little assistance to work out with mathematical precision cases which were influenced by many varying and undefinable factors. Most systems were of gradual growth and expediency had been the predominant factor in their development. The model gave a centre in the determination of which losses were ignored. The arrangement of transformer tappings was ingenious and useful. He agreed with the author's suggestion regarding economical voltage, and thought that, as demand increased in big cities, it might be desirable to increase the pressure in existing feeders. Mr. Ratcliff also expressed astonishment at the author's views on protective systems. Ring mains were over-rated for dense areas.

Mr. J. B. **Palmer** said that heating and not voltage drop might under certain circumstances be the determinating factor in E.H.T cables. He thought the author might state the "average circumstances" under which cables were laid, and he supported Mr. Watson in his remarks on protective gear.

Mr. R. O. **Kapp**, in reply, said that, with regard to protective gear, engineers were unduly impressed by such gear on account of its name, although since it did not operate until a fault developed, it did not really protect the cable. While it did not dispute its advisability in certain cases, in others he would prefer to use extra insulation as a real protection. He confessed that he had no data with regard to the relative costs of overhead and underground cable constructions, but had considered that for small consumers at 6,600 volts the fixed charges on overhead line would give cable an advantage. He considered that the section of a ring main further from the station need not be so heavy as the sections near the station, assuming that some of the load was utilised between the station and the furthest section. With regard to the use of 0·075 sq. in. cable, he thought that makers were now permitting higher current densities, and that cables installed to-day were not required to be of such heavy section as had been necessary in the past.

THE LIVERPOOL MEETING.

At the meeting of the Liverpool sub-centre of the North Western Centre on Dec. 13th, a discussion took place on the papers of Mr. W. B. **Woodhouse** and Mr. R. O. **Kapp**.

Mr. B. **Welbourn** emphasised the importance of the economics of electricity supply, seeing that one half of the capital invested in it was used in outside work. He did not agree with Mr. Kapp's suggestion, in the section on cable lay-out, that one spare cable was necessary. On some large net-works in this country instantaneous protective gear had been found indispensable. In regard to the cost of excavating, laying and jointing, this was not invariably independent of the pressure. A joint might cost from £10 to £100 according to the pressure employed. There was available about 15 years' experience of 20,000 volt cables, and similar satisfactory experience for eight years of joints at this pressure. But little experience on 33,000 volt cable was available, and it seemed desirable to proceed slowly with this higher value.

Mr. J. A. **Morton** disputed Mr. Kapp's figures for capital expenditure on distribution per unit; the figures should be about half that mentioned. He did not agree that 0·075 sq. in section would become a standard on 6,600 volt networks. In his experience it was better to use one cable up to 0·3 sq. in. wherever possible, rather than two smaller ones. No simple formula of the Kelvin pattern could determine the economic pressure. Feeder losses formed an important element and he (Mr. **Morton**) endeavoured to show that their consideration would alter several conclusions. He also doubted if the extra cost involved in increased size of underground cables was proportional to weight of metal. Dielectric losses were important, likewise the rise in the power factor of E.H.T. cables with increased pressure. Economic sizes and pressures could not in practice be ascertained by formulæ, but only by laborious detailed comparisons.

OVER-CONCENTRATION OF POWER STATIONS.

Mr. W. E. **Nisbett** thought the tendency towards concentration of power in superstations was being carried too far. There was a tendency to use cables for super-pressures with much lower power-factors than those formerly used. The speaker criticised Mr. **Woodhouse**'s cable cost curves. 1907 prices were used in some cases, in others up-to-date values. The curves could not be straight lines. For all tensions up to 11,000 v. only mechanical reasons determined the thickness of dielectric. B.E.S. standards were at present needlessly generous as regards insulation thickness.

Mr. A. **Holttun** pointed out the importance of designing an installation from the outset, to provide for subsequent changes. Both authors limited themselves to a.c. transmission. Was a high tension d.c. system at all practicable, and was the such as the Thury system, quite out of the running? Mr. Kapp's method of determining rise of temperature had several practical objections

Mr. H. W. **Clothier** remarked that conditions of use in distribution systems were rarely known beforehand, and the best theoretical treatment was therefore of limited utility. Super-stations might be desirable in order to conserve coal, but with a view to lowest selling cost of electricity a good case could be made out for a number of moderate-sized stations under one control. He doubted the strict accuracy of the diagram of distribution costs and wished that more prominence was given to the economical limits of super-stations at various pressures. The temperature-charts did not give actual temperatures. It was often more important to know the highest local than the general average temperature. Six-core cables had been used for underground work in America at 30,000 volts and seemed promising for uninterrupted trunk feeders.

Dr. E. W. **Marchant** pointed out that Kelvin's Law determined the most economical cable for transmitting a given energy from place to place; but in practice one had to work on a different basis, namely the ratio of the maximum revenue earned by the energy transmitted to the cost of transmission. Results on this basis were not in accordance with Kelvin's Law. Mr. Woodhouse's formula for the current-carrying cable capacity of cables of varying cross section agreed closely with results obtained in the research on the heating of buried cables; these results suggested that a large number of small cables was preferable to a small number of large ones. It was hoped to make further tests on dielectric losses.

Mr. W. B. **Woodhouse**, briefly replying, said he was in agreement with Mr. Kapp that elaborate interconnecting net-work for protective reasons was too costly. He discussed Mr. Nisbett's comments on the cost of cable equations; for one pressure they had a straight line relation. Dielectric losses varied with pressure, construction, and working temperature of the cable. He agreed that the utility of Kelvin's Law depended on the point of view. Replying to Mr Clothier, Mr. **Woodhouse** said the cost of supplying electricity over a wide area must be somehow cheapened. Agricultural operations were often intermittent and cheapness was more important than absolute continuity of supply. The possibility of revising dielectrics for lower pressures was important, but it was necessary to proceed cautiously in schemes involving much higher pressures than at present.

The Physical and Optical Societies' Annual Exhibition.

(Continued from p. 107.)

H. W. SULLIVAN.

The exhibits of Mr. H. W. SULLIVAN contained many items of interest, in both wireless and submarine telegraphy. The announcement in the catalogue that a selenium cell capable of carrying 1 ampere was to be seen was sufficient to provoke many inquiries. Investigation proved that this formed part of Mr. Cox's amplifier, of which we give a description below.

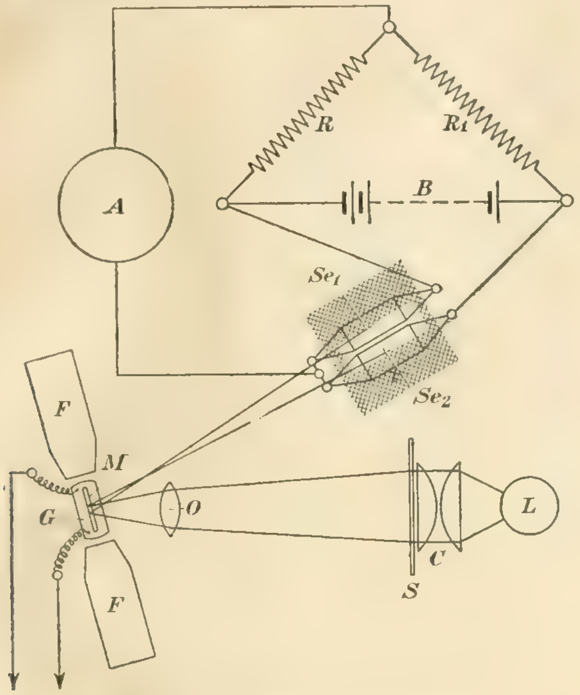

FIG. 9.—DIAGRAM OF COX'S AMPLIFIER.

K. C. Cox's Selenium Amplifier for Submarine Telegraphy is an instrument used to increase the working speeds of submarine cables by amplifying the very attenuated signals received at high speed sufficiently to operate ordinary recording or relaying apparatus. It is illustrated diagrammatically in Fig. 9. A beam of light from the source L is projected on to the mirror of the receiving galvanometer G and thence to a pair of selenium cells Se_1, Se_2. These cells are arranged as a pair of bridge arms. When the galvanometer is at zero the surface of each cell is half illuminated by the beam and is half dark, the bridge system being then balanced. This partial illumination is effected by having a screen S in the form of a vertical grid near the optical system C.

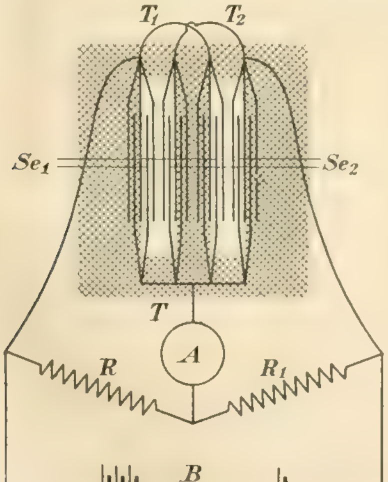

FIG. 10.—DIAGRAM OF PAIR OF CELLS AND CONNECTIONS.

Deflections of the galvanometer by received signals cause the image of the grid to shift across the cells, so that the previously dark part is illuminated and vice versa. This causes large corresponding changes in the relative resistance of the cells, thus actuating the instrument A, which may be a recorder or relay of any desired type.

In practice a large number of very narrow cells or sections of a cell are used, these being arranged in pairs with one " bar " of light to each pair, so as to make full use of the very small galvanometer deflections obtained when working at high speed on long cables. The various pairs are connected as a series of bridges in parallel Two such pairs are illustrated in Fig. 10.

A 24-PAIR CELL.

In Fig. 11 is shown a working cell of 24 pairs of sections, the total selenium surface being 4 in. by 4 in. The form of construction adopted is that in which alternate strips of brass and mica on edge are clamped together. The brass is about 0·003 in. thick and the mica slightly less. The height of the brass is a little more than that of the mica, to the extent of two or three thousandths of an inch. When the melted selenium is run over the surface it fills the interstices between the tops of the brass strips. It is then carefully rubbed off so as to leave the minimum of selenium necessary to act as a bridge between the strips.

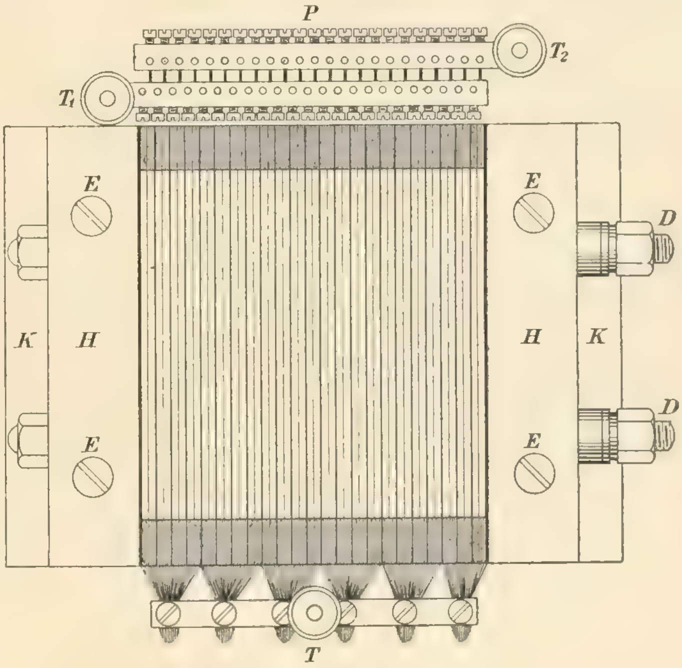

FIG. 11.—DETAILS OF CELENIUM CELL.

The terminal bar T is common to all sections, but the bars T_1 and T_2 are connected respectively to the right and left sections of each pair. In the latest pattern all three terminal bars are cut in half so that a group of selenium sections may be placed in all four bridge arms, as in Fig. 12. A small adjusting slide resistance at one apex of the bridge is then the only idle resistance in the circuit.

SELENIUM AND CABLE RELAYS.

There have been many attempts to utilise selenium for the purpose of a cable relay, and the success of the present system is due to the improved cell used. We understand that it has proved, during more than six years' continuous working, to be perfectly reliable, and it does not appear to deteriorate if correctly made. Its working resistance in the amplifier is about 1,000 ohms for each of the four groups of sections, or 4,000 ohms per square inch of surface.

Cells of this type are made in smaller sizes for other purposes, and subdivided or not as required. They are stated to respond satisfactorily to telephonic frequencies.

In the application of selenium cells the question of " inertia " is always important. This is comparatively small in the cells here used. Fig. 13 shows the characteristic of the cell for an illumination of 500 foot-candles during five seconds. This curve was obtained by placing the cell under an instantaneous shutter and in series with a recorder and battery.

The curve in Fig. 14 is that obtained in the cross circuit of the bridge (Figs. 9 or 10). In this case the rise and fall are each the mean of the rise *and* fall in Fig. 13, two of the bridge groups being "lightened" as the other two are "darkened."

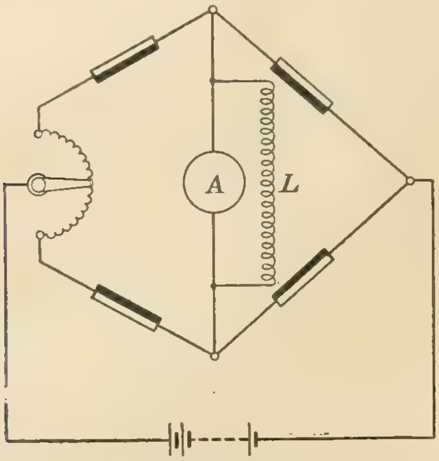

FIG. 12.—BRIDGE ARRANGEMENT WITH SELENIUM CELLS IN ALL FOUR ARMS.

In order to eliminate the inertia effect from the instrument *A*, the latter is shunted with an inductance (*L* in Fig. 12). The effective current curve in *A* then becomes square as in Fig. 15. Fig. 16 is interesting as a reproduction from records and shows the effectiveness of the inductance in correcting for inertia on actual received signals.

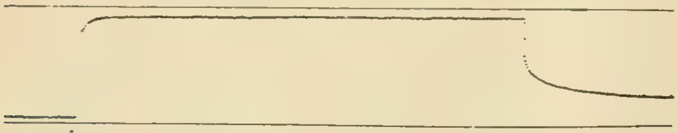

FIG. 13.—CHARACTERISTIC CURVE OF SELENIUM CELL UNDER 500 FT.-CANDLES.

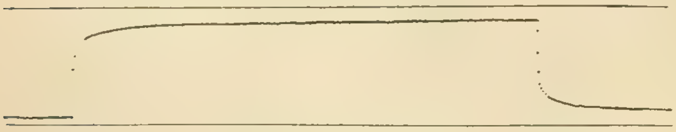

FIG. 14.—CHARACTERISTIC OF A PAIR OF SELENIUM CELLS WHEN USED IN THE BRIDGE OF THE AMPLIFIER.

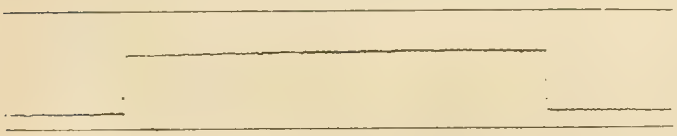

FIG. 15.—CHARACTERISTIC OF A PAIR OF SELENIUM CELLS WHEN CORRECTED BY THE USE OF INDUCTANCE.

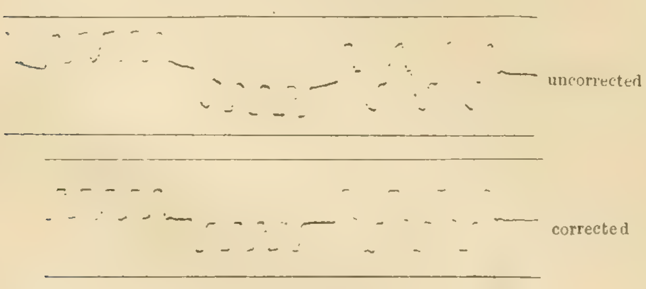

FIG. 16. RECORDS OF RECEIVED SIGNALS SHOWING THE EFFECT OF CORRECTION BY INDUCTANCES.

Steadiness of the instrumental zero in the amplifier is ensured by mounting the component parts—lantern, lens, galvanometer and selenium cell—on a cast-iron bed of the lathe type. The lens, galvanometer and cell are enclosed in a dust-proof case.

AMPLIFICATION ADJUSTMENTS.

The amplification is adjusted by varying the voltage of the battery *B* (Fig. 9). With $B=100$ volts, $L=100$ c.p., and the cell placed about 15 in. from the galvanometer mirror, the energy applied to the galvanometer may be amplified ten thousand times in the instrument *A*. An amplification of 40,000 may be obtained by making $L=500$ c.p., $B=150$ volts, and in some cases sub-dividing the cell further. In ordinary practice in submarine telegraphy an amplification of 1,000 to 5,000 is usually sufficient to work a good Morse relay.

The high amplification obtained has enabled a simple and accurate method of correcting for earth currents and other causes of zero variation to be applied. An auxiliary relay in the selenium bridge circuit controls a motor-driven rheostat which adjusts the balance of this bridge circuit so as to compensate for any zero variation in the system whether due to earth currents or other causes.

HIGH FREQUENCY A. C. APPARATUS FOR MEASURING SMALL CAPACITIES.

A very convenient set of apparatus was shown for the comparison of capacities to a high degree of accuracy, using the bridge method and a telephone, as shown in Fig. 17. The modification to which attention may be drawn is the use of a variable condenser in both of the two arms, enabling balance to be obtained at convenient points on the scale of both. A thermionic valve oscillator *O* was used as a supply of alternating current for the bridge. The anode oscillatory circuit of this generator was tuned by a separate variable mica condenser *C* in order to adjust the frequency of the supply to any value between the limits of 500 and 2,000 cycles.

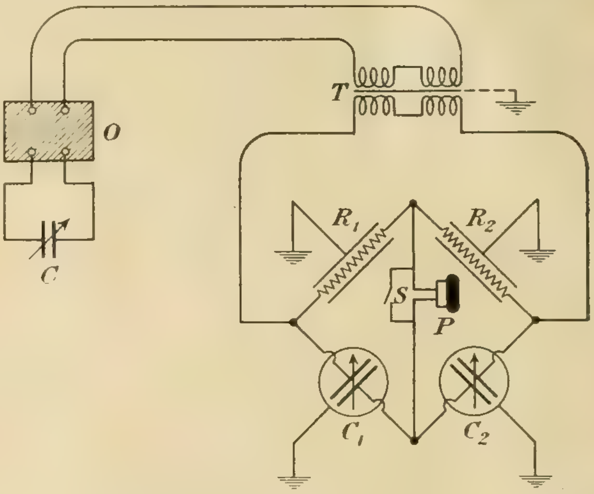

FIG. 17.—DIAGRAM OF APPARATUS FOR COMPARISON OF CAPACITIES.

Before being applied to the bridge the supply was taken through a special screened transformer *T*, the windings of which had been carefully balanced. R_1 and R_2 are the ratio arm resistances rendered non-reactive by patented methods of winding, their residual self-inductance having been reduced to limits which the makers state to have been hitherto considered impracticable. The capacity arms of the bridge were, in this instance, similar laboratory standard, variable air condensers of 50 to 1,200 mmfds. capacity and fitted with magnifying reading attachments and with extension handles to avoid the introduction of excessive capacity to earth by the hand in operation.

The real object of the test was to enable visitors to compare for themselves the two standard condensers which differed from each other by not more than 1 mfd. at any part of their scales. As the power-factors of the condensers were sensibly zero, perfectly sharp balancing could be obtained without the addition of any loss compensating apparatus in the other arms of the bridge.

The balance detector was a telephone headgear set of suitable resistance with a press switch *S* inserted in its leads for the purpose of short-circuiting the telephones in order to distinguish perfect silence more easily. With this arrangement any capacity up to 1 mfd. or 2 mfds. may be measured by connecting a standard three-dial mica condenser adjustable in steps of 0·001 mfd. in parallel with C_2, and inserting the capacity to be measured in place of C_1. This is very convenient and very accurate If a non-reactive rheostat be inserted in series with the standard condenser the leakance of the capacity under test may be determined. Again, variable air condensers paralleled with the ratios enable a measure of power factor to be taken.

SINGLE VALVE AMPLIFYING RECEIVER.

The set, of which Fig. 18 is a view, is completely self-contained, the aerial and earth leads being brought direct to it. The only apparatus required external to the set are the 4-volt accumulators 50-volt anode dry battery, and a pair of high resistance telephones. Single circuit tuning is employed, the inductance being a continuously variable multi-coil variometer, in which an exceedingly high range of mutual inductance variation is obtained. The coils of the variometer are very flat, and are embedded in insulating discs, one of which may be rotated between the other two. This arrangement gives an evenness of scale throughout the whole 180 deg. of movement.

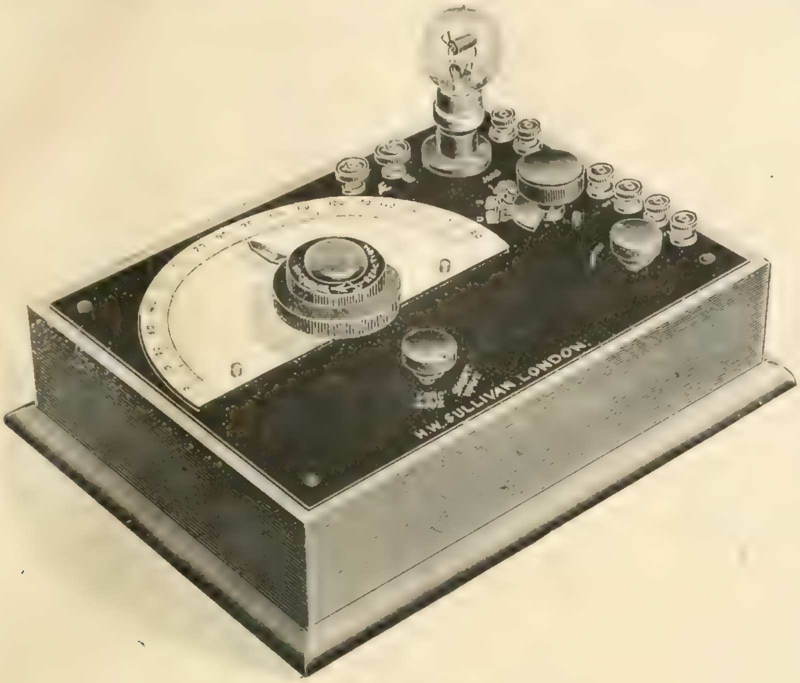

FIG. 18.—SINGLE VALVE RECEIVER WITH WIDE RANGE.

An inductance range of 3,500 to 50,000 micro henrys is obtained on the long wave-length scale, whilst a two position multi-functioning switch alters the internal variometer connections to obtain a short wave-length inductance range of 200 to 3,500 micro-henrys. An inductance ratio of 250 to 1 is thus obtained throughout the range of the instrument. The variometer is used in conjunction with an adjustable bank of fixed condensers, which may be placed either in series or in parallel with the variometer by means of a series-parallel switch giving the wave-length range stated above.

The variometer is also fitted with a set of reaction windings, which are embedded in a disc and rotated relative to the main inductance on a spindle concentric with the spindle of the latter, the two operating handles being conveniently placed one above the other.

The mutual inductance between the variometer coils and the reaction coils (the latter also changed by the long-short wave switch) may be adjusted to such values as will produce self-oscillation of any frequency corresponding to wave-lengths between 600 and 20,000 metres.

C, W. HETERODYNE WAVEMETER.

A continuous-wave wave meter was shown with a range of from 600 to 6,000 metres. This can be used also as a plain oscillation generator for use in the separate heterodyne method of C.W. reception. The circuit used is shown in Fig. 19, the oscillatory circuit consisting of the variable air condenser C and the two variometers V_1, V_2, the circuit being closed to high-frequency oscillations by the fixed capacity C_1 of a sufficiently large value not to appreciably affect its natural frequency.

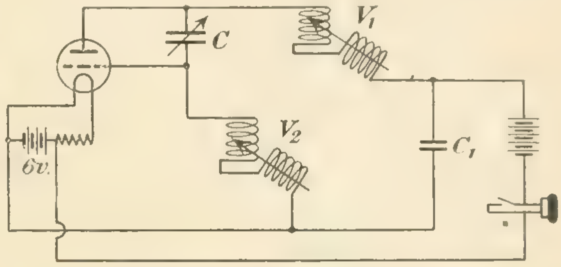

FIG. 19.—DIAGRAM OF HETERODYNE WAVEMETER.

The variometers and the variable condenser are all simultaneously variable, one coil of each variometer being fixed to and rotated with the moving plate system of the condenser, and the other two coils secured to the fixed plate system. By this method a greater wave-length range is obtained in the one scale, with the added advantage of a straight line law connecting wave-length and angular movement over the scale. Half the fixed plates of the condenser are insulated from the other half, and connections are taken to a three position switch, so that the range of the variable condenser can be altered by connecting the two insulated sections either in series or in parallel, or by using one section alone. Thus an inductance-capacity range of 70 to 1 is obtained. There are two 180 deg. scales, one being graduated in degrees and the other in wave-lengths.

(To be continued.)

Correspondence.

A QUESTION OF NOMENCLATURE WIRE RADIO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Eccles' letter in THE ELECTRICIAN last Friday so nearly represents what I consider to be the facts on this subject that it is difficult to add anything to it, except perhaps that I do not think the actual word he composes would ever be popular

The only difference between ordinary telephony on wires and so-called " wire radio " is the length of the waves, and I think the best solution would be to prefix a word which would suggest " high frequency." Of course wireless telephony is high-frequency telephony, but the term " wireless " so exactly expresses the difference between this and ordinary telephony that I do not think the proposed third definition would be confused with wireless.

In brief, you then have three kinds of telephony :—

(*a*) " Telephony," to describe the normal means of telephoning directly along wires ;

(*b*) " Wireless telephony," to describe telephony without wires by high-frequency methods ; and

(*c*) " *New word* (short-wave) telephony," to define high-frequency telephony along wires.

I am, &c.,

Derby, January 20. J. SAYERS.

VARIABLE-SPEED ROLLING MILL DRIVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with interest the comments in Mr. Hull's letter in your issue of January 22. My object in mentioning the " Scherbius-Milch " system was mainly to call attention to the wider possibilities opened out by the double range sets. The name " Scherbius-Milch " was erroneously applied to the diagram, Fig 3, in my article, which diagram illustrates Mr. Hull's U.S. Patent No. 1,306.594. I have to thank Mr. Hull for calling attention to the difference between the two systems.—I am, &c.

Manchester, January 24. W. E. SWALE.

100 PER CENT. LOAD FACTOR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I should like, through the medium of your journal, to ask the attention of electricity supply engineers to the question of quoting special rates for appliances of fixed capacity working continuously day and night.

Some years ago an interesting device for storing energy in the form of hot water was introduced, and a good many supply undertakings did at that time quote low rates for the energy taken by this apparatus, using no meter and sealing the connections. Recently a good deal of attention has been given again to appliances of this class, but inventors are being discouraged by the reluctance of supply undertakings to quote special rates for such supplies.

It is, I believe, argued that because the 100 per cent. load factor apparatus operates across the peak it does not justify cut prices for energy. It must be remembered, however, that these appliances would be used to a great extent on parts of the mains network where loading is at present intermittent and the load factor on the cables low. Moreover, in most stations the actual peak occurs in the winter time and lasts for a very short period, and a rate might be calculated to take in consideration the overlapping of this shortpeak.

For example, if 8d. a unit is the price for supply taken on the peak, and 1d. a unit would be profitable for, say, a 23-hour supply taken off the peak, it is obvious that an all-round figure of 1⅓d. would meet the requirements and probably encourage a very desirable load of this kind.

The matter should receive sympathetic attention because the water heating problem is largely bound up with the storage of electrical energy on the consumers' premises in the form of heat. Moreover, there is indication to-day of further interesting inventions for heating; these probably await for their development only the encouragement of the supply engineer in the form of suitable tariffs. It would be interesting if you could obtain the views of engineers on this subject.—I am, &c.,

London, J. W. Beauchamp,
January 18. Director & Secretary,
British Electrical Development Association.

[We shall be pleased to publish the views of our readers on this subject.—Ed. *E.*]

Progress in Junction Box Designs.

Among the various difficulties against which electric supply engineers have had to contend, during the last few years, has been the slow production of junction boxes. Bad as the position was for obtaining deliveries during the war, since the armistice, hundreds of new consumers have been clamouring for connection; but the supply of straight-through and terminal boxes for the new mains, and service boxes and house-service cut-outs for new consumers lagged months behind the demand.

In these circumstances, it is not surprising that the **Edison Swan Electric Company, Ltd.**, should have decided to commence the manufacture of junction boxes at their Ponders' End works. The boxes made by this company, while following the lines which have been found most suitable for normal conditions in general practice, possess some interesting features in technical detail. Fig. 1 illustrates their three-core service box, a feature of which is that, while there is ample room for making connections, and good clearance between the conductors themselves and the wall of the box, the amount of compound required for filling is reduced to a minimum. This point will be particularly appreciated by engineers in charge of large networks, on which the expenditure on box compound is a serious item. It will be seen by the illustration that the compound gland type has been adopted, and that the uncertainty of proper bonding between the lead of the cable and the box, occurring in some designs, is eliminated by a tinned copper earthing strip at each way, which is sweated to the cable and screwed down against a machined surface on the box itself. Another point, which will meet with the approval of the practical mains engineer, is the thickness of the lugs. Many engineers know to their cost the trouble from breakages of lugs in the earlier designs of junction boxes.

In their terminal boxes (Fig. 2) the Ediswan Company have adopted the wiping gland in preference to the compound gland. The former, although it may involve the exercise of a little more skill in fitting up the box, always presents, it is claimed, a neater appearance, ensures good bonding, and eliminates the drippiness and stickiness which is frequently in evidence when a compound gland is used in a vertical position. In their terminal box, the company have departed from the usual practice of screwing the wiping gland into a thread-cut in the two halves of the box. With a screwed-in wiping gland it is virtually impossible to have a perfect joint both between the two halves of the box from top to bottom and between the gland and the box. If one is sufficiently tight, the other is apt to be too loose. In the Ediswan pattern, the brass wiping gland has a wide flange which is bolted to a machined surface on the lower end of the box. The bonding is thus perfect, and at the same time the two halves of the box can be bolted tight together and the compound poured in at a high temperature without any risk of its leaking. Separate bushes are provided for each

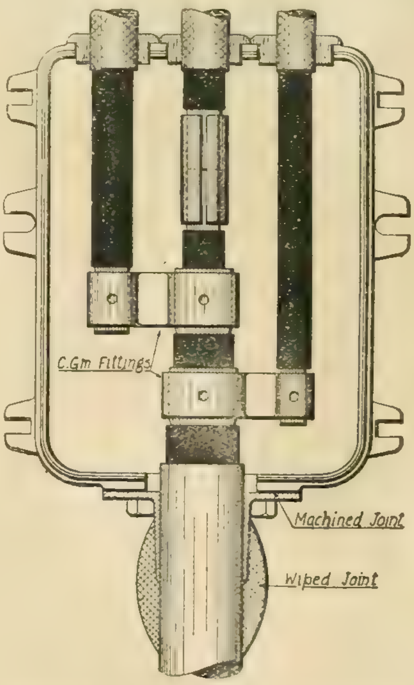

Fig. 2.—Ediswan Terminal Box for Concentric Cable.

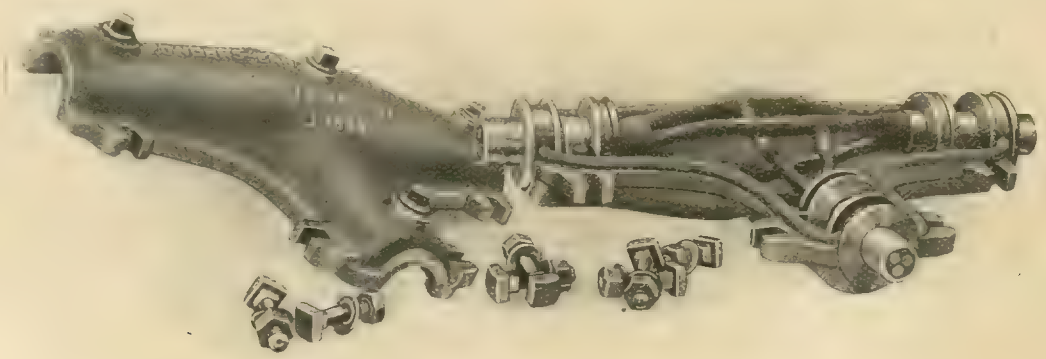

Fig. 1. -House Service Box for 3-core Cable.

of the tails, which have a straight vertical run making short-circuiting absolutely impossible.

The Ediswan Company has also brought out a line of house-service cut-outs. This includes a neat pattern of combined double-pole cut out and sealing chamber which, it is hoped, will entirely remove the prejudice against placing the fuses of both poles in one case. As is seen by the illustration (Fig. 3) the cover opens downwards. The fuses are of the well-known Ediswan Home Office pattern, separated by an insulating fillet and accidental short-circuiting or earthing is virtually impossible. The cable can be led in either at the bottom or either side, as three blank bushes are provided. A similar design is adopted for the triple-pole cut-out, two patterns being made one with three fuses for three-phase services, and the other with a link instead of a fuse in the middle for three-wire direct-current services.

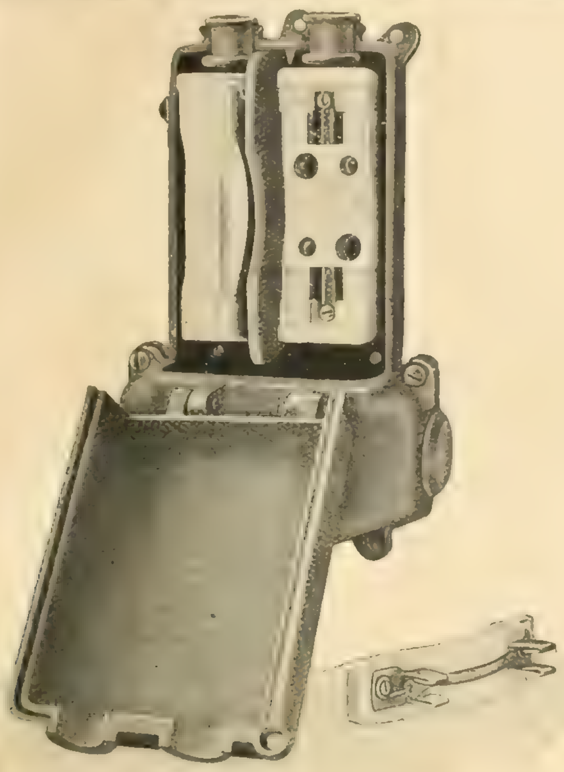

FIG. 3. -DOUBLE-POLE HOUSE SERVICE CUT-OUT WITH SEALING CHAMBER (Open).

The South Midland Centre Dinner.

The annual dinner of the SOUTH MIDLAND CENTRE OF THE INSTITUTION OF ELECTRICAL ENGINEERS was held at the Grand Hotel, Birmingham, on Friday last. There was a large attendance.

In proposing the toast of the "Institution," Mr. F. FORREST (Chairman of the Centre), referred to the importance to the Institution of the students' sections, of which one had been formed in Birmingham during the preceding session. He likened these sections to the thyroid gland and said they would insure to the Institution the quality of perpetual youth.

In response to the toast, Mr. Ll. B. ATKINSON (President) spoke of the growth of the Institution and hoped that the local sections of the Institution in Birmingham would aim at co-operative endeavour by questions arranging for common headquarters with a library and meeting rooms.

Mr. GILBERT C. VYLE, in proposing the toast of the "Electrical Industry," said it seemed to him utterly futile for the sake of differences of money value to enrich the foreigner. He hoped that those in this country who were placing contracts for electrical gear would look to the quality of the goods and not decide only on price. Speaking of mergers and combinations in the industry he remarked that if these were done on a sound basis they should result in good all round, but profits should not be made at the expense of the user. The profits should result from internal economies and should be shared with the user, whose confidence would thereby be secured, and he could see that combinations were for his good as well as that of the industry.

Mr. P. J. PYBUS, in responding, said that foreign markets were almost entirely closed to British firms, and though they were working in every possible way to reduce costs he feared that in some cases it would be extremely difficult to compete abroad with German products, even if they eliminated wages and working costs altogether. He also referred to the slowness with which schemes for the electrification of railways were being proceeded with in this country. In France one or two large enterprises of this kind had been put in hand, but not one of any magnitude, so far as he knew, in this country. He thought it would be a great gain to the country if the Government working with responsible business men, would endeavour with mutual trust to find some better way of alleviating unemployment. He pointed out that it was always better to keep a man in work at his proper job. The time-honoured custom was to allow him to lose his job and then try to help by putting him on what had been termed "muck-shifting propositions."

Electrical Contractors' Dinner.

The annual dinner of the ELECTRICAL CONTRACTORS' ASSOCIATION was held at the Connaught Rooms, Gt. Queen-street, London, on Wednesday, January 19th, the President, Mr. P. Collinson, being in the chair. Those present included Mr. Llewelyn B. Atkinson (President of the Institution of Electrical Engineers), Major H. Richardson, O.B.E., M.C. (President of the Incorporated Municipal Electrical Association), Mr. Hugo Hirst, Mr. C. H. Wordingham, Mr. J. Y. Fletcher, and Mr. J. W. Beauchamp.

In proposing the toast of the "Allied Associations and Honorary Officials," Mr. HIRST said that he was conceited enough to think that if there was one man in the electrical industry who had helped the growth of a healthy race of contractors it was himself. It had occurred to him in the very early days of the electrical industry to start a sales business with the result that the foremen of the large manufacturing companies had become the first electrical contractors. Times had, however, changed since then and contractors must now realise that they must be an efficient link in an efficient chain. If they were not they simply became parasites. It therefore followed that a contractor, while looking after his own interests had a duty to perform, but if certain installation work might be taken as an example, it was evident that they did not all realise this. The contractor was an important link between the producer and the consumer, and to perform that duty he must understand the problems of both. If he did so with the development of the domestic load he had a great future before him, otherwise there would be disaster.

Mr. P. COLLINSON, in reply, said that he thought the best way to answer Mr. Hirst's criticism was to refer to the activities of the three federated contractors' associations. They felt that the time had now arrived for licensing contractors so that unsuitable men might be eliminated. They had approached the Board of Trade to get a scheme put in operation, but so far without success. Nevertheless, they hoped to be able to do something which would raise the status of the contractor. The training of apprentices was also receiving consideration and they hoped in this way to turn out a superior body of men. They were not opposed to progress, but the wheels of progress must not be allowed to crush them out of existence. There should be a definite line of demarcation between the activities of municipal departments and contractors, and he was glad to say that a conference was to be held at which, if the spirit was right, a settlement would no doubt be achieved. Agreements which they had had with the Cable Makers' Association for many years had been most successful, and he hoped that it would be possible to enter into similar agreements with other interests in the industry.

Mr. H. G. PURCHASE, M.P., also supported this toast.

Mr. H. J. CASH, in proposing the toast of the "Guests," said that contractors did not realise sufficiently the importance of membership of the Institution of Electrical Engineers, a body which now looked after the interests of the whole industry. The interests of municipal engineers and contractors were really identical and he hoped in future it would be possible for them to make common cause He referred briefly to the work of the British Electrical Development Association and said it was one of the great powers of the future.

Mr. LLEWELYN B. ATKINSON, in reply, emphasised the need for associated effort. The formation of a contractors' association was in itself a most difficult task, as they were a scattered body, and the advantages of combination were not immediately obvious. The Association had, however, already raised the status of the contractor, while the agreement with the cable makers had not only been of use to the contractors, but also to the cable makers themselves by standardising the different classes of customers.

Major H. RICHARDSON, who also replied to this toast, said that the desire for co-operation among other sections of the industry was never so real as it was to-day. The old policy meant that the industry was nearly bled white, but with combination the electrical industry would have the world before it. He thought there was a need for more affiliation as it was difficult to keep in touch with a number of associations with very similar objects. No one would benefit more from this coming together than would the consumer. The Incorporated Municipal Electrical Association appreciated the contractors' difficulties and he felt sure the meeting which had been arranged would remove many of the obstacles which were really more apparent than real. Heating and cooking by electricity would be great factors in the future, but to bring about this consummation properly-designed tariffs and a cheap price per unit were essential.

The Sun Electrical Company Staff Dinner.

The directors of the Sun Electrical Company entertained the staff to the number of about 140 at a dinner at the Holborn Restaurant, London, on Saturday last, to celebrate the 21st year since the formation of the Company.

As befitted a coming -of-age party, youth and beauty of both sexes were well represented, and even those of riper years seemed so infected with the prevailing atmosphere of merriment that one would not have been surprised to see Mr. Rawlings and Mr. Beaver lead a dance in the style of the immortal Cheeryble Brothers.

Mr. W. J. Rogers, in proposing the toast of "The Directors," said the electrical industry needed facilities for development if it was not to be paralysed by a flood of foreign competition.

Mr. R. T. Smith, acknowledging the toast, said he had prophesied a year ago that Germany would flood this country with cheap goods, and that prophecy had come true, but he was glad the Directors of their Company had been able to look ahead and preserve the resources of the Company. It had never been so prosperous as it was to-day, and he was sure it would have a brilliant future.

Mr. W. R. Rawlings also replied.

During the course of the evening Mr. Beaver, on behalf of the Directors, then presented Miss M. I. Deudney with a bracelet-watch. He said Miss Deudney had been in the service of the Company since its inception and had displayed great business acumen as his private secretary.

Engineers' Club.

In our last issue we gave the names of those appointed on the provisional committee of the proposed Engineers' Club. The following additional members have now been appointed:—

Mr. Daniel Adamson, Colonel O. C. Armstrong, D.S.O. (President, British Engineers' Association), Mr. Thomas Bolton, Mr. E. C. Clark, Mr. C. T. Colpitts, Mr. Fred J. Dixon (President, Institution of Water Engineers), Mr Howard Foulds, Mr. Alan R. Fenn, Dr. E. Hopkinson, M.P. (past President, Institution of Mechanical Engineers), Dr. H. S. Hele Shaw, LL.D., F.R.S., Mr. W. L. Hichens, Mr. W. W. Hughes, Brigadier-General G. M. Jackson, Mr. Max Muspratt, Mr. Frank Merricks (President, Institution of Mining and Metallurgy), Mr. Frank Mellowes, Mr. C. H. Merz, Mr. T. C. Pulman, Mr. H. Richardson (Hon. Secretary, The Engineers' Club, Manchester), Sir Harry Renwick, K.B.E.

Edison Bells.

The weak spot in electric bells is the contact pillar, and the Edison Swan Electric Company, Ltd., have placed on the market a range of bells fitted with a special contact pillar, which is designed to prevent the contact screw from being moved out of adjustment by vibration or rough handling. The screw is clamped securely, and the mounting of the pillar itself is such that it is impossible for it to turn or become loose. The accompanying Fig. 1 shows this novel feature. The Company manufacture a complete range of bells, buzzers, indicators and accessories and in a pamphlet recently issued by them illustrated particulars are given of a few of their principal lines of this class of products. Fig. 2 is an illustration of the Company's all-metal bell.

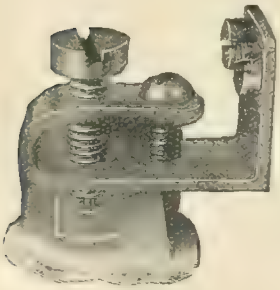

Fig. 1.

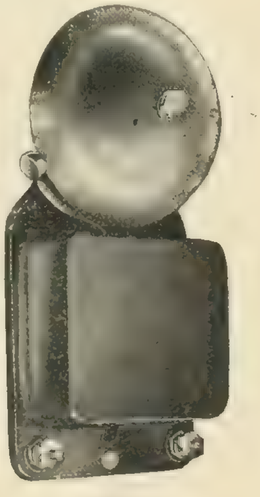

Fig. 2.

The Use and Abuse of Light in Studios for Kinema Film Production.

A discussion on the above subject was opened by Mr. J. C. Elvy at the meeting of the Illuminating Engineering Society held on January 18th.

Mr. Elvy opened his address by a brief summary of the historical development of the cinema. He emphasised the need for professional advice in arranging the equipment of studios, quoting cases in which a studio had been erected, and it was only afterwards discovered that sufficient power could not be obtained from the local supply company. Flexibility of equipment was of great importance. The problems involved were so complex that they could not be adequately dealt with by a single expert.

Instances had been recorded of artists suffering from inflammation of the eyes, attributable to abnormal lighting conditions in studios, such as exposure to very powerful arcs and searchlights at close quarters. He was disposed to favour diffused methods of lighting, giving conditions approximately the same as natural lighting, and the avoidance of "spot-lights" and concentrated beams of light, which gave rise to hard and sharp shadows.

Accentuating the Ultra-Violet Constituent.

Further information was needed on the comparative actinic values of the various illuminants used, and the region of the spectrum that was most useful. Photographically, it appeared desirable to accentuate the ultra-violet constituent in illuminants, but it should be remembered that exposure to excess of ultra-violet light was believed to be prejudicial to the eyes. Possibly, however, these alleged prejudicial rays were not of great photographic value, and might be eliminated. Some device for comparing the actinic brightness of different parts of a scene was needed. Actinometers were not satisfactory. Assuming that the relative actinic values for a given brightness of standard illuminants were known, it appeared that tests with illumination photometers might prove of considerable value. There was also room for more scientific designs of reflectors used with arc lamps, as at present an unduly large proportion of the light emitted did not reach the scene, but was shed on the surroundings.

Some details were also given of the use of light in printing processes, and in conclusion the lecturer expressed the hope that the Illuminating Engineering Society would form a joint committee to make investigations in this field.

Exhibition of Studio Lamps.

A number of lamps and appliances were subsequently exhibited Mr. William Day displaying a series of exhibits of historic interest, dating from the earliest beginnings of the industry. These included one of the first arc lamps, taking about 2½ amperes, and run from a battery of Gron cells. Typical multiple open and enclosed arcs and mercury vapour lamps were also shown, one form of unit of special interest being an indirect type, in which the light of the arc was directed on to a species of umbrella with a white inner surface, whence it was diffused in all directions. Mr. H. C. Carter exhibited, by means of a portable cinema outfit, a film taken by the light of gasfilled lamps.

Among others who joined in the discussion was the Right Hon. G. H. Roberts, M.P., Chairman of the Ministry of Health Committee on "The Prevention of Blindness," which is now studying the question of possible injury to eyesight through bright lights in cinema studios. Much of the discussion turned on such alleged injuries. Mr. Alfred Legg, of the Actors' Association, urging the need for care and precautions while disclaiming any desire to hinder the development of the industry. Others, such as Mr. Kimberley (of the Hepworth Studio), Mr. Rowson and Capt. J. W. Barber gave their experience to the effect that cases of eye-injury were extremely rare, provided reasonable precautions were taken. Several speakers agreed that the use of naked powerful arcs at close quarters was unnecessary, and that the most artistic effects were obtained by using suitable methods of diffusing the light.

Mr. L. Gaster endorsed the appointment of a joint committee comprising representatives of the Illuminating Engineering Society and the cinema industry, ophthalmologists and others interested to inquire into the whole subject. There was no doubt that an investigation on these lines would be of great benefit to the industry. He mentioned that, quite independent of Mr. Elvy's introductory paper, the Society had prepared a series of queries, the circulation of which should lead to some useful information.

The death is announced of Mr. Arthur Armitage, for many years chief assistant electrical engineer at Nottingham Corporation electricity department. Mr. Armitage was 45 years of age.

Mersey and West Lancashire Joint Authority.

The inquiry into the two schemes for the formation of Joint Electricity Authorities for the Mersey and West Lancashire Electricity District opened at Liverpool on Tuesday, and the proceedings were continued on Wednesday and yesterday. Both schemes gave administrative, financial and technical details. One covered the whole of the area as defined by the Commissioners, and was backed by the majority of the local authorities, including the Corporations of Liverpool, St. Helens, Bootle, Warrington and Widnes, but the rival proposals of Birkenhead and Wallasey only related to the Wirral or Cheshire side of the Mersey, for which it is desired to set up a separate authority. The conference of local authorities promoting the main scheme were represented by counsel, who pointed out the necessity for the reorganisation of electricity supply in the district. For reasons of economy and for facilitating the industrial development of the area a good and cheap supply of power was urgently required, and it was only by carrying out the proposals outlined in the scheme could this be provided. It was proposed to proceed by stages, the first step contemplated being the interlinking of the generating stations at Liverpool, Bootle, Birkenhead, Wallasey, St. Helens and Warrington ; but later a connection would be made with the United Alkali Company, the Mersey Power Company and Ellesmere Port, and through Birkenhead to a junction with the main running from Liverpool to Cheshire.

Sir JOHN SNELL presided, and the other Commissioners present were Sir Harry Haward, Mr. H. Booth and Mr. W. W. Lackie. After Mr. Honoratus Lloyd, K.C., had explained the main scheme, and had outlined the nature of the opposition,

Mr. FRANK C. WILSON, chairman of the Liverpool Tramways and Electricity Committee, and chairman of the conference of local authorities responsible for the scheme, gave evidence. He said Wallasey Corporation supported it until November last. The establishment of a joint electricity authority would be very helpful to the trade not only of the Port of Liverpool but the whole of South-west Lancashire and Cheshire. It was impracticable to treat the Mersey as a frontier. He could not conceive that Wirral could supply itself more cheaply than it could by joining the proposed joint authority. If it could he would be in favour of the northern districts taking their supply from Wirral.

In cross-examination, he said the basis of the scheme was that the Treasury were to find 4½ millions of money, and the generating stations were to be handed over to the joint authority. He could not give the date when it was proposed to link up with the Mersey Power Company, which at present supplied the Ship Canal Company. He should think it would be within the next ten years. The large area proposed was most conducive to efficiency and economy of supply and to convenience of administration. There was a reasonable community of interest throughout the area, and the money required could be more easily raised on the security of the larger district than if the district were cut into two, and the generating stations must come under the control of the joint authority. It might be feasible to make arrangements under which, by the co-operation of the existing undertakings, the joint authority could secure a measure of control without actual taking over of the generating stations, but he did not think it would be satisfactory. The expenditure contemplated was not additional expenditure, but only expenditure in another form.

Mr. HAROLD DICKINSON, Liverpool City electrical engineer, gave formal evidence as to population and area of the proposed district.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Office on receipt of published price, plus postage.]

"Bau Grosser Elektrizitätswerke." By G. Klingenberg. (Berlin : Julius Springer.) Pp. 106.

"The Slide Rule." By C. N. Pickworth. (Manchester : Emmott & Company.) Pp. 133, 17th Edition. 3s. 6d. net.

"Factory Administration and Cost Accounts," by Edward T. Elbourne (London : Longmans, Green & Company.) Pp. xx.+811. 45s. net.

"The Theory of Direct-Current Dynamos and Motors," by John Case, M.A. (Cambridge : W. Heffer & Sons.) Pp. xiii.+196. 15s. net.

"The Log of H.M.A. R.34 Journey to America and Back," by Air-Commodore E. M. Maitland, C.M.G., D.S.O. (London : Hodder & Stoughton.) Pp. xii.+168. 10s. 6d. net.

"Experimental Wireless Stations," by Philip E. Edelman, E.E. (London : Henry Frowde, Hodder & Stoughton.) Pp. 392. 16s.

"The Absolute Relations of Time and Space," by A. A. Robb, Sc.D. (Cambridge : University Press.) Pp. viii.+80. 5s. net.

"The Electrician's Handy-Book," by T. O'Conor Sloane. (London : Hodder & Stoughton.) Pp. 823. 27s. 6d. net.

"Wireless Design and Practice," by M. B. Sleeper. (London : Henry Frowde, Hodder & Stoughton.) Pp. 246. 7s. 6d. net.

"Modern High Speed Influence Machines," by V. E. Johnson, M.A (London : E. & F. N. Spon). Pp. viii.+278, 14s. net.

"Bibliotheca Chemico-Mathematica," Vols. I. and II. Catalogue of works in many tongues on exact and applied Science with a subject-index. (London : Sotheran & Co.) Pp. xii.+964, £3 3s.

"Wireless Telegraphy and Telephony," by L. B. Turner. (Cambridge University Press). Pp. x.+195, 20s. net.

Royal Ediswan "Fullolite" Lamp.

One of the principal objections to the use of the ordinary type of gas-filled lamp for shop window lighting, &c., where lamps are often used without shades, and are set at an eye level, has been the glare effect of the intensely brilliant filament. A similar objection is also met with in office and domestic lighting when methods other than the indirect system are employed. It is claimed that the "Fullolite" lamp, which has recently been introduced by the Edison Swan Electric Company, Ltd., has completely overcome this objection. It consists of the usual gas filled lamp but the bulb is of opal glass instead of the usual clear glass. The opal bulb completely eliminates the glare of the filament and perfect diffusion of light is obtained obviating eyestrain. The surface of the opal glass being smooth and polished, the bulb does not collect dust, in the same way that the ordinary sand-blasted or acid obscured lamp, with its roughened surface, will do. The new lamps can be obtained in all standard voltages and ratings up to 200 watts.

The Employment and Training of Railwaymen.

At the Milman-street Training School of the London Electric Railway Company last week a film was shown and a Paper was read by Mr. E. YORKE, chief inspector, on the subject of the "Employment and Training of Railwaymen." In the course of his Paper, Mr. Yorke said the Employment Bureau and Training School at the North Lambeth station were opened in February last, and the departments of the school included a booking office school and a motor school, containing a standard motor equipment in connection with which lamps were arranged on diagrams, so that the path of the current could be graphically shown, while diagrams were also used to show the working of the parts of the Westinghouse air brake. A signalling school was to be established, and the cinema would be used for purposes of instruction.

The selection of labour should receive the same care as was given to the purchase of materials and stores. Each man, before being engaged, was medically examined, and attended the school for instruction during the probationary period of four or five days while his references were obtained and considered. When the time for promotion arrived the men were sent to the school for instruction, and examination, the period varying from a few days in the case of a gateman to 12 days for a guard or motorman. Special emphasis was laid on the necessity of obtaining an intimate knowledge of the Rule Book and Appendices.

Mr. Yorke said he did not think the cinema could be used in detailed instruction, but it would be valuable to use it to impress important points and illustrate the effect of inattention to them, and the film which was now to be shown was prepared with that end in view.

International Symbols.

The International Electrotechnical Commission has issued a revised edition of its publication No. 27 on "International Symbols." The new issue differs only in regard to the deletion of several notes relating to the late enemy countries and the addition of symbols for the difference of electric potential and magneto-motive force. For the former the letter symbol is V, but for magneto-motive force the National Committee will propose a letter, while the letters recommended in case the principal symbols are not suitable are U and $\mathcal{S}$ respectively.

According to reports, M. Hermod Petersen, engineer of the Norwegian radio telegraph dept., has discovered an IMPROVED METHOD OF TRANSMITTING PHOTOGRAPHS by telegraphy, and a demonstration was given at Sandefjord on Saturday. The new system is based on alternating current instead of the continuous-current system hitherto used, and it is eatimated that work which now requires 117 operators in Norway can be done by 16.

Legal Intelligence.

Morrow v. Stepney Borough Council.

On the 19th inst. the Court of Appeal (the Master of the Rolls and Warrington, Younger, L.J.J.) dismissed the appeal of the Borough Council from a judgment of Mr. Justice P. O. Lawrence granting an injunction to restrain a nuisance caused to plaintiff by the discharge of grit and ashes from the chimneys of defendants' electric power station. The facts of the case were in THE ELECTRICIAN of June 18, 1920. The Council pleaded their statutory powers of supply and urged that the prevailing conditions made the carrying on of such undertakings difficult, particularly by reason of the inferior quality of the coal obtained and the short supply of labour. While repudiating liability the Council paid £100 into court in satisfaction of plaintiff's claim. After hearing evidence Mr. Justice Lawrence held that a continuing nuisance had been proved, and as there were no exceptional circumstances to justify the court to award damages in lieu of an injunction, he granted an injunction, which was, however, suspended until Nov. 12 to give defendants time to abate the nuisance. On Nov. 12 the suspension was continued until the first Friday in Easter sittings. He also awarded £50 as general damages for the discomfort suffered by plaintiff.

After hearing Mr. JENKINS, K.C. (with him Mr. Harman) for appellants, who had admitted that the court was bound by legal authority and that it was proposed to appeal to the House of Lords, the Court dismissed the appeal.

The MASTER OF THE ROLLS said that the appeal raised two points. First, whether defendants were protected by their statutory powers from any action which might be brought against them on payment of compensation to plaintiff for any damage which he had suffered by the exercise of those powers, and, secondly, whether the learned Judge had properly exercised his discretion in refusing an application to award damages instead of granting an injunction. It was admitted that the first point was covered by the decision in Shelfer v. City of London Electric Lighting Company, and counsel had, therefore, not attempted to argue it, but had only raised it to enable the case to be taken to the House of Lords. On the second point, though it was not absolutely covered by authority, after reading the judgment and looking at all the facts of the case, he (his Lordship) was of opinion that they could not interfere with the learned Judge's discretion consistently with what was said in Shelfer's case.

Lord JUSTICES WARRINGTON and YOUNGER concurred, and the appeal was dismissed with costs.

Commercial Topics.

German Machine Tools.

A question of considerable importance to the machine tool industry of this country was discussed at the annual meeting of the Machine Tool Trades' Association last week, when the chairman (Sir Alfred Herbert) moved "That no member of the association shall be permitted to deal in German machine tools." He admitted that a great many manufacturers would favour the resolution, while a good many importers would be against it. His firm, as manufacturers and importers, would suffer financially to some extent if it were carried, but even if it were adopted they could not prevent German machine tools coming into this country through people who were not members of the association. With the exchange in its present condition, it was impossible for British manufacturers to compete with German machine tools.

As an amendment, Mr. J. H. Barker (Messrs. Greenwood & Battley) moved that a similar embargo should be placed on American tools. He said, "We have made peace with the Boche, and we ought to treat him as far as possible, however difficult it may be to do so, as a brother. It behoves us as Englishmen to stand to our bargain and to our word. My firm is prepared to deal with the Boche, and to offer his goods, not furtively, but openly." Having put the views of his firm before the members, Mr. Barker withdrew the amendment. Another member said the resolution would increase the cost of production, and ultimately it was negatived by a large majority.

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Central and South American Electrical Supplies

According to a correspondent of the "Times" Trade Supplement, complaints are being made in MEXICO that "it is next to impossible to obtain supplies of British-made electrical materials," and an impression exists in local circles that the United Kingdom is neglecting her overseas markets in favour of her home demands. It is stated that American travellers are receiving more attention than would otherwise be the case, and the country is being inundated with price lists from U.S.A. firms, who are promising speedy deliveries. The troubled political and uncertain conditions that have prevailed in Mexico have militated against industrial developments in that country and firms have been reluctant to incur bad debts. The prospect is now somewhat brighter and it is to be hoped that greater attention will be paid to this important market.

The situation in ECUADOR is much the same. There is a demand for electric light and power cables, wires and switches in Quito, but it is asserted that an English catalogue or price list is rarely seen. Complaints of absence of enterprise are easily launched and not easily disproved. However, we hope that our exporters and manufacturers will see that at least suitable trade literature, in the Spanish language, and well illustrated, if possible, is provided for this country and other parts of South America.

Electricity Supply.

Extensions of the SOUTHEND supply undertaking, estimated to cost £300,000, have been approved by the Corporation.

The Ministry of Transport have granted nine months' extension of time to Petters, Ltd., for carrying out the YEOVIL electric lighting order of 1914.

The battery-room at the electricity station of the LARNE ELECTRIC LIGHT COMPANY was burnt out on the 18th inst. The battery was of large capacity and was not insured.

Electric lamps have replaced the old paraffin lamps at BALLYBOY (Co. Monagham), where an electricity station was recently erected by Mr. R. McMurray.

CHICHESTER City Council has offered the local Electric Light Company £7. 10s. per lamp per annum for the supply of current to and for the maintenance of 250 public lamps.

A new 500 kw. generating set will be available at BARNSTAPLE in a week or two and the supply of electricity for power and lighting will then be on a more satisfactory basis.

In a recent order made by the Ministry of Transport the Urban Electric Supply Company has been authorised to increase the maximum charge for electricity at GRANTHAM to 10d. a unit, an increase of 3d. over the figure in the Company's provisional order.

Sanction has been asked by ROCHDALE Electricity Committee to a loan of £106,000, to cover the cost of transforming plant and cables in connection with the scheme for the supply of electricity in bulk from the Lancashire Electric Power Company.

FORRES Town Council is considering a proposal of a local wood merchant (Mr. John Bremner) to suplpy electricity for public and private lighting. Underground mains will be used, and it is probable that application will be made for a Special Order.

The threatened strike of the technical staff at NEWPORT (MON.) electricity works has been averted by the Electrical Committee agreeing to pay the salaries demanded, but the question of the conditions of employment has been deferred for future consideration.

In order to meet the increasing demand for electricity the BO'NESS Town Council has been obliged to embark upon further extensions of plant at a cost of £45,000. The extensions include a turbo-generator and a boiler, and application has been made for sanction to borrow the necessary money.

ABERSYCHAN Urban Council has applied to the Electricity Commissioners for a special order authorising the Council to supply electrical energy in Abersychan (Mon.) Urban District, and to sell electrical lines, fittings, apparatus, &c. Objections must be sent to the Electricity Commissioners by Feb. 14.

The INCREASE IN THE PRICE OF GAS IN NORTH LONDON by 10d. per 1,000 feet must be very unwelcome news for gas consumers. The new charge for gas will be 5s. 6d. a thousand, and this high figure should help electric supply authorities in obtaining new consumers. No doubt there will be many inquiries for electricity for lighting, and we hope that electrical engineers will take full advantage of this favourable opportunity.

Notice is given in regard to the SOUTH WEST MIDLANDS ELECTRICITY DISTRICT, which was provisionally determined on September 20th last by the Electricity Commissioners, that the time for submitting schemes for effecting an improvement in the existing organisation for the supply of electricity, or for making objections or representations in regard to the district, has been extended to the 31st March.

A conference of local authorities in WORCESTERSHIRE, convened by the Worcester Electricity Committee, has considered the question of the reorganisation of electricity supply in the South-West Midlands area. It is proposed to ascertain if the Electricity Commissioners were likely to assent to the formation of a separate area in a part of the proposed South-West Midland district, and, if so, the conference will submit a separate scheme.

The dispute between the technical staff at BURNLEY Electricity Works and the Corporation, due to the latter's refusal to adopt the Joint Board's schedule of conditions of employment, has reached an acute stage. The strike notices, which were suspended last month, are to take effect on February 8th, unless the Corporation accept the scheme. The Council agree to the wage clauses, but object to the conditions sought to be imposed, especially regarding sick pay.

A dispute has arisen between HEXHAM Urban Council and the local electric supply company as to the use of wooden poles for carrying overhead electric wires, and notwithstanding the appeal of the Electric Commissioners the Council insists upon the use of steel poles. It was proposed to erect the poles from Eastgate to Hackwood and along the private road leading to South Park, a distance of about 500 yards, and steel poles will entail additional cost. We hope that the Commissioners will deal promptly with the obstructive tactics of the Council, which, if encouraged, will restrict the use of electricity in rural areas.

BUXTON Urban Council has been authorised to borrow £6,500 for mains and services, repayable in 25 years, £15,222 for plant (15 years), and £500 for meters (10 years). At the last meeting of the Council Dr. Buckley deprecated the borrowing of money for short terms. He pointed out that money was extremely difficult to get, and they would have to pay very high interest. If they took up loans on a ten-year basis, as in the case of meters, it would be equivalent to paying for interest and sinking fund, 17 per cent. on the loan. It would be necessary in future to consider carefully when they asked for sanction for short period loans, whether it would not be expedient to charge it on the rates.

The Electricity Commissioners have sanctioned the borrowing by Hammersmith (London) Borough Council of £16,635 (on account of the £21,693 applied for) in order to defray expenditure in connection with the electric mains distributing system and the augmentation of feeders. In July last Hammersmith Council accepted an offer of the Kensington and Notting Hill Electric Lighting Companies to provide a bulk supply of electrical energy for the "White City" and other consumers in the northern part of the Borough. The terms now put forward by the Companies are that the Council should pay for this energy at works cost, plus the amount of expenses incurred in connection with the supply, and that the difference between this total and the amount received from the "White City" authorities be equally divided between the Companies and the Council.

A conference of local authorities in Stirlingshire was recently held at Falkirk in order to consider the proposed Grampian Water Power Provisional Order. Some time ago several of the authorities proposed to form a Joint Electricity Authority, but the promotion of the Order has altered the situation. At the conference the burghs of Falkirk, Stirling, Grangemouth, Alloa, and Armadale were represented, and it was stated that if the Joint Board of the local authorities was established the area would run contiguous to that proposed under the Order. As water was a national asset, and as electricity could be generated more cheaply by water power than by steam, it was agreed to ask the Electricity Commissioners to secure provision being made in the Order whereby they would be able to get a supply if necessary from the new Company under conditions to be mutually arranged.

The award of Mr. S. E. Fedden, of Sheffield, on the Dispute between Bingley Urban Council and Keighley Corporation as to the supply of electricity in bulk by the latter authority to Bingley under agreement dated October, 1913. From time to time Bingley Council complained about the frequency of the stoppages and breakdowns in the supply, and the arbitration arose out of a stoppage of supply in July which extended from 2.47 a.m. on a Tuesday to 5.5. a.m. on the following day. Mr. Fedden had to determine (1) whether the interruptions and breakdowns in the supply had been due to any neglect on the part of the Keighley and Bingley electricity departments or either of them, and if so, which; (2) whether everything reasonably requisite under the agreement had been done by Keighley Corporation to ensure and maintain the continuity of the supply; (3) whether Keighley Corporation had done everything reasonably possible, in accordance with the agreement, to restore the supply as soon as possible after interruptions and breakdowns.

Mr. Fedden, who heard the representatives of the parties, states in his award that after considering the facts and all the circumstances, he had determined as follows: (1) That the interruptions and breakdowns in the supply had been due to neglect mainly on the part of the Keighley electricity department, and to a lesser degree on the part of the Bingley electricity department; (2) everything reasonably requisite under the agreement had been done by Keighley to ensure the continuity of supply, but everything reasonably requisite under the agreement to maintain the continuity of supply had not been done; (3) that Keighley Corporation had not done everything reasonably possible in accordance with the agreement to restore the supply as soon as possible after interruptions and breakdowns. The costs of the arbitration are to be borne as to four-fifths by Keighley and one-fifth by Bingley Urban Council.

The Electricity Commissioners recently received an application from Woolwich Borough Council for sanction to a loan of £230,000 for extensions of the electricity undertaking, including the installation of a 5,000 kw. generating set, two boilers, river work, coal conveying plant, switchgear, &c., and also a main transmission line to the borough boundary, to give a supply in bulk to Erith Urban Council. The Commissioners approved the proposals, but the Council had not submitted sufficient information to enable the application to be dealt with as a whole, though they asked for an immediate sanction to borrow £60,000 on account. The tenders were as follows: For a 5,000 kw. turbo-alternator, £32,925; condensing plant, £11,833; and a 33,000-volt cable, £20,646. The Commissioners were prepared to issue a sanction to borrow £20,000 for the main transmission line (repayable in 40 years), and £40,000 for plant (20 years).

The Council having asked for sanction to the postponement of the date of commencing repayment of the loan, the Commissioners were satisfied that in regard to the cable to Erith, which was not likely to be fully loaded for some years, postponement was justified, and they proposed to allow repayment to be deferred for three years.

As the working of the undertaking involved a charge on the local rates, and as the London County Council had an arrangement with the Council in regard to the acceleration of repayment of debt outstanding in respect of superseded plant, the L.C.C. were asked to offer observations on the application. To this invitation the Finance Committee of the L.C.C. reply by stating that "from the point of view of the general financial position of the borough, the application of the Borough Council for sanction to borrow such a large sum as £230,000 for electricity purposes is a matter for serious consideration by the Electricity Commissioners, and that the Council, while expressing no opinion as to the merits of the scheme, assumes that the Commissioners are satisfied that the expenditure will result in an early improvement in the present unsatisfactory financial condition of the undertaking; that the Council is of opinion that the debt outstanding upon any superseded plant should be repaid, and the Borough Council required to enter into an arrangement with the Council in regard to the liquidation of any loans outstanding on any plant which is to be superseded by reason of the further extension of plant now proposed to be sanctioned on similar lines to the arrangement made in July, 1919."

Electric Traction.

The Ministry of Transport have authorised Burnley Corporation to increase the statutory tramway fares from 1d. to 1½d. per mile.

The Court of Inquiry in connection with the wages dispute in the Tramway Industry commenced its proceedings at St. Ermin's Hotel, Caxton-street, S.W. 1., on Wednesday last. The inquiry is being held in public.

As the result of a conference between representatives of the Corporations of Middlesbrough and Stockton and the Urban Council of Thornaby, the local tramways will be transferred to municipal working in March, when the Sunday service will be revived.

London County Council has sanctioned the borrowing by Hammersmith Council of £13,404, including £11,668 for six electric vehicles and £975 for a motor car. The County Finance Committee, however, do not see their way to advance the amount in view of the heavy demands for housing purposes.

Newcastle-on-Tyne Corporation last week rejected a proposal by the Tramways Committee to grant free tramcar passes to members of the Council. It was stated by Mr. Lawson that out of 41 towns, 22 do not grant any passes, and 14 only grant them to the Chairman and Vice-Chairman of the Committee, and in some cases to the Mayor.

It is proposed to introduce an all-night tramcar service on 12 routes in Glasgow on Feb. 7. The manager (Mr. Jas. Dalrymple) has been requested by the Tramways Extension Committee to report as to the advisability of utilising trackless trolley cars for the services on various extensions of the municipal tramway system which have been authorised.

A special committee of Chester Corporation recommends that an exhaustive inquiry be made with regard to the relative merits of putting the tramway track into thorough working order or of selling the trams and instituting a motor 'bus service. The Tramways Committee has formed a sub-committee to prepare a further report on the matter.

A deputation from the Birmingham tramways department visited Bradford on Friday in order to inspect the local trackless trolley car system. Bradford possesses the only double-deck railless trolley vehicle in the country, and the Corporation propose seeking powers to run similar vehicles on three of the routes in the city which need repair. The Birmingham deputation were conveyed in the railless vehicle to Thornbury, Bolton and Bankfoot, and later they were entertained to luncheon at the Town Hall.

Eight of the new tramcars ordered by Belfast Corporation have now been put into commission. Fifty cars are on order, and it is expected that the whole of them will be delivered within the next six months.

Applications have been made to the Ministry of Transport for permission to increase the minimum fare to twopence. Although the proposal is to fix the minimum fare at 1½d., there is a possibility that in the near future the charge will be increased to 2d., as there will be a heavy deficit on the current year's working and the Committee is also faced by a heavy outlay on the reconstruction of the tramway track.

Institution Notes.

The works of Messrs. C. A. Parsons & Company, at Heaton, were visited on Saturday, January 15, by over 100 members of the North Eastern Students' Section of the Institution of Electrical Engineers and the Junior Institution of Engineers.

We are glad to learn that applications for membership to the proposed Birmingham Engineers' Club are coming in rapidly, so that those who wish to have the use of the club as soon as the premises are open should lose no time. Sir Alfred Herbert, K.B.E., Mr. Lincoln Chandler and Mr. Donald Hope have accepted vice-presidencies of the club.

A dinner of the Finsbury Technical College Old Students' Association was held in Manchester on Jan. 20. There are now some 28 old students enrolled in this local section, and as there must be many more in the district, those concerned are asked to communicate with the hon. local secretary, Mr. H. F. Coucher, 9, Cartwright-road, Chorlton-cum-Hardy.

The inaugural meeting of the Loughborough branch of the Women's Engineering Society was held on Jan. 19. A programme for the session has been arranged, which includes visits to engineering works and lectures by prominent engineers. The next meeting will be held on Feb. 22, the subject for debate being that "Women are More Suited to Technical than to Practical Engineering." Sub-centres of the Society are being formed at Bedford and Birmingham.

Three papers on "Electric Welding" were read before the Liverpool Sub-centre of the Institution of Electrical Engineers on Monday, January 17. Dr. J. H. Paterson opened with his Paper which dealt with "The Chemical and Metallurgical Aspects of Electric Arc Welding." He very briefly pointed out the difficulties yet to be overcome in electric welding, especially on the metallurgical side and hinted that there was a very wide field open for research. Mr. L. B. Wilson in his Paper dealt with "The Cost of Electric Resistance Welding," and gave some very interesting figures relating to the financial side of electric welding. He further showed on the screen the latest developments in machines for the purposes of resistance welding. Mr. F. J. Heyes outlined briefly the work that he had accomplished on "Electric Arc Welding Applied to Aluminium" in the course of a research carried out in the Laboratories of Applied Electricity, The University, Liverpool. The Paper was very interesting and opened up the possibilities of the welding of aluminium.

Imperial and Foreign Notes.

Picton (N.S.W.) Municipal Council is borrowing £6,500 for an electric supply scheme.

A scheme for electricity supply in Camden and Campbelltown (N.S.W.) is under consideration by the local authorities. The capital expenditure is estimated at £16,550.

Prof. Cotton has been appointed to advise Sydney (N.S.W.) City Council upon the question of generating electricity by water power from the Colo river.

Glen Innes (N.S.W.) Council has decided to establish electricity works. The plant will comprise three gas engines, driving 85-kw. generators, and the capital expenditure is put at £14,000.

H.M. Trade Commissioner at Wellington (N.Z.) reports that the Borough Council of Taumarunui, a rising township on the main line from Wellington to Auckland, has adopted a scheme to develop electric energy from the Wanganui River for power and lighting. The works are estimated to cost £44,000, and a poll of ratepayers is to be taken to authorise a loan for the purpose.

The ratepayers of Wairoa (N.Z.) electric power district have approved the proposal of the Wairoa Electric Power Board to borrow £100,000 for erecting main electric transmission and feeder lines between Waikaremoana and the Borough of Wairoa, including sub-stations and equipment (£35,000), for erecting subsidiary transmission-lines, feeders, and sub-stations from the main transmission line to outlying districts in Wairoa County (£60,000); adn also the purchase of electric motors, machinery, fittings, &c. (£5,000).

The Hampden (Victoria) Shire Council's proposal to establish a scheme for supplying electricity in bulk over a radius of 40 miles is being considered by neighbouring municipalities. At a conference with the Warrnambool Council the question of extending the scheme to Warrnambool was considered. Mr. Lincolne, consulting electrical engineer to the Hampden Shire Council, said a transmission line from Garvoc, the boundary of the Warrnambool Shire, to Warrnambool, would cost about £5,000 and would be capable of transmitting up to 200 kw. Transformers would cost £2,000, and another £1,000 would be required for a sub-station, a total of £9,000. The Warrnambool Council has now accepted the offer of the Hampden Council to supply electrical energy in bulk at £15 per kilowatt per annum, plus 2d. per unit.

A radio-telegraph station has been erected at Port Esmeraldas, Ecuador, by Cie Française de Telegraphie sans fil.

The President of Brazil has sanctioned the resolution of Congress which authorised the Agencia Americana to erect wireless stations in Brazil.

Telephone communication between the United States and Cuba is to be provided by the Cuban-American Telephone and Telegraph Company, which has been authorised to lay three cables from Havana to Key West.

H.M. Consul General at Milan reports that the Società Idroelettrica Cisalpina, Milan, formed in March, 1919, with a capital of 2,000,000 lire paid, is to increase its capital to 30,000,000 lire by the issue of 56,000 new shares of 500 lire each for erecting the projected hydro-electric plant in the Liro Valley, Valtellina.

It is reported that the Federal Wireless Company, of San Francisco, has secured a contract for the erection of a High Power Radio Station at Shanghai, with subsidiary stations at Shanghai, Canton, Peking and Kharbin. A sum of over £1,000,000 will be lodged as security, and the company will have the revenue of the stations and complete control of them for 10 years, after which the Chinese Government will have the right of purchase. The British Legation has entered a protest against the contract on the ground that it violates the rights of the Chinese Wireless Telegraph Company, the joint concern of Marconi and the Chinese Government, which by contract in May, 1919, was given the first opportunity to supply the wireless requirements of China. Japan is also constructing a high-power station near Peking under another contract, so that the position is somewhat mixed, and patent rights are also said to be involved.

Bankruptcies and Liquidations.

Jas. Sherred Denley, electrician, &c., 69, Regent-street, Cheltenham, has been adjudicated bankrupt.

John Wm. Gladwin, electrical engineer, 81, Burcot-road, and 1a, Meersbrook Park-road, Sheffield, has been adjudicated bankrupt.

Claims against Geo. Fredk. Kiveron, electrical engineer, Goulders-place, Attercliffe Common, Sheffield, are to be sent by Feb. 9 to Mr. L. J. Clegg, Official Receiver's Office, Figtree-lane, Sheffield.

In consequence of the sale of its undertaking to Mr. Peter Dobson, of Leyburn, the Leyburn Electric Supply Company, Ltd., is being wound up voluntarily, with Mr. Dobson as liquidator.

A first and final dividend of 4s. 2½d. will be payable on Feb. 4 at 9, Bedford-circus, Exeter, to creditors of Ivor Jas. Hudson and Basil Howard Newman, electrical engineers, 85, Queen-street, Exeter.

James Wm. Layton, electrician, 5, Noble's Bank, Sunderland, attended at Sunderland Bankruptcy Court for further examination last week. He said he had made a mistake in his statement that platinum increased from £30 to £57 an ounce after the armistice. The rise took place about the end of 1919, and prevented him from tendering for contracts. The examination was further adjourned.

Miscellaneous.

Mr. Francis Ince, a director of the Electrical Standardising, Testing and Training Institution, who died on Nov. 30 last, left estate £79,858 gross and £9,457 net.

Applicants desiring permission to attend the lectures in the Faculties of Arts and Science of the University of Glasgow during the winter session commencing Oct. 10, 1921, must apply to the Registrar by May 31.

The following companies were struck off the Register of Joint Stock Companies on Jan. 18:—Coke Ovens and By-Products Company, Galvo Box Company, Hemming Conduit Grip, and Llanelly Motor and and Electrical Engineering Company.

Owing to a hitch in the American arrangements for establishing wireless communication between British and American amateurs, it has become necessary to postpone the tests fixed for Feb. 2, 4, and 6 until a date which will be announced later.

The Post Office authorities are negotiating for a site near Cheapside for the erection of a telephone exchange which will have facilities for from 20,000 to 30,000 lines. This would be the second post-war London exchange, as a new centre is in course of construction in Great Tower Street.

On Saturday 100 members of the National Engineers' Association paid a visit of inspection to the Dick Kerr Works of the English Electric Company, Preston. The visitors showed keen interest in the large turbo-alternators in course of construction. Five workmen acted as guides, and at the close tea was served in the works canteen.

An International Automobile Exhibition will be held at Basle from May 28 to June 8, 1921. There will be eight sections covering all types of passenger and industrial cars, motor ploughs, engines, accessories, tools, &c. The general manager is Dr. W. Meile, of 30, Gerbergasse, Basle, from whom particulars can be obtained, but applications for participation must be received by the 31st inst.

A giant eye magnet for removing fragments of metal from injured eyes has been installed in the operating theatre of Preston Royal Infirmary. The instrument has been designed by Mr. J. F. Simpson, tramway engineer, with the assistance of Mr. G. J. Gibbs, consulting engineer. The cost was defrayed by workmen engaged in the local metal trades.

The outcry against the increased telephone charges continues and there have been rumours of a modification of the attitude of the Post Office. It is officially stated that there is no truth in the statement that the Government had decided to suspend the operation of the new rates and to revise the proposed tariff. Unless Parliament otherwise determines, the new rates will take effect as intended, except that it has been decided to defer the introduction of the new trunk charges until April 1.

Our readers should make a note of the dates between Feb. 10 and March 4 next. The West End of London will contain much of interest to them at that time. On Feb. 10 the Efficiency Exhibition will open at Olympia and close on the 26th, and on the 21st of the same month the British Industries Fair, organised by the Board of Trade, opens its doors at the White City, and continues until March 4. Those who live in the provinces and can arrange to be in London between Feb. 21 and 26 will be able to visit both "shows" on the same day, as they are within a stone's throw of each other. Messrs. Benn Brothers will be represented at each exhibition. At Olympia their stand is No. 161 in the Main Gallery, and at the White City they will be found in Section "G," stand No. 8. It is hoped that all interested in trade and technical journals and books will inspect the exhibits at these stands.

The arrangements are well in hand for the Birmingham Section of the British Industries Fair. The electrical exhibits will be more numerous and more comprehensive than last year. The Duke of York will visit the Fair on March 1, and 75 representatives from 16 Continental commercial missions will visit the Fair.

On March 2 these missions will be the guests of the Council of the Fair, who will entertain them to an official luncheon and dinner, at which the Lord Mayor will preside. There is every reason to believe that the President of the Board of Trade (Sir Robert Horne) and the Parliamentary Secretary to the Department of Overseas Trade (Mr. E. G. Kellaway) will visit Castle Bromwich, and that, in addition, the High Commissioners of the various British Dominions will also be present. The Lord Mayor, who is president of the local section of the Fair, will attend on the opening day (Feb. 21) in his official capacity, but there will be no formal opening. Intending visitors are recommended to make immediate application with regard to hotel accommodation, to the general manager, 95, New-street, Birmingham.

Heavy losses are caused to thrifty persons in all classes of the community by the failure of so-called "banks," and also by investments in unsound and even fraudulent concerns. In the interests of the nation, as well as of small but thrifty investors, any means for obviating these periodic losses should be welcome. It is, therefore, desirable to point out that Lloyds Bank Limited places its service, with its wide-spread system of branches, at the disposal of the public for the deposit of savings, how ever small. The bank has for many years had a large savings bank department in the South West of England, and the same facilities are now available throughout the whole of its system. Lloyds Bank is one of the foremost institutions of its kind in the world. It has over 1,500 offices in England and Wales; its subscribed capital is £70,688,980, its paid-up capital £14,137,796, its reserve fund £10,000,000, while its deposits amount to over £325,000,000.

The Secretary for Mines has reappointed, with extended terms of reference, the Miners' Lamps Committee which was appointed by the Home Secretary in May, 1919. The members of the Committee are Mr. William Walker, C.B.E. (chairman), Prof. F. E. Armstrong, M.Sc., Mr. Thomas G. Davies, Mr. Hubert Jenkins, Mr. Geo. A. Mitcheson, Mr. Samuel Roebuck, M.B.E., Mr. Jesse Wallwork and Prof. R. V. Wheeler. The secretary is Mr. E. G. Fudge, of the Mines Department, and by the terms of reference they are instructed to inquire and report upon the following questions :—

(*a*) What improvements are possible in miners' lamps as regards safety and illumination, and what alterations are desirable in the present method of testing and approving such lamps for the purposes of Sec. 33 of the Coal Mines Act, 1911 ; (*b*) whether the present arrangements for maintaining such lamps in a safe and efficient condition at the mines are adequate, and, if not, what steps should be taken to improve them ; (*c*) what steps should be taken to safeguard the general use by the workmen in a mine of safety lamps which give no indication of inflammable or noxious gases.

At the Birmingham and Midland Institute Exhibition, held on the 11-14 inst, the Edison Swan Electric Company, Ltd., exhibited an extensive range of X-ray and electro-medical appliances. The high-tension generating unit comprised a 16 in "Jointless Section" induction coil and a "Premier" mercury interrupter fitted with an Ediswan mechanical h.t. rectifier. Both articles are manufactured at Ponder's End, under the personal supervision of Mr. Leslie Miller, A.M.I.E.E. The X-ray couch exhibited is of the latest design, with fully protected underslung tube box. In addition to the lead lining inside the tube box, further protection from the rays is effected by a lead-lined wooden panel which faces the box and works in conjunction with it. Amongst the electro-medical exhibits the Ediswan portable high-frequency and cautery generator attracted most attention. This is a compact and efficient instrument with a remarkable output. In addition to generating high-frequency current suitable for all purposes it is capable of heating both large and small cautery burners. The gross weight of this instrument is only 10 lb. Another interesting article was the Ediswan "Saloon" electric hairdryer, which is adaptable for use either on a stand or as a hand model. A large amount of hot air is produced, the heating element taking 600 watts.

Imports.—The following are official values of electrical machinery, apparatus and material, imported into this country (*a*) during December 1920, and (*b*) the aggregate figures from Jan. 1 to Dec. 31, with increase or decrease compared with 1919 :—

Electrical machinery, (*a*) £146,822 (decrease £42,343), (*b*) £1,335,200 (increase £473,577) ; telegraph and telephone cables other than submarine, (*a*) nil, (*b*) £50 (increase £12) ; telegraph and telephone apparatus, (*a*) £52,037 (decrease £16,035), (*b*) £243,931 (decrease £63,801) ; other electrical wires and cables, rubber insulated, (*a*) £4,137 (increase £3,781) (*b*) £33,054 (increase £25,608) ; with other insulations, (*a*) £10,214 (increase £4,932), (*b*) £133,537 (increase £112,207) ; carbons, (*a*) £18,304 (increase £15,251), (*b*) £153,406 (increase £123,720) ; glow lamps, (*a*) £12,236 (increase £12,228), (*b*) £75,480 (decrease £138,291) ; arc lamps, and electric searchlights, (*a*) £8,956 (increase £8,784), (*b*) £16,723 (increase £16,520) ; parts of arc lamps and searchlights (other than carbons), (*a*) £151 (decrease £4,425), (*b*) £13,107 (decrease £58,872) ; primary and secondary batteries (*a*) £13,162 (increase £8,078), (*b*) £129,925 (increase £83,611) ; meters and measuring instruments, (*a*) £15,468 (increase £11,724), (*b*) £97,939 (increase £57,679) ; switchboards, (*a*) £8,668 (increase £8,578), (*b*) £11,420 (increase £10,064) ; electrical goods and apparatus unenumerated, (*a*) £132,624 (increase £81,776), (*b*) £890,830 (increase £447,993). Total of electrical machinery, apparatus and material, other than uninsulated wire, (*a*) £429,098 (increase £98,111), (*b*) £3,161,450 (increase £1,095,316).

Exports.—The exports of electrical machinery, apparatus and material, (*a*) during December, 1920, and (*b*) from Jan. 1 to Dec. 31, with increase or decrease compared with 1919, were as follows :—

Electrical machinery, (*a*) £328,700 (increase £112,392), (*b*) £2,677,067 (increase £773,936) ; including railway and tramway motors, (*a*) £15,127 (increase £8,772), (*b*) £49,469 (decrease £40,649) ; other generators and motors, (*a*) £191,964 (increase £75,657, (*b*) £1,525,722 (increase £471,907) ; and electrical machinery unenumerated, (*a*) £121,609 (increase £37,963), (*b*) £1,101,876 (increase £342,678) ; telegraph and telephone cables, submarine, (*a*) £326,295 (increase £248,225), (*b*) £1,776,940 (increase £1,154,307) ; other than submarine, (*a*) £125,079 (increase £67,574), (*b*) £1,040,596 (increase £520,764) ; telegraph and telephone apparatus, (*a*) £150,844 (increase £102,097), (*b*) £1,225,854 (increase £804,675) ; other electrical wires and cables, rubber insulated, (*a*) £166,072 (increase £68,585), (*b*) £1,752,916 (increase £925,184) ; with other insulation, (*a*) £147,278 (increase £9,311), (*b*) £2,044,394 (increase £965,395) ; carbons, (*a*) £29,288 (increase £28,292), (*b*) £149,757 (increase £136,956) ; glow lamps, (*a*) £26,461 (increase £15,904), (*b*) £319,382 (increase £169,475) ; arc lamps and searchlights, (*a*) £3,267 (increase £3,240), (*b*) £20,638 (increase £13,132) ; parts of arc lamps and searchlights (other than carbons), (*a*) £1,475 (increase £699), (*b*) £15,419 (increase £4,411) ; batteries, (*a*) £75,932 (increase £47,880), (*b*) £627,584 (increase £192,252) ; meters and measuring instruments, (*a*) £29,888 (increase £7,677), (*b*) £396,421 (increase £166,573) ; switchboards, (*a*) £13,860 (increase £8,132), (*b*) £117,032 (increase £67,635) ; electrical goods and apparatus unenumerated, (*a*) £244,543 (increase £99,825), (*b*) £2,117,453 (increase £785,609). Total of electrical machinery, apparatus and material, other than uninsulated wire, (*a*) £1,670,982 (increase £821,833), (*b*) £14,281,453 (increase £6,670,304).

Personal and Appointments.

Wollongong (N.S.W.) Council recently appointed Mr. L. Ferris, of Murrumburrah, as municipal electrical engineer.

Mr. H. C. Waters, technical director of the A.G.E. Electric Motors, Ltd., Stowmarket, has been appointed managing director of the Company.

Mr. F. Downes, telegraph engineer, of the Great Northern Railway Company, has been appointed president for the ensuing year of the Railway Electrical and Telegraph Engineers' Conference.

Owing to reasons of health, Dr. E. K. Muspratt has resigned from the board of the British Insulated & Helsby Cables, Ltd., and Mr. J. A. Smith has been elected to fill the vacancy.

Mr. C. E. Watmough has been elected rolling stock engineer of the Leeds tramways department, in succession to Mr. Bromley, and Mr. A. A. Allen becomes car works superintendent.

Mr. Percy R. Allen, O.B.E., retired on the 1st inst. from the active engineering management of the Castner Kellner Alkali Company after 26 years of continuous service, but he has been retained by the Company in a consultive capacity and he also practises as a consulting engineer at his residence, Linden Lodge, Runcorn, Cheshire, in connection with the designs of steam and gas power plant, and the application of electricity in mining work. In reference to the statement as to the cost of power made by the Managing Director of the Company on the occasion of the recent presentation to Mr. Allen, we learn that while acting on Mr. Allen's advice when the company installed large gas engines, they did for a period produce power at a lower cost than at the Falls of Niagara, and at the new turbo station designed by him just before his retirement the power production cost compares favourably with most of the supply stations in Great Britain.

Catalogues, Price Lists, &c.

A striking folder has been published by the London Telephone (New System) Company, Ltd., Donington House, Norfolk-street. W.C.2., on their Inter-communication Telephone System for factories, offices, business premises, &c.

Messrs. W. T. Henley's Telegraph Works Company, Ltd., Blomfield-street, London Wall, E.C.2, notify that they have a number of re-fills left, suitable for use in the calendar which they issued last year, and any customer of the company who has retained the calendar and desires a re-fill can have one on application. The re-fills are the same as those issued with this year's calendar, and the monthly cards contain alternate cards of general cable information.

The C.A.V. electric horns and standard electrical equipments are so well-known in the motor industry and to motor users, that they require no recommendation to our readers. In a new folder issued by Messrs. C. A. Vandervell & Company, Ltd., some illustrated particulars of the design and operation, with measurements and prices of the company's electric horns are given. Three models are shown, the windings of each being for 6 or 12 volts.

A leaflet issued by Messrs. Machin & Bowmer, Ltd., 19, Brazennose-street, Manchester, and 40, Gerrard-street, London, W., gives some particulars, with instructions for the application of their "Ariel" solid non-grip belt dressing. It is claimed that "Ariel" is not merely a surface dressing ; it is a preservative which penetrates the belt ; it contains no resin, pitch, gum, tar or other injurious ingredient ; it has all the properties of the best liquid non-slip dressings, with none of their disadvantages ; and it is very convenient and economical.

A nicely printed and well-illustrated pamphlet, emanating from the Agricultural and General Engineers, Ltd., Central House, Kingsway, London, W.C.2, is devoted to road making and transport plant for local authorities. Particulars are given of steam and motor rollers, steam and electric vehicles, steam tractors and traction engines, trailer wagons and sleeping vans, steam and oil engines, &c., and also of the "Bull" electric motors and dynamos. The manufacturing resources and arrangements of the Company are such that they can successfully undertake the manufacture and supply of any plant required for the making or repair of roads, the transport of materials, &c., no matter how large the contract.

Business Items, &c.

The new telephone number of the Hatcham Manufacturing Company, Ltd., is Museum 5,895.

Edward Jas. Bailey and Wm. Nathan Smart, electrical engineers, 17 and 19, Cross-street, Oldham, have dissolved partnership. Debts by Mr. Smart.

Messrs. Howard S. Cooke & Company, manufacturers of screws, terminals, &c., have removed to their new factory at 370, Warwick-road, Greet, Birmingham. Telephone : Victoria 363.

Messrs. R. B. Hand & Company, Ltd., 65, High Holborn, W.C.1, have been appointed sole distributing agents for the British Isles for Messrs. R. G. Haskins Company of Chicago, who specialise in labour-saving devices, such as portable electric drills and grinders, &c.

Messrs. Higgs & Hill, Ltd., of South Lambeth-road, S.W. 8, ask us to announce that there is no foundation for the rumour which has gained currency that their electrical engineering department is about to be closed. The firm are busy with many important contracts for the Government and private clients, fully maintaining their prestige as electrical engineers in the building trade.

Tenders Invited.

Camberwell (London) Council require tenders by Feb. 7 for the supply of stores, including electric lamps and fittings. Forms of tender from the Borough Engineer.

Manchester Electricity Committee require tenders by February 14 for supply and laying of 33,000 volt trunk feeder, pilot and telephone cables. Specification from Mr. F. E. Hughes, Town Hall, Manchester.

Croydon Corporation want tenders by Feb. 11 for a gas engine and pump, or electric motor and pump for Beddington sewage farm. Specification from the Borough Engineer.

Middlesbrough Corporation require tenders by Feb. 9 for laying a double line of tramways in Grange-road West. Specification from the Borough Engineer and Surveyor.

Great Yarmouth Corporation invite tenders for the supply and erection of h.t. switchgear. Copies of specification from the engineer, Mr. Gordon Bryant. Tenders to the Town Clerk by Feb. 11.

Belfast Tramways Committee want tenders by Feb. 26 for stores, including electrical accessories, copper strip, cable, lamps, insulating tapes, carbon brushes, wire and ears, g.i. wires, &c. Forms of tender from the General Manager.

The date for the receipt by the Crown Agents for the Colonies, on behalf of the Government of the Uganda Protectorate for a concession of a portion of the Ripon Falls of the Nile for the generation of electric power has been extended to Feb. 19.

The Commissioners of His Majesty's Works, &c., require tenders by Feb. 1 for six months' supply of switches, fuses and fuse boards, Forms of tender from the Controller of Supplies.

Aberdeen Corporation invite tenders for supply and erection of electric pumping machinery capable of delivering 6½ million gals. per 24 hours, including transformers, motors, pumps, &c. Specifications from the Water Engineer, 41½, Union-street, and tenders by Feb. 21.

The Midland Railway Company Northern Counties Committee (Ireland) require tenders by Feb. 3 for six or 12 months' supply of stores, including telegraph ironwork, wire, batteries, electric lamps, &c. Forms of tender from the General Stores Superintendent, Belfast.

Tenders are invited up to March 2 for the supply and delivery to the Australian Postmaster-General's Department, State of South Australia, of (a) telephone parts (Schedules 558 and 559); and (b) telegraph and telephone materials (Schedule 560). Tender forms from the High Commissioner for Australia, 406, Australia House, Strand, London, W.C.2.

The Tramways Committee of Manchester Corporation invite tenders for various stores, including permanent way points. tongues and hardened steel centres, welding portions, &c., also motor controller parts, resistances, commutator segments, armature and field coils, trolley poles, lamps, insulating material, carbon brushes, overhead equipment trolley bases, wheel bushes and spindles, cables, copper, brass, &c. Schedules from the general manager, Mr. J. M. McElroy, 84, Piccadilly, Manchester, and tenders to the Chairman of the Committee by Feb. 15.

The City of Auckland (N.Z.) invite tenders for the supply and erection of one 3,000 kw. and one 5,000 kw. turbo-alternator, rotary converters (1,500 kw. and 500 kw.) switchgear and transformers, also water tube boilers, conveyor pumps, pipework and h.t. and l.t. cables. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew & Rider, 8, Queen Anne's-gate, S.W. 1, and tenders by noon, February 22, 1921, to Mr. Alex. Wyllie, C/o. Messrs. Preece, Cardew & Rider.

The Electricity Commissioners of Victoria (Australia) invite tenders for the supply of plant and material required for the Morwell Power Scheme, including 25,000–12,500 kw. turbo-alternators, 600 kw. turbo-alternators, transformers, switchgear, cables, transmission steel towers, steel telephone poles, &c. Tender forms and specifications can be obtained from the Agent-General for Victoria, Victoria House, Melbourne-place, Strand, London, W.C.2, and drawings can be seen at the offices of Messrs. John Coates & Company, Ltd., consulting engineers, at the same address. Tenders by noon, March 31, to Mr. R. Liddelow, secretary, Electricity Commissioners, 673, Bourke-street West, Melbourne.

The Electricity Commissioners of Victoria also require tenders by noon, March 31, for telephone wire (specification 45) and pin type insulators (specification 46) in connection with the Morwell Power Scheme. Specifications can be seen at the offices of Messrs. John Coates & Co. and tender forms, &c., obtained from the Agent-General.

Tenders are invited up to Feb. 23 for the supply and delivery to the Postmaster-General's Dept., State of South Australia, of electric lamps (Schedule 561); up to March 21 for the supply and delivery to the Postmaster-General's Dept., State of New South Wales, of telephone and telegraph apparatus, testing instruments and switchgear parts (Schedule 814); and also up to March 29 for the supply to the Postmaster-General's Dept., State of Western Australia, of telegraph materials (Schedule 333). Tender forms, &c., from the High Commissioner for Australia, 406, Australia House, Strand, London, W.C.2.

For the Uruguayan State Power Department (Montevideo) tenders are invited for the supply of 10,450 meters. The supply is a three-phase, 50-cycle system, with 200 volts between phases. Meters required are single-phase meters with single tariff for range of 2·5 to 20 amperes and three-phase meters for range of 5 to 75 amperes. Induction type meters preferred. Tenders, accompanied by certificate of deposit of 1,000 gold pesos (about £200) to the Secretaria del Directorio de las Usinas Electricas del Estado, Calle Dayman No. 1471, by March 29. Specification (in Spanish) and also specification of tenders for 500 d.-c. meters for the provinces can be seen at the Department of Overseas Trade.

Patent Record.

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SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

145,578 Western Electric Co. Electric repeaters for telephony. (20/5/19.)
145,720 Krupp Akt.-Ges. Electrical switch operated by a current of air. (27/12/18.).
145,728 Krupp Akt.-Ges. Apparatus particularly applicable for the adjustment of distant continuous current motor. (16/3/18.)
146,279 Bennett. Electric current interrupters. (24/6/19.)
146,825 Eureka Vacuum Cleaner Co. Electric switches. (18/1/17.)
153,225 Fairbrother. (Sieben.) Electric couplings for thermo-electric appliances. (8/3/20.)
153,234 Hornby. Commutators for electric motors. (19/4/20.)
153,235 Redrup. Distributors for magneto-electric machines. (6/12/19.) (Divided Application on 151,125.)
153,238 Lenaghan. Selector apparatus for use in and automatic or semi-automatic telephone system. (23/4/19.) (Divided Application on 152,702.)
153,251 Godfree. Magneto-electric generators for use in connection with internal-combustion engines. (5/8/19.) (Divided Application on 148,695.)
154,232 B. T.-H. Co. (G. E. Co.) Methods of and means for amplifying electrical variations. (22/2/16.)
154,247 B. T.-H. Co. (G. E. Co.) Radio-signalling systems. (27/5/19.)

Comprises an electron discharge or vacuum tube having an anode and a filament, wherein is provided in the space between the said elements a secondary element of perforated or open metal work integral with or attached by direct metallic contact ot the anode. The secondary element is preferably arranged close to the filament, and its open-work nature is designed to neutralise largely the space-charge, while allowing the majority of the electrons to pass through the spaces to the main portion of the anode.

154,258 B. T.-H. Co. (G. E. Co.) Methods of and apparatus for manufacturing electric incandescent lamps. (26/6/19.)
154,271 Cooper. Dynamo-electric machinery. (24/7/19.) (Cognate application, 20,544/19.)
154,290 Lo Thermo Patents, Ltd., & Burleigh. Dynamo-electric machinery. (18/8/19)
154,293 Newbery & Evershed & Vignoles. Direction communicating systems for guns, searchlights, range-finders, torpedo tubes, and other apparatus. (19/8/19.)
154,295 Scholes & Claremont. Device for securing electric cables and the like to walls and other supports. (20/8/19.)
154,300 Imbery. Electric furnace for the continuous heating of rivets. (21/8/19.)
154,303 Western Electric Co. (Western Electric Co.) Electric signalling systems, especially applicable to combined telegraph and telephone systems. (21/8/19.)
154,312 Hattersley. Memorandum devices for use in connection with telephones and other purposes. (22/8/19.)
154,313 Automatic Telephone Manufacturing Co., Harrison & Smith. Telegraph printing systems. (22/8/19.) (Cognate application, 25,369/19.)
154,343 Royston. (Federal Storage Battery Co.) Electric Storage batteries. (30/8/19)
154,347 Craufurd & Wylie, Doughty. Method and apparatus for detecting distant ships whereon dynamo-electric machinery or the like is running. (1/9/19.)
154,348 Kidner. Method of varying the electric current passing through electro-magnets or solenoids in automatic musical instruments or players causing different degrees of loudness in the note played. (22/9/19.)
154,360 Igranic Electric Co. & Mackley. Push-button controls of electric motor-starters. (4/9/19.)
154,360 Taggart, Scott. Thermionic devices. (8/9/19.)

APPLICATIONS FOR PATENTS.

July 10, 1920.

20,354 Signal Ges. Membraneous transmitter for subaqueous signals. (13/3/15, Germany.)
20,355 Signal Ges. Submarine sound-receiving devices. (8/9/15, Germany.)
20,356 Signal Ges. Transmitting and receiving devices for subaqueous sound waves (4/4/16, Germany.)
20,357 Signal Ges. Sound producing or receiving devices. (5/6/17, Germany)
20,358 Signal Ges. Sending or receiving device for subaqueous sound waves. (17/9/17, Germany.)
20,359 Signal Ges. Sound producing or receiving devices. (22/2/18, Germany.)
20,360 Signal Ges. Subaqueous sound producer or receiver. (11/7/18, Germany.)
20,361 Signal Ges. Sound-transmitting arrangement. (14/4/19, Germany.)
20,362 Signal Ges. Sound producers and receivers. (31/7/19, Germany.)
20,363 Signal Ges. Sound producers and receivers. (4/8/19, Germany.)
20,364 Signal Ges. Receiving device for submarine sound signals. (18/8/17, Germany.)
20,365 Signal Ges. Listening devices. (30/3/17, Germany.)
20,369 Signal Ges. Device for ascertaining direction of sound waves. (29/5/15, Germany.)
20,370 Signal Ges. Electro-magnetic vibratory devices. (12/7/15, Germany.)
20,371 Signal Ges. Sound receivers. (29/11/15, Germany.)
20,372 Signal Ges. Sound apparatus. (17/2/16, Germany.)
20,373 Signal Ges. Sound apparatus. (15/3/16, Germany.)
20,374 Signal Ges. Sound-signalling device. (3/3/17, Germany.)
20,375 Signal Ges. Subaqueous sound producers and receivers. (5/11/17, Germany.)
20,376 Signal Ges. Direction-finder for sound waves. (10/7/15, Germany.)
20,399 Ges. fur Drahtlose Telegraphie. Multiplex telephony. (27/5/19, Germany.)
20,400 Ges. fur Drahtlose Telegraphie. Thermionic tube electro-magnetic wave-generating arrangements. (25/10/18, Germany.)
20,401 Ges. fur Drahtlose Telegraphie. Generation of high-frequency currents. (19/1/15, Germany.)
20,402 Ges. fur Drahtlose Telegraphie. Thermionic tube electro-magnetic wave-generating arrangements. (9/9/18, Germany.)
20,404 Optische Anstalt C. P. Goerz A.-G. Electrodes for searchlights. (19/9/18, Germany.)
20,405 Optische Anstalt C. P. Goerz A.-G. Electrodes for searchlights. (24/9/18, Germany.)
20,406 Optische Anstalt C. P. Goerz. A.-G. Arc lamps for searchlights. (14/10/18, Germany.)
20,408 Optische Anstalt C. P. Goerz. A.-G. Arc lamps. (11/6/19, Germany.)
20,414 Krupp (F.) A.-G. Electro-magnetic tension devices. (23/6/19, Germany.)
20,415 Krupp (F.) A.-G. Electric resistance connections. (21/11/18, Germany.)
20,431 Gauthier. Using dynamos of vehicles as speed indicator. (26/4/19, France.)
20,440 Boker Co. & Schmidt. Electrical Annunciator, &c. (27/3/18, Germany.)
20,441 Magestic Electric Development Co. Electric heaters, &c. (26/12/17. U.S.)
20,465 Fromont. Accumulators. (21/9/16, France.)
20,466 Fromont. Accumulators.
20,498 Gessellschaft fur Drahtlose Telegraphie. Cathode generators. (9/9/18, Germany.)
20,499 Gessellschaft fur Drahtlose Telegraphie. Conducting coils. (4/3/18, Germany.)
20.500 Gessellschaft fur Drahtlose Telegraphie. Production of oscillations by cathode tubes. (30/4/19, Germany.)
20,505 Conradty. Bow collectors for electric vehicles. (17/6/18, Germany.)
20,506 Conradty. Slip pieces for bow collectors. (1/9/15, Germany.)
20,507 Gessellschaft fur Drahtlose Telegraphie. Antenna for receiving electric waves. (18/6/18, Germany.)
20,508 Conradty. Bow collectors for street railways. (28/4/16.) Germany.
20,552 Korting & Mathiesen A.-G. Oscillating watt-hour meters. (9/6/15, Germany.)
20,573 Constructions Electriques de Belgique Soc. Anon. Process for regenerating energy in d.c. motors. (7/6/19. Belgium.)

Companies' Reports, &c.

From the statement of the chairman (Mr. R. M. Horne-Payne) at the annual meeting of the British Columbia Electric Railway Company, Ltd., last week, we learn that an improvement took place in the position of the Company during the past year. As a result of increased population and expanding trade the gross receipts were the largest for any year in the history of the Company, and despite the heavy increase in costs of operation, the directors were able, after making proper provision for depreciation, sinking fund, and renewals, to recommend dividends for the year of £4 13s. per cent. on the preferred and £6 1s. per cent. on the deferred ordinary stock of the company. With permanent conditions established on a reasonably remunerative basis, they could secure the necessary capital to proceed on the progressive lines adopted in the past with great advantage to British Columbia. Pre-war returns were not sufficient to attract capital for the development of public utilities such as theirs, the growth of which was inevitable if the districts served were to receive in the future the services they had been accustomed to in the past. The growth in the population had necessitated a substantial expenditure on capital account during the year. The company's debentures being irredeemable, a considerable part of the provision which the directors had made for depreciation had accumulated in cash and was being utilised for necessary extensions and developments. Both the public in Columbia and the shareholders might congratulate themselves that the sound policy of the company in the past had enabled it to meet the continued growth of the company without having recourse to the issue of fresh capital.

Extensions and Developments.

It had become a vital necessity to obtain additional power on account of the growth of the business, and the resultant increase in consumption of power, which amounted to 22·4 per cent. in 1919-20. In the latter year 3,981 additional light and power consumers were connected. The Company owned certain valuable water rights which could be developed, but the directors considered that, in view of the present high cost of materials and labour, it was undesirable to commence development of a new hydro-electric installation at present. In addition to the power already derived from the water powers owned or controlled, a contract was entered into in 1912 with the Western Power Company of Canada, under which the greater portion of the output of the Western Company was now taken by their Company. The management advised that, having regard to the importance of an increasing and uninterrupted supply, it was undesirable to rely upon making additional outside contracts, and that the best course to pursue was to purchase the Western Power Company of Canada outright. Arrangements had been completed whereby their Company had acquired the majority of the share capital of the Western Power Company. As part of the arrangements, they had guaranteed the principal and interest of $5,000,000 of outstanding 5 per cent. first mortgage bonds of the Western Company. The directors proposed to draw up plans for the utilisation of the full capacity of the Western Company's development, and provided the demand for power continued and they could be assured of reasonable rates for services, it was intended to proceed with the development, which, when completed, would put them in a position to supply the needs of the surrounding communities for a long time to come. The improvement in business continued and showed every sign of continuing. The board had no hesitation in reaffirming their faith in the speedy growth of the prosperity of British Columbia, provided legislation was prudent and stable, and there was a reasonable attitude on the part of Labour.

An interim dividend of 5 per cent. (1s. per share) has been declared by the Vera Cruz Electric Light, Power & Traction Company, Ltd.

The net profit of J. G. White & Company, Ltd., for the past year was £28,100, and a dividend on both classes of capital of 7 per cent. has been declared, a sum of £30,000 having been placed to reserve.

The directors of the Metropolitan Railway Company have declared a final dividend at rate of 2 per cent. per annum on the ordinary stock, making 1½ per cent. for the year 1920 (against 1¼ per cent. for the preceding year). A sum of £50,000 (against £40,000) has been placed to general renewals fund, and £15,500 carried forward (against £20,000).

The directors of the Liverpool Overhead Railway Company recommend payment of a final dividend (for the half-year ended Dec. 31 last) at rate of 5 per cent. per annum on the preference shares and 3½ per cent. per annum (both less tax) on the ordinary shares, making for the year 5 per cent. on the preference and 3 per cent. on the ordinary shares.

The directors of the Provincial Tramways Company recommend a final dividend of 10d. per share on the ordinary shares for the year ended Sept. 30, making a total distribution of 1s. 6d. per share (or 7½ per cent.) for the year. The sum of £10,000 is placed to reserve and depreciation account, and £10,000 is provided for excess profits duty.

The report of the Yorkshire (West Riding) Electric Tramways, Ltd., for 1920, states that, after providing for debenture interest, the net income is £28,676, plus £1,386 brought forward. A dividend of 6 per cent. per annum on the 6 per cent. cumulative preference shares is recommended, and a sum of £20,347 has been placed to renewals, depreciation and reserve fund in lieu of accident insurance.

In order to bring the capital of the company more into accord with the value of the undertaking, the directors of the Shanghai Electric Construction Company, Ltd., recommend an increase of the capital from £320,000 to £400,000 and the capitalisation of £80,000 of undivided profit by issuing as a bonus 8,000 fully paid shares of £10 each (giving one new share for every four shares now held). The directors have declared a second interim dividend in respect of the year 1920 of 6 per cent. (12s. per share), less tax, payable on Feb. 1. The final distribution, which it is anticipated will be the same as last year, will be announced when the accounts for the year are ready.

The revenue of the Chatham & District Light Railways Company for the year 1920 was £90,716 and the expenses were £69,174. After deducting £3,744 interest (£2,403) and £6,000 transferred to reserve for depreciation, and adding £3,393 from 1919, the balance was £12,789. Of this amount £5,590 has been paid as interim dividends (5 per cent. per annum for the half-year ended June 30 on the preference and ordinary share capital) and the directors recommend that the balance be disposed of by paying dividends at rate of 5 per cent. per annum for the half-year ended Dec. 31, 1920, on the preference and on the ordinary share capital, leaving £1,609 to carry forward. There was an increase of £11,876 in revenue and £16,559 in expenses, compared with 1919. There has also been an expenditure of £842 on deferred repairs.

New Companies.

COMPAGNIE STURTEVANT (172,044).—Reg. Dec. 16, as an unlimited company without share capital, to acquire the business carried on in France and elsewhere as "Compagnie Sturtevant," and to carry on in France or elsewhere the business of engineers, manufacturers, merchants, installers of fans, blowers, exhausters, water spray air filters, steam engines and turbines, &c. First directors are: G. A. Mower, G. R. Thursfield and M. A. Doggett. Secretary: P. J. Tidmarsh. Reg. office: 147, Queen Victoria-street, E.C.

A. J. DRONSFIELD, LTD. (172,531).—Private company. Reg. Jan. 11. Capital, £4,500 in £1 shares. To take over the business of agents, suppliers, merchants and dealers in machinery, machine tools, small tools and machine-shop equipment carried on by A. J. Dronsfield and W. H. Middleton as "A. J. Dronsfield & Company," and to carry on the business of motor, electrical, civil and general engineers, &c. First directors are: A. J. Dronsfield, W. H. Middleton. Reg. office: Craven House, Kingsway.

E. A. INGOLD, LTD. (172,591).—Private company. Reg. Jan. 14. Capital, £2,000 in £1 shares. To take over the business of an electrical engineer, factor and agent carried on by E. A. Ingold at Leeds. Directors are: E. A. Ingold and J. M. H. Hoffman (both permanent). Reg. office: 17, East Parade, Leeds.

MEDWAY'S SAFETY LIFT COMPANY, LTD. (171,903.)—Private company, reg. Dec. 8, capital £40,000 in £1 shares, to carry on the business of manufacturers and builders of lifts, elevators, escalators, moving staircases, cranes, &c., and to acquire the business carried on by E. M. Medway and A. S. Medway, as Medway's Safety Lift Company. First directors are E. M. Medway, A. S. Medway, A. G. Mickleburgh, P. H. F. Smith and B. T. Rumble. Secretary, J. Thomas. Reg. office, Victoria Works, St. Peter-street, Maidstone.

MORRIS, VALENTINE & WILLIS, LTD, (172,420).—Private company. Reg. Jan. 4. Capital £1,000 in £1 shares. To carry on the business of electrical, mechanical, motor, and general engineers, electricians, &c. First directors are: D. G. Morris, A. Valentine and H. Willis. Reg. office: 187, West End-lane, N.W.

POWER PRODUCTION COMPANY, LTD. (5,084).—Private company. Reg. in Dublin Dec. 10. Capital £1,000 in £1 shares. To carry on the business of designing, constructing, buying, selling and operating power plants, &c. First directors are: J Dornan and T. G. Price (and secretary). Reg. Office: Commercial-buildings, Dame-street, Dublin.

RANAND EQUIPMENT COMPANY, LTD. (171,862.)—Private company, reg. Dec. 6, capital £100 in £1 shares, to carry on the business o dealers in plant, machinery, engines, tools, and supplies, required in connection with railway, tramway and similar undertakings, specialists in the assembling of springs, shock absorbers and other apparatus for reducing vibration in motor cars, tramcars, &c. F. A. R. Rand is first director. Reg. office, Teddington Wharf, Manor-road, Teddington.

SCHOLEY CONSTRUCTION COMPANY, LTD. (172,385).—Private company. Reg. Jan. 1. Capital £20,000 in £1 shares. To adopt and agreement with H. Scholey, C.B.E., for the transfer of certain property and rights to use a process relating to an improved method of treating rails, &c., with apparatus for heat treatment "in situ," and to carry on the business of manufactures of railway and tramway apparatus, rolling stock, &c. First directors are: H. Scholey, C.B.E., G. H. Roberts, M.P., C. W. Hill and E. S. Ormsby. In the event of the latter ceasing to act as director, C. P. Sandberg shall be entitled to nominate a director in his place during the continuance of the "principal agreement."

SMITH & ANSELL, LTD. (172,491).—Private company, reg. Jan. 7 Capital £7,000 in £1 shares. To take over the business of manufacturers of electric light fittings, &c., carried on as Smith & Ansell. Directors are: H. S. Smith (chairman) and B. Ansell. Reg. office: 109, Great Hampton Row, Birmingham.

SPIRAL FLEXIBLE METALLIC TUBING COMPANY, LTD. (172,545)—Private company. Reg. Jan. 11. Capital, £10,000 in £1 shares. To take over the business of manufacturers of and dealers in flexible metallic tubing carried on at New Basford, Notts, as the Midland Flexible Metallic Tubing Company. Permanent directors are: J. W. Hulme, W. Hulme, L. Hulme, A. J. Ralph, J. Lister and A. France. Secretary: W. Hulme. Reg. office: Mount Street Works, New Basford, Notts.

UNIQUE, LTD. (172,640)—Private company. Reg. Jan. 17, capital £500 in £1 shares, to carry on the business of manufacturers of and dealers in lamp shades, electric and gas globes, &c. The permanent directors are D. A. Abrahams and H. F. Kean. Secretary: H. F. Kean. Reg. office: 25, Shaftesbury-avenue, W.C.

UNITED LAMP BLACK WORKS, LTD. (171,969).—Private company. Reg. Dec. 11. Capital £150,000 in £1 shares (75,000 "A" ordinary and 75,000 "B" ordinary). Objects: To carry on the business of manufacturers and sellers of and dealers in oil, lamp black and other kindred products and bye-products of oil; to acquire, erect and establish factories and works for the manufacture and production of such black and products; and to acquire, on the terms of two agreements with the General Electric Company, and with the Columbian Carbon Company, the Binney & Smith Co., and the L. Martin Co., the leases of existing factories, &c. First directors are: M. Solomon, T. Settle, G. W. Holding and G. C. Lewis. Reg. office: 67, Queen Victoria-street, E.C.4.

WHITE, ANDREWS & COMPANY, LTD. (172,586).—Private company. Reg. Jan. 13. Capital, £10,000 in £1 shares, to carry on the business of electrical and general engineers, founders, machinists, &c., and to adopt an agreement with A. E. White, H. G. Andrews, Senr., and H. G. Andrews, Junr. Permanent directors are: H. G. Andrews, Senr. (Ch.), H. G. Andrews, Jnr. (Sec.), and A. E. White and G. F. Bennett. (joint man. directors). Reg. office: 9-10, Water-lane, Ludgate-hill, E.C.4.

Benn Brothers' Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics."—"Cost of Air Ton Miles compared with other forms of Transport"; and "Speed and Endurance of the Rigid Airship," by E. H. Hewitt.

"Cabinet Maker."—Special Credit Issue: "The Annual Credit Index"; "Calico Painting and Printing in the East Indies in 17th and 18th Centuries": and "Modern Bank Office Furniture."

"Chemical Age."—Special Emipre Number: "Chemicals, Dyestuffs and Chemical Plant for Export."

"Farm and Home."—"The Canadian Cattle Embargo"; "The Farmer's Orchard"; and "Shire Horse Breeding in Wales."

"Fruit-Grower."—"Insect Pests of Mushrooms"; "Fruit Culture at Chelmsford"; and "Pruning by Principle."

"Gardening Illustrated."—"Morello Cherry as a Bush Tree"; "Leaf Spot of Celery"; and "A Trio of New Carnations."

"Gas World."—"Developments and Prospects of Gas Furnaces," by W. Newton Booth; and Review of the Gas Light & Coke Company's Records, 1920.

"Hardware Trade Journal."—Annual Credit Issue: "Hardware Design"; and "Fencing Material for the Argentine."

Prices of Metals, Chemicals, &c.

TUESDAY, Jan. 25.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£76 0 0	—	£3 0 0
Electro Wirebars ...	,,	£79 0 0	—	£3 0 0
H.C. wire, basis ...	per lb.	1s. 0⅛d.	—	⅜d.
Sheet	,,	1s. 1⅜d.	-	⅜d.
Phosphor-bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. 4 d.	—	⅜d.
Brass 60/40—				
Rod, basis	,,	0s. 9⅛d.	—	⅜d.
Sheet, basis	,,	1s. 2d.		—
Wire, basis	,,	1s. 1½d.	—	
Pig Iron—				
Cleveland Warrants	per ton	£11 7 6	—	—
Galvanised steel wire, basis 8 SWG		£34 0 0		
Lead Pig—				
English	,,	£25 0 0	—	—
Foreign or Colonial	,,	£23 2 6	—	£0 2 6
Tin—				
Ingot	,,	£172 0 0	—	£19 10 0
Wire, basis	per lb.	2s. 4½d.		2½d.

Salammoniac.—Per cwt. 100s.-95s.

Sulphur (Flowers).—Ton £16 5s.

,, (Roll-Brimstone).—Per ton £16 5s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £38.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 10½d.

Sodium Chlorate.—Per lb. 4½d.

Rubber.—Para fine, 1s. 0½d.; plantation 1st latex, 1/1½d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co., Ltd.

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Forty Years Ago.

(THE ELECTRICIAN, JANUARY 29, 1881.)

HOOSAC TUNNEL.—Experiments have determined that the attempt to light the Hoosac tunnel by electricity is successful only when the tunnel is clear of smoke.

CITY and GUILDS OF LONDON INSTITUTE.—We notice that a placard setting forth the subjects of examination and other particulars with regard to the scheme for the advancement of technical education has been circulated widely by the above institute, so as to place the subject well before the working classes.

NEW ELECTRICAL PROPERTY OF SELENIUM.—M. Blondlot has presented to the French Academy of Science a note on what he considers to be a hitherto unnoticed property of this interesting metal. To one of the poles of a capillary electrometer he connected a piece of annealed selenium by means of a platinum wire; to the other pole he connected a plate of platinum. On bringing the two metals in contact the electrometer remained at zero; but on their being rubbed together a marked deviation was observed. M. Blondlot thinks that the effect is not thermoelectric, as the current is in the opposite direction to that which would be set up by heat.—"La Lumiere Electrique."

ELECTRIC PAPER.—It is well known that ordinary letter paper if rubbed acquires electric properties. M. Wideman, however, has found that if one takes Swedish filter paper, or this paper laid between pieces of letter paper, and subject it to the following treatment it displays strong electric properties, and sparks several centimetres long can be obtained. The paper should be plunged into a mixture of nitric acid and sulphuric acid of equal volume. The paper thus pyroxilised is then washed in plenty of water and dried. Then rub quickly, having stretched it on a waxed cloth, in order to give it electric properties. Nearly every experiment with static electricity can be accomplished with the paper.

Arrangements for the Week.

FRIDAY, January 28th (to-day).

PHYSICAL SOCIETY.

5 *p.m.* At the Imperial College of Science, South Kensington, London, S.W. Papers on "The Magnetic Separation of the Neon Lines and Runge's Rule," by Prof. H. Nagaoka; "A Method of Demonstrating the Retro-active Property of a Triode Oscillator," by Capt. E. V. Appleton; and "The Quickness of Response of Current to Voltage in a Thermionic Tube," by Dr. D. Owen and Mr. R. M. Archer.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 *p.m.* At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "Fuel Oil," by Mr. W. A. White.

SATURDAY, January 29th.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS. GRADUATE SECTION.

6.30 *p.m.* At the Mining Institute, Neville-street, Newcastle-on-Tyne. Paper on "Diesel Engine Flexibility," by Mr. W. S. Burn.

MANCHESTER ASSOCIATION OF ENGINEERS.

7 *p.m.* At the Memorial Hall, Albert-square, Manchester. Paper on "Cast Iron v. Semi-Steel," by Mr. E. Wheeler.

MONDAY, January 31st.

INSTITUTION OF ELECTRICAL ENGINEERS.—INFORMAL MEETING.

7 *p.m.* At the Chartered Institute of Patent Agents, Staple Inn Buildings, Holborn, London, W.C. Discussion on "Possible Economies in House Wiring," opened by Mr. L. Milne.

WEDNESDAY, February 2nd.

INSTITUTION OF ELECTRICAL ENGINEERS. NORTH-WESTERN STUDENTS' CENTRE.

7.30 *p.m.* At Houldsworth Hall, Deansgate, Manchester. Resolution, "That Alternating Current is Better Than Direct Current for Industrial Purposes," proposed by Mr. D. B. Hoseason.

INDUSTRIAL LEAGUE AND COUNCIL.

7.30 *p.m.* At Caxton Hall, Caxton-street, London, S.W. Lecture on "Some Factors in Present-day Industry," by Prof. A. W. Kirkaldy, M.A.

ROYAL SOCIETY OF ARTS.

8 *p.m.* At John-street, Adelphi, London, W.C. Paper on "Oil Burning Methods in Various Parts of the World," by Mr. A. F. Baillie.

THURSDAY, February 3rd.

INSTITUTION OF ELECTRICAL ENGINEERS, LIVERPOOL STUDENTS' SUB-CENTRE.

7 *p.m.* At the University, Brownlow-street, Liverpool. Lecture on "Lord Kelvin, His Life and Work," by Mr. J. A. Robertson.

FRIDAY, February 4th.

JUNIOR INSTITUTION OF ENGINEERS.

8 *p.m.* At Caxton Hall, Westminster, London, S.W. Lecturette on "Surface Tensions and Some of its Industrial Applications," by Mr. W. H. Balantyne.

ROYAL INSTITUTION.

9 *p.m.* At Albemarle-street, London, W. Discourse on "The Electrical Expression of Human Emotion," by Dr. A. D. Waller, F.R.S.

THE ELECTRICIAN

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Notes.

The Kelvin Medal.

We are glad to learn that at a recent meeting of the Awards Committee, which consists of the Presidents of the principal British Engineering Institutions, the first triennial award of the Kelvin Gold Medal instituted in 1914 as a part of the memorial to Lord Kelvin, was made to Dr. William Cawthorne Unwin, F.R.S. There are some rewards which any recipient, whatever his eminence, is further honoured to receive. There are others which derive the greater part of their glamour from the names of those to whom they have been awarded. It will, we think, be conceded that the Kelvin medal should be a happy combination of both these classes, and that Dr. Unwin should be the first of a long line of Kelvin medallists who will both give to and receive honour from this award. This Dr. Unwin himself undoubtedly does, and it is hardly necessary in The Electrician to say anything about his achievements in engineering, either directly or in the even greater field of teaching others to achieve, but we may quote with approbation the words of the committee that "after their consideration of representations received from leading engineering bodies in all parts of the world," they found Dr. Unwin "the most worthy to receive this recognition of pre-eminence in the branches of engineering with which Lord Kelvin's scientific work and researches were closely identified." We understand that arrangements for the presentation of the medal will be announced shortly, and we hope that they will be worthy of the occasion. It has long been a slur on this country that not sufficient public recognition is given to the great work done for civilisation by engineers. The presentation of the Kelvin medal will offer a chance of altering this.

The Reorganisation of Electricity Supply.

From the report of the proceedings at the public inquiry into the re-organisation of electricity supply in West Lancashire and on the Merseyside it will be gathered that the Electricity Commissioners are making a thorough investigation of the whole situation in that area and that they appear to be inclined to base their decision upon the requirements of the entire district. We sincerely hope that this will prove to be the case, for we have had too much parochialism in the supply industry in the past, and any purely obstructive tactics, whether by local authority or company, should not receive the slightest countenance at this stage. In this particular instance the principal point to be decided is which of the two schemes will be the more economical. Important as this is, however, our sympathies are with Mr. H. Dickinson, the engineer responsible for the larger scheme, who was called upon suddenly for a statement showing how much of the programme he proposed would be carried out in the first, second and third years, how much money would be spent in those years, and how it was proposed to find the money. This sort of conundrum requires time to answer, and we are not therefore surprised that the figures were not immediately forthcoming. In view of the existing state of the law and of the lack of control of the promoters of the scheme over the existing undertakers in the district, it is a little difficult to see how they can ever be forthcoming until the Joint Authority relinquishes the ghostly for the material form, though doubtless approximate estimates could be furnished.

Co-operation the Main Thing.

We notice that nothing definite was stated as to how the transfer of the generating stations was to be effected, but the scheme is based on the acquisition of the existing stations, and the main thing is therefore to obtain the co-operation on an equal basis of the various local authorities in the area, that is to avoid the suspicion of dictation from Liverpool Corporation or from any other authority. We are convinced, moreover, that Mr. Dickinson's scheme, notwithstanding the destructive criticism of some of the counsel engaged, is in the main a good one, and that it would at least effect a considerable economy in the supply of electricity. If the hard-headed manufacturers and business men of Lancashire are once satisfied that they are going to get a cheaper and better supply, they will become customers of the Joint Authority and the demand for electrical energy will grow rapidly. This is already, we are glad to see, the declared attitude of the directors of the Manchester Ship Canal Company, and their example is a good augury for the success of what we expect will be the first Joint Electricity Authority to be formed in England. Though the inquiry has been adjourned to a later date in order to prepare proposals for financing the scheme, we do not anticipate any difficulty on this point provided the Electricity Supply Bill is passed within the next two or three months.

Electric Traction in Bavaria.

In pre-war days Germany used to be held up to British electrical engineers as a shining example of efficiency in all branches of the industry, and particularly in the field of electric traction. If, however, we admit this superhuman quality in our late enemies, some explanation is surely required for the small progress which has been made in converting their railways from steam working. The most obvious explanation is, of course, the war, but an interesting article in a recent issue of the "Railway Gazette" shows that, as far as Bavaria at least is concerned, this is not the only reason, and that the delay is also due to bureaucratic interference, and to opposition from vested interests. As long ago as 1908 we described in The Electrician an extensive scheme for the application of electric traction to certain portions of the Bavarian State railway system. Up to the present, however, nothing has yet been done, though financial considerations are now bringing the matter to a head, and American interests are arranging for a loan of 20,000,000 marks, which sum is to be used for carrying out the electrification of the railways, and for the development of water power. In other words Bavaria has been reduced to pawning her water power and her railways to the United States in order that they both may be developed in a way necessary to her well-being.

The Export of Water Power.

Before this solution was arrived at it had been suggested that Switzerland might come to the help of Bavaria by supplying her with electricity from her surplus water power. For various reasons this solution is no longer possible, and indeed Switzerland is also thinking of following Bavaria's example and of negotiating a loan in the United States for the purpose of developing her water power resources for her own use. It is hardly likely that either Bavarian or Swiss interests will view this arrangement with any great complacency, and that attitude is likely to be shared by British financial houses. Indeed we are glad to learn that steps are being taken by certain British companies to tempt the Bavarians with a lower rate of interest than the Americans seem able to offer, and we sincerely hope that this chance of obtaining what should be a most fruitful market and useful sphere of activity will not be neglected.

Increases in Gas Prices.

There is at the present time great consternation among gas consumers all over the country, at which we are not surprised. For during the past few months some of the supply companies have been frankly putting up their prices while others, following a course permitted by recent legislation, have been changing over to new systems of charging, a policy which has the dual result of puzzling the consumer and of more or less camouflaging an increase. Now, while we have always deprecated comparisons between the cost of electricity and gas based purely on the selling prices of these commodities, there are times when such comparisons are not without their utility, and at present there are many cases where it can be shown there is a direct saving on the revenue account by using electricity for domestic purposes, rather than gas. The figure of merit, given by dividing the price per unit of electricity in pence into the price per 1,000 cubic ft. of gas in pence, is one way of doing this. Where this figure is between 24 and 30 a domestic electric load should be easily obtainable, and the ease increases as the figure of merit rises. Supply engineers who are anxious to develop their domestic load might note and act accordingly.

A Word of Warning.

A word of warning is, however, necessary in this connection. Some undertakings, especially the smaller ones, see in increased gas charges only an excellent chance of revising their own tariffs in an upward direction. This is doubly a bad policy, for such undertakings usually operate in areas where there is a fair lighting load, but so far little or no domestic load. To increase the lighting charges is, therefore, to offend, and perhaps to reduce, the majority of their best paying consumers, while to increase the charges for heating and cooking affects a very much smaller proportion of their revenue. Yet a little consideration will show that to act in this way is a most short-sighted policy, as while the domestic load is no doubt small at present (even smaller, perhaps, than it need be), it will inevitably be the load which will develop most in future, and taken in hand even now will prove a very satisfactory revenue-producing proposition. These, then, are good reasons for its encouragement, and if any revision of prices is necessary it would be better to deal more drastically with the purely lighting consumer, whose load factor is low, than to stunt the growth of a very promising plant before it has had time to develop.

The Legality of Retrospective Increases.

This argument applies with greater force to the procedure which has been adopted at Kingston-on-Thames, where not only have the charges for electricity been increased under the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, but these increases have been dated back to September 30th last. Admitting for the moment that the increases are necessary to meet the higher costs of fuel, salaries, wages and other charges, this is no excuse for the fundamental injustice to the consumer which is contained in the procedure which we have outlined, and we very much doubt, besides being unjust, whether it is legal. In pre-war days, certainly, before commencing supply electricity undertakers were required to give notice to the local authority by what methods they proposed to charge and to give a month's notice both to the local authority and to every consumer before that method was changed. Why should it be any different now? War conditions, D.O.R.A. Regulations and departmental orders have accustomed us to high-handedness from both Government and municipal authorities, but surely the time has now come when all such irregular and bureaucratic methods should be discarded and we should return to governance according to the common law of the land. So strongly do we feel on this subject that if we were consumers in the Kingston area (which we are glad to say we are not) we should be disposed to challenge not only the legality of the order but the decision to make the charges retrospective. At its best it is very bad business.

The Need for Automatic Train Control.

The accident which occurred between two passenger trains between Vauxhall and Waterloo stations on the London & South Western Railway on November 20th last is of interest to electrical engineers for two reasons. The minor is that one of two trains involved was electrically-operated, and the major is that the accident could have been prevented had electrical signalling apparatus been more widely employed. At the point where the accident occurred the two up tracks of the Windsor line converge into one, and during the rush hours in the morning, when the accident occurred, it happens that two trains often arrive at the point of convergence almost simultaneously, and delay to one or other occurs. On this occasion "line clear" had been given to the electric train, when a steam train overran signals at danger, and collided with it, slightly damaging one of the coaches. Fortunately the promptness of the signalmen concerned and of the guard of the steam train prevented the accident being very much more of a disaster than was actually the case. We are glad to see in his report that the inspecting officer, Major G. L. HALL describes the accident as one which would have been prevented by the use of a system of automatic train control, and he proposes to bring it to the notice of the Committee which is sitting to consider this subject. We hope it will help to arrive before long at a definite conclusion on this important question.

Protection of Ratepayers.

IN these days of rapidly rising rates and extravagant public expenditure any proposals for checking increases are welcome. It is doubtful, however, if some of the recommendations of the Select Committee on the procedure governing Bills which involves charges on the rates will do much to help the unfortunate ratepayer, and though it is a healthy sign that our pundits admit the ratepayer needs protection, the proposal to allow a *locus standi* against a private bill to 100 electors or to one-twentieth of the total number, will be more an encouragement to wilful obstructionists of useful public schemes than anything else. At present the public are sufficiently protected by the Borough Funds Acts, 1872 and 1903, and by other acts as well by the standing orders of both Houses of Parliament. That this is so can be seen by the fate of several of this year's private bills for many of the most useful measures relating to tramways, electricity supply, gas, &c., have been greatly modified at recent meetings of the ratepayers.

Public Bills and Government Departments.

WHAT is really needed is greater vigilance over the public Bills, and especially those introduced by Government departments. The proposals in some of these measures frequently involve a charge upon the rates, but it is seldom that the official responsible for the drafting of the measure troubles himself about the cost of giving effect to his pet ideas. For this reason we are glad that the Committee recommend that in regard to bills which include charges upon the Exchequer, and also charges (mandatory or permissive) on the rates, the discussion and decision relative to the rate charge should be taken with the charge upon the Exchequer in the usual financial resolution, both in committee and upon the report stage. In Bills where the charges fall only upon the rates, they also suggest that a financial resolution should be moved in the committee of the whole House subsequent to second reading, and that the estimated rate expenditure for the year should be included in the memorandum issued by the Chancellor of the Exchequer before the Budget. Though the Committee did not consider the question of the growing charges imposed upon local authorities by some of the administrative regulations of Government departments, this is an important matter which will also have to be considered by those who wish to economise the resources of the country.

The Tramways Inquiry.

THE Court of Inquiry which has been assembled under the chairmanship of Sir DAVID HARREL to inquire into various questions which have arisen out of the tramway employees' claim for a national increase in wages has so far disclosed an enormous amount of information, which will rather obscure than elucidate the points at issue. If this is not the object of this flow of talk (we are not quite sure what the object is), we recommend all those concerned in putting forward the employees' case, from Mr. BEVIN downwards, to study some elementary book on the rules of evidence, or, if that be too dull, to read or re-read the proceedings in the immortal trial of Bardell *v.* Pickwick. For really, in a wages question, to vilify the various tramway authorities because they refuse to discuss the proposed increases with the men, to say that this policy is wrecking the whole principle of Whitleyism, to describe the past financial policy of the various tramway undertakings as all wrong, and to appeal to the sentimental side of the Court by producing tramwaymen's wives to testify how difficult it is for those engaged in this industry to live upon their present stipend, while no doubt excellent stage management, does not really advance the cause it is supposed to assist. This is not to say that we do not welcome the fullest investigation into the present condition of the tramway industry, because such investigation can only disclose the really deplorable state of affairs into which many undertakings have fallen.

The Real Question.

BUT the present Court, which has no means of enforcing its decisions and recommendations, must not forget that the real question that it must determine is the ability of the tramway undertakings to pay further increases. To recommend increases without being sure of that ability would be fatal to both parties. For these undertakings are not directly productive concerns, and it is not, therefore, possible for the employees to secure higher wages for themselves and financial stability for the concern by increased production. It is true that increased wages up to a certain point can be counteracted by raising the fares, but the limit to this policy is soon reached, and already the effect in some cases has been to reduce the number of passengers carried and to bring about a falling off in the revenue. Any further increases would, therefore, mean a further progress downhill, especially in smaller towns, where passengers will find it cheaper and more healthy to buy a bicycle on the instalment system than to travel in the cars. It is, therefore, becoming more and more evident that an elementary course in economics is necessary for those who are advising the tramwaymen to ask for more wages at the present time. If this inquiry makes this clear, it will at least have fulfilled one important function. But we are not very optimistic.

The Re-Modelling of the National Council.

THE movement towards the reconstitution of the National Council for the electricity supply industry by drawing its members from the thirteen district councils, to which we referred last week, has, we understand, a parallel in the Whitley Council for the non-trading municipal services. The district councils in question object to accepting the ruling of their national council on the score of inadequate representation on that Council. That is, there is in both cases a feeling that the National Council should be a body "derivative" from the district councils and not a separate constitution. Whether or not this result will be obtained in the electricity supply industry is now to depend on the votes of the district councils. We believe opinion is very much in favour of reconstitution either on these lines or on the lines of the alternative proposal which has been put forward by the employees' side of the National Joint Board of Employees and Staff Members of the electricity supply industry in No. 6 area.

This proposal takes the form of a recommendation that all future questions of conditions of employment, remuneration and other vital matters should be referred to the District Joint Boards of the National Board before any definite decision is reached. The question is the more interesting as it is likely that what happens in the electricity supply industry will not be without considerable influence on events in the history of the municipal non-trading councils which we have already mentioned One thing is certain, that the widespread concern which is being taken in this question at least shows that the Whitley scheme is in no danger of languishing in the electricity supply industry, and this in itself is a good thing.

Mechanical Standardisation of Motors.

The difficulty with the Englishman is that, as Mr. Jerome K. Jerome once remarked, "he has too much ego in his cosmos." This drawback is particularly evident when the mechanical details of motor design and construction are considered. Standard voltages and frequencies are, it is true, ideals for the future, and we have already made some advances in connection with such questions as temperature rise, but a good deal more might be done than is being done in standardising such things as brush holders, oil rings, bearings, heights of shaft centres and other similar details. The present variety, while a testimony to the ingenuity of our designers and manufacturers, is really only another way of building up costs and lessening production at a time when it is eminently necessary to reduce the one and raise the other. Such a standardisation would for one thing mean a reduction in the cost of labour, and for another the elimination of a number of unnecessary patterns, jigs and tools. Simplification is much harder to achieve than complication, but is a point to which a good deal of attention might well be paid at the moment.

Electro-Textile Progress.

This issue of The Electrician is the third that we have specially devoted to a consideration of the application of the electric drive to the operation of textile machinery. We have been told that this is quite the wrong time to publish such an issue, because the textile industry of this country and the world at large, for causes into which we need not go, is in the doldrums, and that the revival which seemed a week or two ago to be imminent has turned out only to be a false start.

A Way out of the Slump.

But while agreeing that the textile industry is experiencing a slump of the most acute kind, we cannot admit this to be any reason why we should not discuss the part which electricity is playing, and is likely to play, in the development of that industry and why we should not show how a good deal of the present depression may be alleviated by the more general employment of the electric drive. Indeed, if there is one thing more than another which stands out clearly in the articles and information which we publish in this issue it is that after a great struggle the electric drive has proved its right to a place in the textile industry and that present conditions, though this may not be immediately evident, will only serve to emphasise its usefulness. Though, therefore, conditions are very different from what they were this time last year and we can no longer write that the textile industry is booming; and while we have, on the face of it, every reason for being pessimistic, we can assure our readers that we are, as a matter of fact, quite optimistic.

Electricity the Best Form of Motive Power.

In our last textile issue we also made the statement that it had been proved without a manner of doubt that electricity was the best form of motive power to use in a textile factory. That statement still stands in all its truth and is now so evident that it is hardly necessary to enlarge upon it further. It may, however, be said that the success of the electric drive is not entirely due to economic reasons, but is, in fact, a result, as Mr. J. R. Randles points out in his article on another page of this issue, of the study of the application of the electric drive to textile mills along true lines of research. Much of this preliminary work, apart from its bearing on the success or otherwise of the employment of electric driving, may eventually result in changes in textile machinery of a far-reaching character, especially as the time is now coming when more and more true electric mills, like that which is now being erected at Rochdale by the Dunlop Rubber Company, will be completed in which full advantage can be taken of the economies and conveniences given by that form of drive in a way that has not been possible where conversions or semi-conversions of older mills have been the rule.

Many Interesting Problems to be Solved.

But satisfactory development means that there are still many interesting problems to be considered and solved. There is, first of all, the question of speed, to which we referred last year. As regards constancy of speed, there is no doubt that the electric drive, whether it be applied to individual machines or groups of machines, offers advantages which are obtainable in no other way. This point is discussed in all its bearings and from many points of view in several of the articles which are published in this issue. Indeed, like the question of whether it is best for a mill to install its own generating plant, or whether it is better to obtain a supply from the public mains, it is a perennial problem which, whatever its practical value, can always be theoretically discussed without becoming dull.

Experience, however, goes to show that the individual drive is being increasingly used for light work and even, as Mr. G. F. Sills points out, for heavy work, mainly because it offers advantages which may be roughly summarised as follows: a larger output per loom, a reduction in the number of breakages owing to irregular drive, a reduction in the time lost in stoppages, a cleaner product owing to the absence of oil and dirt from overhead bearings, and a freer atmosphere, while at the same time a better quality of fabric is woven and power is only consumed while the machine is running. In addition, the absence of belts and overhead gearing makes the weaving shed a lighter and pleasanter place to work in. It may therefore be said that the individual drive is not unlikely to be the drive which will be generally adopted in future, though where old mills are being converted to electric working, group operation may continue to be used for some time, especially on ring frames.

The Question of Gearing.

An interesting question in this connection is one which is discussed both by Mr. Sills and by Mr. G. S. Sharman: that of the best type of gearing to use between the motor and the machine which it is driving. Mr. Sills gives a number of reasons why it is better to use modern machine-cut gearing rather than the belt drive, and supports these reasons by actual examples of work that have been satisfactorily carried out in this way. These reasons may be summed up in the two phrases, "economy" and "increased production." Mr. Sharman argues on the same side, pointing out that modern gearing is very different from that employed at the time when it was not unusual to find a 20-ft. wheel on an engine driving one or more smaller wheels on the second motion shaft, the whole transmitting power to the mills with the generation of a great deal of noise and vibration and losses as high as 50 per cent. of the total power developed. Modern tooth gearing may, in fact, be efficiently used practically to the exclusion of rope and belt driving, for the reason that it gives a more positive and quieter drive and eliminates errors due to speed variation.

Daylight, Handling and Heating.

The more general use of electricity in textile mills will also mean that the various shops can be so laid out as to utilise the greatest possible amount of daylight, and to employ artificial illumination in the most efficient and economical way. This is by no means the case at present. It will also mean that materials can be better dealt with and the use of electric heating developed. The former question is one that modern labour difficulties will force to an almost automatic solution, and the advantages of so dealing with goods will thus become almost equally obvious to textile manufacturers, as they are to readers of The Electrician. Electric heating is not likely to find its place without a greater struggle, for reasons not unconnected with the conditions under which textile work is best carried on. Nevertheless it is already being employed, and we are interested to learn that there is at least one mill now in course of erection where electric heating will be adopted. We have no doubt that the results obtained there will lead to this progressive example being followed in many other cases.

Details of Power Consumption.

The question of the power consumed in the various textile operations is a matter about which we require more information and upon which, therefore, research might very well be undertaken. As Mr. Randles rightly says, co-operation between mill designers and electrical engineers is of the utmost importance, so that each may learn the lessons which there are undoubtedly waiting to be learned from the other. Another argument in favour of accurate measurement of the power consumed not only for purposes of test, but as a matter of routine, is that in no other way can the machinery be so easily maintained in good running condition, while the comparison of various makes of the same class of machine is also easily effected, and unnecessary expenditure thereby avoided.

The textile industry and the problems which have to be solved by those interested in the introduction of the electric drive into it, are, however, not confined to this country, and the two articles by Mr. Frank Nasmith and Mr. W. D. Fox respectively, which deal with the way in which this work is being carried out in the United States, and in Germany, are therefore likely to be of interest. While going outside what may be called the strictly textile field we also publish articles by Messrs. T. Woodhouse and P. Kilgour on the application of electricity to driving machines in the jute industry, and by Mr. E. E. Fuller on the important allied question of the use that can be made of the electric drive in paper making.

The Electricity Supply Engineer's View.

Turning from the manufacturer's to the supply engineer's point of view, it will be found from the opinions that are given on another page of this issue, that while there is not a little natural pessimism there is also a good deal of optimism, and it is interesting to note that in spite of the many arguments against the electric drive, arguments which are sometimes so good as to appear almost unanswerable it is coming more and more into use, and is likely to show an ever increasing development. In fact, as Mr. Rudd, of Rochdale, says, if the evidence against the possibility of extending the use of electricity to the textile trades had been true, most Lancashire electricity supply engineers would be comfortably supervising a 2,000 kw. to 3,000 kw. station, instead of being occupied during the whole of their waking hours in considering how they could best satisfy the ever-increasing demands on their plants. Mr. Rudd attributes the greater use of the electric drive to the forced reduction in the hours of working in the mills, a reduction which has meant a corresponding decrease in production, and to the subsequent necessity on the part of the textile manufacturer to install additional machinery to counteract this. To erect steam engines as was done in the past would now mean a capital expenditure which is quite prohibitive. The textile manufacturer, therefore, approaches the supply engineer in a spirit of pessimism to find out to his surprise that he cannot only save capital, but revenue and energy as well, with the added advantages of increased production and an entire freedom from all responsibility as to power supply.

With this attitude Mr. W. J. H. Wood, of Bolton, and Mr. C. D. Taite, of the Lancashire Electric Power Company, entirely agree, and there is no doubt that where care is taken to consider each case on its merits, and a detailed study is made of the equipment best likely to solve the particular problems met with, especially with regard to grouping, more and more textile manufacturers will be encouraged not only by first-hand evidence, but by the results which their competitors are obtaining to adopt the electric drive. This is once again a case where the war has assisted the electricity supply industry.

Every Reason for Optimism.

We therefore have ample reason for the optimism which we expressed above. The only obstacles which at present seem to stand in the way of a really great development of the electrical and textile industries in conjunction, once the present depression has passed away, is the shortage of generating plant and motors which is being generally experienced, and the prices which are being charged for electrical equipment of all kinds. It is not part of our duty, nor is it necessary for purposes of this argument, to say whether these prices are justified or are the lowest that can be charged, but it must be pointed out that financial stringency, especially in the textile industry, is so acute at the present time that common prudence forbids the incurring of any but absolutely unavoidable expenditure. High prices are, in certain districts at any rate, seriously militating against the development of the electrical drive in the textile industry, and will continue to have an increasingly harmful effect as time goes on. On the one hand they render it necessary for electricity supply undertakings to increase their charges, and on the other they make potential consumers shy of sinking so much capital in the purchase of electrical apparatus. It is easy to say that this is but a temporary state of affairs, but it must be remembered that ill effects caused by these high prices will persist for some time, and if therefore during the next few years cheap prime movers are obtainable either from manufacturers in this country or from abroad, it will probably pay textile manufacturers to install them rather than the electrical drive. These two points must therefore receive attention without delay, otherwise textile manufacturers will be, reluctantly enough it be said, turning to some other form of drive, which, though not so efficient as the electric motor will at least enable them to produce more goods then they can do at the present time. Prevention of this lies in the hands of the electrical industry generally and steps towards prevention will bring about the necessary cure.

The Individual Gear Drive for Heavy Looms.

Recent Interesting Developments.

By G. F. SILLS, A.M.I.E.E., A.Amer.I.E.E.

IN view of the considerable amount of development work which has been carried out during the last ten years on the individual electric drive for weaving sheds, a general description of the latest improvements of this type of drive will probably be of interest. The individual motor with belt drive, using a spring suspension type base, was easily adaptable for light looms where the picks were relatively high, that is to say, not below 175; otherwise the belt drive ratio was too high for successful working, in view of the fact that alternating-current loom motors, for commercial reasons, were standardised for a running speed of about 965 revs. per min.

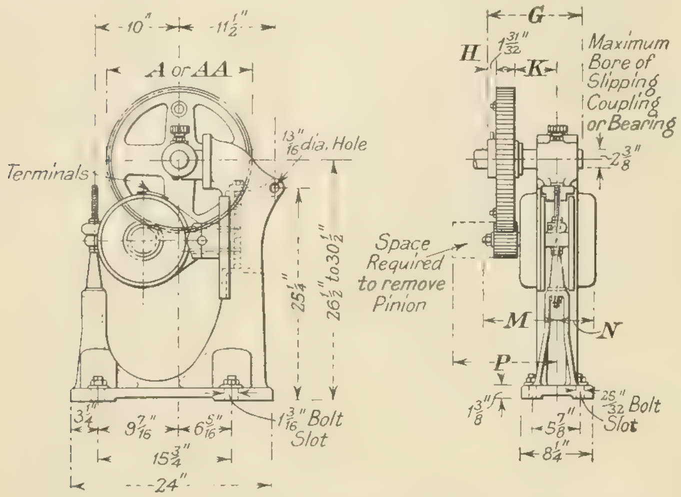

FIG. 1.—ENGLISH ELECTRIC COMPANY'S ¾-H.P. to 1¼ H.P. STANDARD LOOM MOTOR ARRANGED FOR GEAR DRIVE.

For picks below 175 the gear drive was developed, was successful in operation, and is to-day being used on many thousands of looms. When properly applied, the gear drive, together with its slipping clutch, the use of which will be explained later, is a drive superior even to the individual belt drive, as it has been found that it gives a better weaving result and a higher production than the latter. This is only what would be expected, since the gear drive approaches most nearly to the ideal arrangement of a motor direct coupled to the loom shaft.

THE ADVANTAGES OF THE INDIVIDUAL DRIVE.

Perhaps it would be just as well to state briefly the advantages of the individual electric gear drive. These may be summed up as follows:—

1. A larger output per loom is obtained. This can be safely taken as an increase of about 10 per cent., and even in some cases of 25 per cent. This is due to the increased average speed, and consequently a greater number of picks in a given period. As the motor runs at a steady number of revolutions, the maximum output is obtained from the loom during the whole time of operation, whereas it is well known that with the ordinary overhead belt drive the nunber of picks varies due to the torsional vibration of the shaft, flapping of belts, variation in belt slip due to atmospheric and other conditions.

2. The regular speed it is possible to obtain reduces the number of warp and weft breakages very considerably. The time absorbed by stoppages is considerably reduced owing to:—

(*a*) The shorter time taken by an operator to start the motor as compared with the method of moving the belt from a loose to a fast pulley.

(*b*) The high starting torque of a loom still further assists in securing prompt starts, and makes it possible to start the loom satisfactorily without assistance with the lay in any position.

3. A cleaner woven product, due to the absence of oil and dirt from overhead bearings, is produced. This is of great importance in the manufacture of delicate fabrics.

4. A cleaner atmosphere prevails generally, as there is not the disturbance of the air present in the old-type of shed with the long overhead belt drive.

5. A better quality fabric is woven, due to the more even turning moment.

6. Power is only consumed while each loom is running, so that unnecessary friction losses are avoided, due to only part of the looms being in operation during the periods of trade depression, or waiting for yarn, beams, &c. This feature saved the country a considerable amount of coal during the war, when it was compulsory to only run a certain percentage of the looms in a shed.

It is not the intention here to go into the details on points summarised above, although it might be stated that plenty of evidence is available from actual use to uphold the advantages claimed for the individual gear drive. To give an instance of this: The largest electrical individually-driven weaving shed in the country up to the time of the Armistice had a matter of 1,162 plain narrow reed space Lancashire type looms individually belt driven, each with its own motor. A large exten-

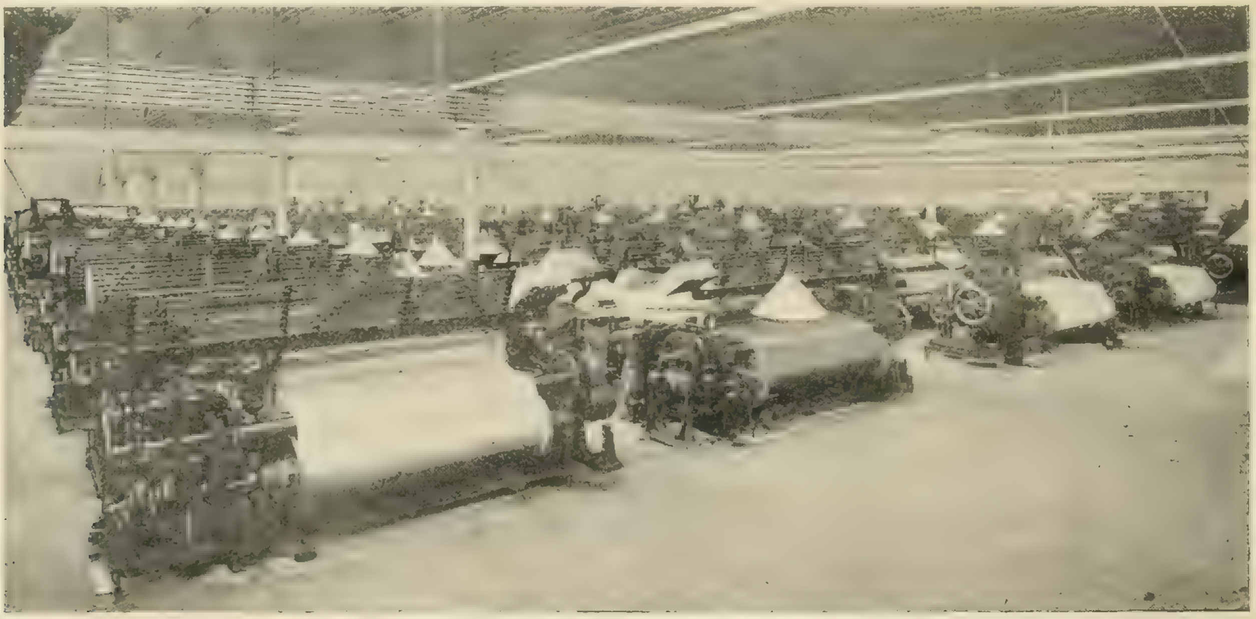

FIG. 2.—PART VIEW OF INDIVIDUAL GEAR-DRIVEN EQUIPMENTS IN A BRADFORD WEAVING SHED.

sion was contemplated. The owners went into the matter carefully, and finally ordered a further 570 individually driven equipments, but with the more expensive gear drive, in spite of the fact that the looms were of a relatively cheap type, and were weaving an article which did not command a high market price.

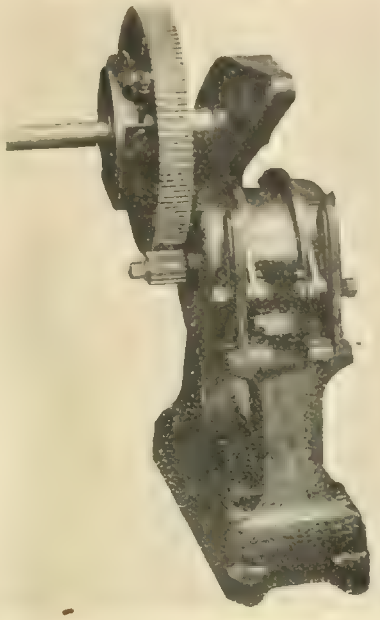

Fig. 3. Front View of English Electric Company's Extra Heavy Type Individual Gear Drive for Heavy Looms.

The Individual Drive in Silk Manufacture.

Fig. 1 shows a view of the latest electrical individual gear drives, suitable for equipments up to $1\frac{1}{4}$ H.P. Many hundreds of this particular construction have lately been supplied to the largest firm of silk manufacturers in the United Kingdom. A number of the equipments just referred to are only $\frac{1}{2}$ H.P., from which it is easy to infer that the buying firm satisfied themselves beforehand of the additional advantages of the individual gear drive over the individual belt drive, viz., increased production and better quality material, as it has been customary in the past for $\frac{1}{2}$ H.P. individually-driven equipments to be of the belt type.

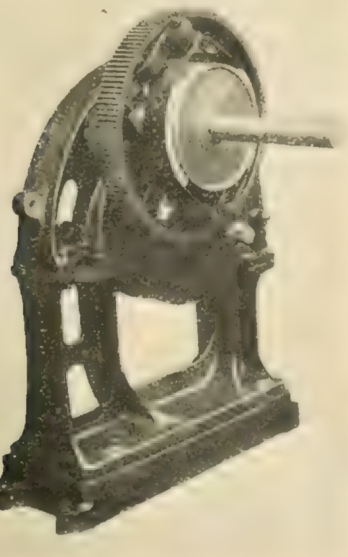

Fig. 4.—Partial Back and Side View, illustrating the Slipping Clutch of the Drive shown in Fig. 3.

This form of gear drive with its pedestal is an improvement on a similar type of which a great number has been manufactured in the past, as it has been designed to be much more substantial mechanically. The pedestal section is stiffer, and from the point of view of convenience both to the buyer and to the manufacturer, the pedestal casting is so arranged as to give heights of centres from the floor varying between $26\frac{1}{2}$ in. and $30\frac{1}{2}$ in. This means that the pedestal casting for the whole of the looms in a shed between the horse-power range given in Fig. 1 would be the same. It will be noted that the motor is held to the pedestal by means of a heavy clamp, which joins the hinge pin on to the outside of the motor lugs, this clamp being adjusted for height by means of a screw. For height of centres from $28\frac{1}{2}$ in. to $30\frac{1}{2}$ in. the pedestal bearing remains in the position shown in Fig. 1, but for height of centres from $28\frac{1}{2}$ in. down to $26\frac{1}{2}$ in. the pedestal bearing is reversed.

Other improvements are the stiffer conical pin which holds the motor clamp in position, and an eye bolt which is supplied to fit on to this pin for carrying the stiffening rod back to the loom frame. A boss is also provided on the pedestal for carrying a second stiffening rod to the loom frame. The centres of the holding down foundation bolts are the same as those on the old type pedestal, thus allowing the new type pedestal to replace the old type pedestal without much alteration. This pedestal is also designed to allow of a loom crank shaft speed of 76 revs. per min. The above gear drive is suitable for the ordinary loom.

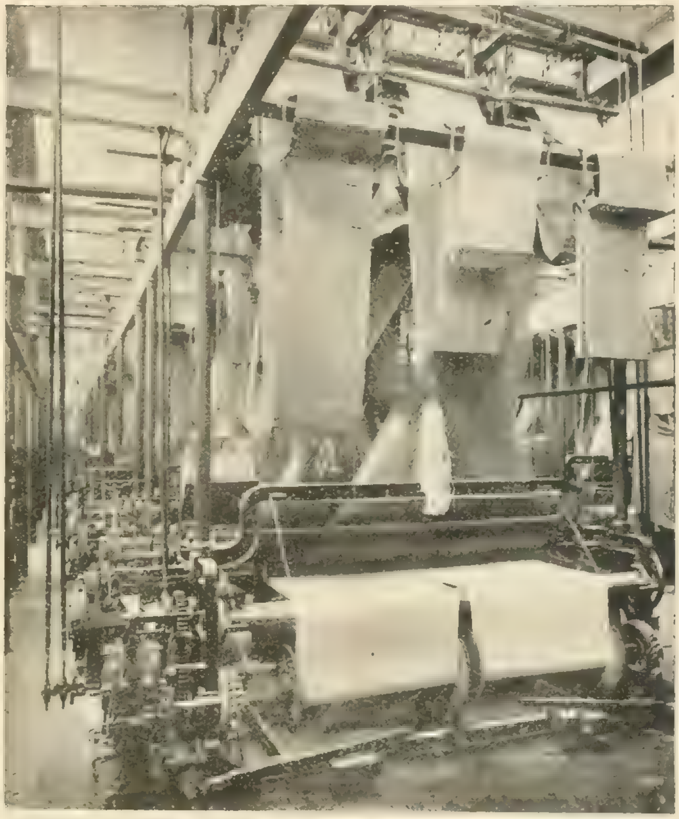

Fig. 5. View of the Individual Extra Heavy Gear Drive applied to Jacquard Looms.

The Drive in the Weaving Shed.

Fig. 2 shows a view of a weaving shed in Bradford equipped with the individual gear drive. This has given the utmost satisfaction to its owners since the beginning of 1916. This shed is particularly interesting inasmuch as most of the looms were originally belt-driven in another shed, and mostly of different centre heights, varying lengths of shaft projections and different diameter shafts. Some of these shafts were in bad condition. The existing looms were of different makes, some of them had dobbies, some had drop boxes, others had circular boxes.

Although the shaft projections were, in a number of instances, shorter than the standard projection usually required for the individual gear drive, three methods were employed to overcome the difficulty. Firstly, $\frac{3}{4}$ in. was turned off the projecting boss on the inside of the slipping clutch, and, if this was insufficient, the pedestal bracket carrying the overhang of the loom shaft was cast with an offset. If this was still not enough the outside end of the bracket in question had its internal diameter enlarged, for a matter of a further $\frac{3}{4}$ in.

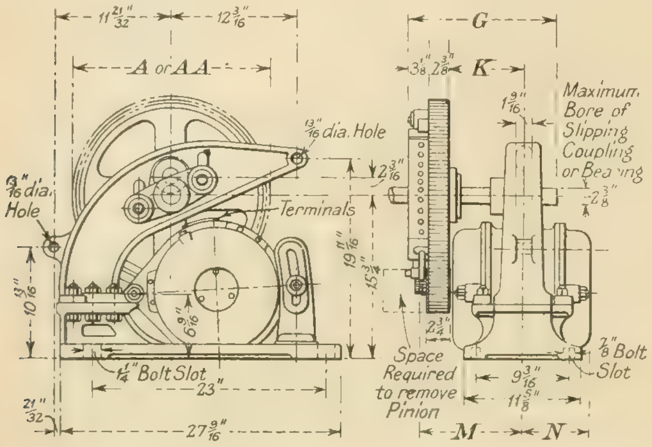

Fig. 6. View of Extra Heavy Individual Gear Drive for Looms with Low Centres.

This shed had been laid out with unusually wide alleyways, and gives a particularly spacious appearance, in fact, visitors have remarked that it is probably the finest shed of its size in the country. The weaving manager of one of the largest concerns in Lancashire made a thorough investigation of this shed, and finally stated that the gear drive in question was doing all that had been claimed on its behalf, and as a result an order was given by his firm for gear driven equipments for a new shed. Other individually gear driven sheds in Bradford might be mentioned which have given every satisfaction, and at least one of them has resulted in a repeat order for extensions after over 4 years' operation. We may also mention the case of a weaving manager from Paisley who contemplated individual belt-drive, but as a result of his visit to the individual gear driven shed referred to above immediately gave an order for his looms to be fitted with individual gear drive.

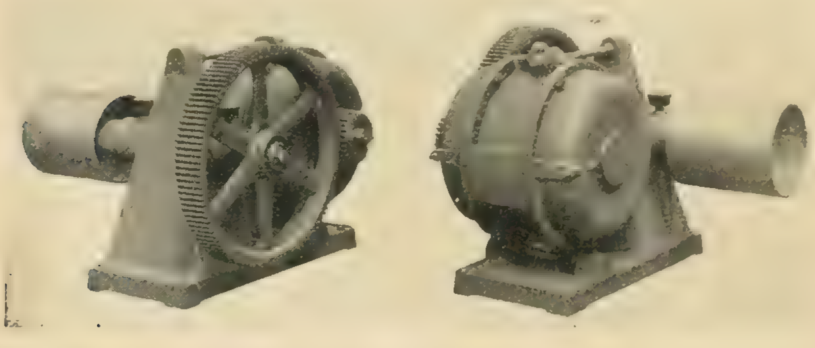

Fig. 7.—View of Loom Motor adapted to Reduction Gear Drive with Countershaft for Preparation and other Machinery.

The Drive for Heavy Looms.

Where the power required is over $1\frac{1}{2}$ h.p., and particularly where heavy looms have to be driven, an extremely substantial form of drive has been developed, as shown in Figs. 3 and 4. This has been in use for a number of years. It will be noticed that whereas in Fig. 1 the motor is supported centrally, in this arrangement for the extra heavy type gear the motor has special end shields, which are clamped to two side supports coming up from the pedestal. The advantage of this is that the shocks and power are transmitted from the pinion to the ball bearing, thence to the end shields, and direct to the pedestal without in any way straining the stator of the motor; in the case of the gear drive for the ordinary loom, as shown in Fig. 1, the shocks are taken through the centre pivot fixed to the stator of the motor. One might remark here that the arrangement in Fig. 1 is quite satisfactory for ordinary looms.

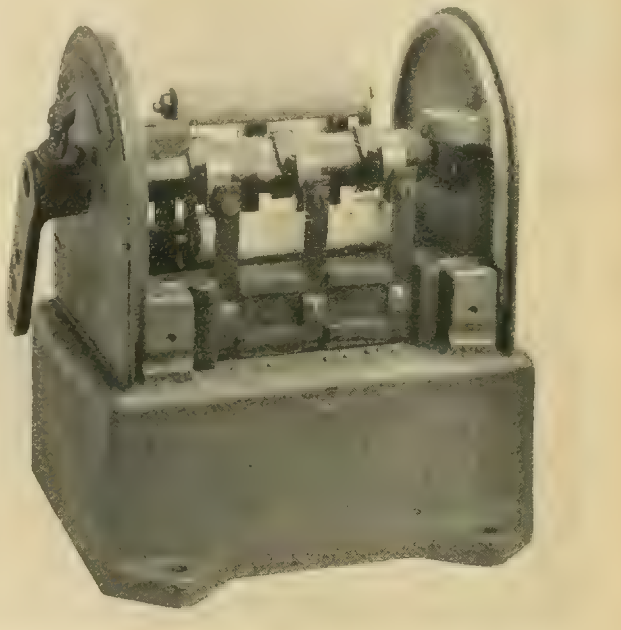

Fig. 8. -View of the English Electric Company's Latest Loom Switch for use with Loom Motors.

Figs. 3 and 4 clearly show the bosses at the front and back at the extremities of the pedestal arm. These are suitable for taking $\frac{3}{4}$ in. tie rods to lock the pedestal to the loom frame, so that the relative movement between the spur wheel and the pinion on the motor, even in the event of heavy vibration, is kept quite safely small. The motor can be swung up or down depending on the number of teeth required on the motor pinion, and it is possible to arrange for a very low ratio of reduction to meet all commercial requirements.

Jacquard Loom Drives.

Fig. 5 is a view of this extra heavy type of gear drive, which has been running successfully for the last 6 years, driving heavy Jacquard looms with double beams, and two orders have been given for duplicate equipments.

A remarkable instance of the reliability of loom motors can be given by referring to the first large individually driven shed installed in this country, started in 1911, where 800 individually driven equipments have been installed. The manager of the shed in question informed the writer that during this period they had not returned more than 12 motors to the makers for repair. On the basis of using 800 motors for 9 years, we arrive at the extraordinarily low figure of 0·16 of 1 per cent. motors repaired per annum. Another proof of the extraordinary small up-keep cost extending over a number of years for the shed in question is afforded by the following facts:—The manufacturers of the motors agreed to undertake their maintenance for the sum of 1s. per motor per year for 10 years. At the end of the ninth year it was suggested to the makers of the motors that they could have the option of cancelling the agreement for the tenth year, from which it obviously follows that the weaving shed proprietors were of the opinion that the up-keep would cost even less than 1s. each per year for the tenth year.

HEAVY CANVAS LOOMS.

The extra heavy type of gear drive has now been successfully applied to heavy canvas looms, using very low counts, and one well-known firm of this class of production has equipped one of its sheds with the gear drive shown in Figs. 3 and 4. They have also other types of drives in their different mills, and are satisfied they are getting an increased production of over 10 per cent. and a first-class product. This heavy drive can be applied up to 3 H.P., and the writer has seen a very heavy loom started up without any hesitation with the crank shaft on the dead centre. and with the lay in the front position; that is to say, the hardest possible position for starting. This was effected with a motor using a pinion giving a greater number of picks than required for actual working. This form of drive has also been successfully applied to carpet and lace looms.

It would not be permissible to use a gear drive of this description unless some means were provided for absorbing the shock on the motor pinion in the event of a "bang off," as there is considerable momentum stored in even a small motor rotor running at 965 revs. per min. This is accomplished by the slipping clutch, shown in Fig. 4. The central cast-iron boss is a light force fit on the loom shaft to which it is keyed, and is also provided with three studs. The spur wheel is bored to be a loose revolving fit on a portion of the central boss, previously referred to, but is kept from turning on this by the spring bands which are adjustable for tension. At starting there should be no slip, and the correct setting is obtained by making a chalk line to cross the spur wheel and central boss with the loom stationary. The loom should be started up and stopped in the ordinary way, when the spur wheel and central boss should still be in the same relative position to one another. If there are any signs of slipping, which is clearly indicated by the chalk line the springs should be tightened until there is no movement. With this setting there should be a relative movement of 1 in. to 1½ in. on a bang off.

DETAILS OF DESIGN.

The small pinions on the motor are usually of mild steel in the extra heavy type drive, and compressed paper for the ordinary type. Samples of the latter have been shown to the writer that have given 3 years' service, which is very satisfactory. It is a simple matter to check occasionally the clearance between the spur wheel and motor pinions by means of a small gauge made out of a piece of wire. The loom motors are specially made for driving looms, are totally enclosed with ball bearings and grease lubrication requiring no attention for long periods. These motors are greatly superior to the usual commercial motor; for instance, the efficiency and power factor of a 1-H.P. loom motor is 87 per cent. and 0·8 respectively, as against 66 per cent. and 0·69 of the commercial motor of the same type. The starting torque of a loom motor is about 2½ times to normal type. The temperature rise of the loom motor is only 35°C., as against 50°C. of the same type of commercial motor. It is of interest to note that these motors, because of their superiority, have been used for quite different work to that for which they were originally intended, viz., in oil refineries, margarine manufacture, for which their characteristics especially fit them. Fig. 6 shows this heavy form of drive with height of centres as low as 15¾ in., otherwise the drive is generally the same as that shown in Figs. 3 and 4.

Fig. 7 shows a further development of the high efficiency, high power factor, high starting torque loom motor up to 3 H.P., with reduction gear and a belt drive which can be used for preparation machinery. In this case the countershaft can be made to run at somewhere round 200 revs. per min., thus enabling very low driving speeds to be obtained. A decided advantage of this arrangement is that the reduction ratio can be varied by substituting a smaller or larger motor pinion as desired.

A NEW LOOM SWITCH.

Fig. 8 shows the latest developments of the loom switch as used in conjunction with the individual gear drive, where it is considered advantageous for the motor to be stopped and started in conjunction with the loom in preference to having the motor continually running. The switch is shown in the running position with the cover removed. The lubricating rollers which wipe both sets of contacts are also clearly shown.

In conclusion, the writer would like to thank the English Electric Company for the use of the photographs and sketches illustrating this article.

Some Considerations in the Application of Electricity to Textile Mills.

By J. T. RANDLES.

In equipping any factory with driving power it is necessary to consider the problem not only from the purely engineering point of view, but also to take into consideration any special requirements necessitated by the various processes used in the industry concerned. Careful study by electrical engineers of the various processes involved in the manufacture of textile goods has, during recent years, largely contributed to the success which has been achieved so far in the application of electrical driving to textile mills. In fact, this study has been conducted in some instances along the lines of true research, and, apart from its bearing on the success or otherwise of applications of electric driving, may eventually result in changes to textile machines of a far-reaching character.

In the majority of cases in this country the electric drive has only been applied to existing mills in order to replace inefficient or worn out engines and transmissions or to facilitate the driving of extensions. There are comparatively few examples of complete mills actually designed to incorporate electric driving. This is, at least, partly due to the fact that few new mills have been built in this country recently. As a result in many cases applications of the electric drive have proceeded along lines more or less limited by the transmission and drives originally installed, and under such circumstances that it has frequently not been possible to take advantage of all the benefits which may be obtained from the adoption of electric driving. This is unquestionably the case, for example, if slow speed line shafts of considerable length are retained when a conversion from mechanical to electric driving is made, though the reasons for doing so may be quite sound. In such cases considerations frequently arise which would not enter into the design of driving arrangements of entirely new mills.

GENERATED V. PURCHASED POWER.

Certain of the issues to be considered, however, when equipping a textile mill with the electric drive are similar, whether an entirely new mill or an existing mill is to be dealt with, and some of these may be considered before discussing the lay-out of the various sections of the equipment which will vary according to circumstances. The first question to arise will generally be whether the power supply is to be generated or purchased. The various arguments for and against each have been discussed at length in the past, and it is not proposed to repeat them here, but it is worth while remarking that the general tendency now-a-days is to buy power whenever possible, rather than to generate it; and there is no doubt that this is fundamentally correct. The business of the management of a textile factory is to produce textile goods, and to do this satisfactorily from a commercial standpoint not only entails the closest attention to the manufacturing processes, but also to the various markets concerned. The installation of private generating plant adds responsibilities necessarily requiring time and attention which could be better devoted to the main issues

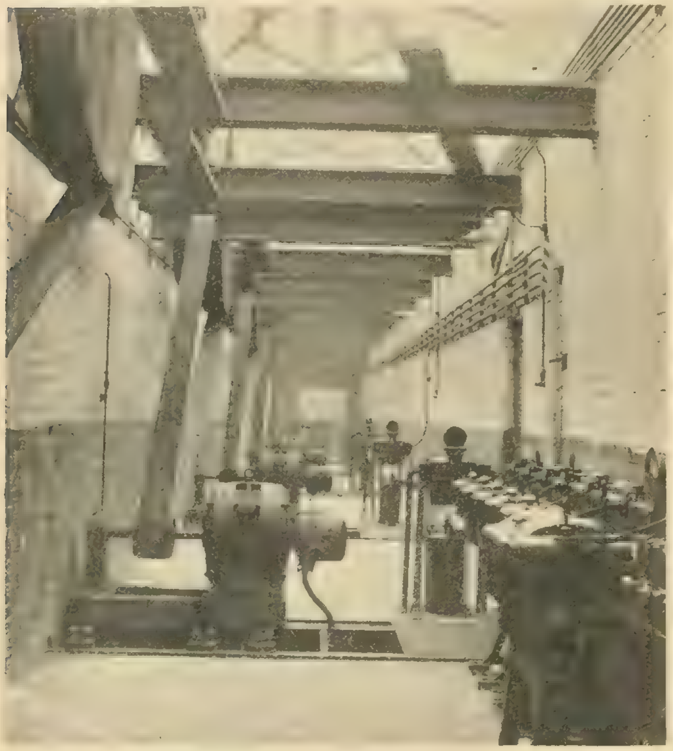

Fig. 1.—Motor Corridor for Group Drive Weaving Shed, 10-40 H.P. Motors.

If the decision is in favour of purchasing power, the voltage and frequency adopted must be the standard of the supply authority from which power is purchased, and even if circumstances necessitate the provision of a private generating plant, it will generally be advisable to adopt the standard frequency and pressure for the district in which the mill is situated if such a standard exists. Apart from this, it will be found that a three-phase, 400-volt, 50-cycle system will meet most requirements, the adoption of this pressure having the advantage that satisfactory lighting between phases and neutral at 230 volts can be arranged without the necessity of installing special lighting transformers. Where individual driving is adopted for weaving sheds, however, the usual pressure is 200 volts, this being more suitable for small high efficiency motors of the loom motor type.

Estimates of Power Requirements.

Before the lay-out of a scheme can be proceeded with, it will be necessary to make a careful estimate of the power required in every section of the mill, and wherever possible this should be based on test figures obtained on exactly similar machinery to that which has to be driven. A considerable amount of accurate information as to the power required to drive almost all types of textile machines operating under various conditions has been collected by certain of the electricity supply authorities in the textile districts and also by a number of the electrical manufacturers, though there is still much to be done in this direction, for it is only by accurate knowledge that success can be assured whether group driving or individual driving is adopted. The sizes of the various motors to be installed will be decided from a consideration of the power figures and will largely determine the satisfactory operation or otherwise of the installation. Constant speed is of first importance in the majority of textile processes, and to obtain this it is necessary to install motors which will operate without excessive slip. While this result may be obtained by installing motors on the large side, care must be taken to ensure that a low power factor does not result. The increase in power usually required after a stoppage at the week-end or on holidays due to the extra tightness of bands, &c., should also not be overlooked. The fact that in certain sections of the trade, textile machines run almost continuously during working hours, and that in the other cases the diversity factor may vary from 60 to 90 per cent., is a further reason for careful investigation of the power required in every instance.

In the case of an existing mill already equipped with textile machinery it is generally found that the group drive system is more readily applicable and the sizes of the various motors will be determined largely by the lay-out of machinery and shafting. The speeds of the various line shafts, the grouping of textile machinery and the space available for the installation of motors varies to such an extent in different mills that it is necessary to consider all the circumstances in each case. Generally speaking, however, the best results have been obtained by installing motors up to 150 B.H.P. to 200 B.H.P. in preference to larger sizes, these sizes allowing of a sufficient number of machines to be driven in each group to obtain steady running.

Switchgear.

As regards switchgear, oil break switches provided with automatic devices are desirable, both on the distributing switchboard and the motor control panels for all circuits except the smallest; considerable trouble and even interference with production may result from the installation of cheap and light switchgear. It is best not to use fuses except in the case of the smaller motors—say, from 20 H.P. downwards. For slip-ring motors, oil-immersed metallic rotor starters are more suitable for the conditions usually found in a textile mill than starters of the liquid type, and they should be mechanically interlocked with their respective stator switches. Emergency stop switches should be placed in readily accessible positions to enable the machinery to be stopped quickly in case of emergency. Such switches can be arranged in series with the no-volt coil on the stator switch.

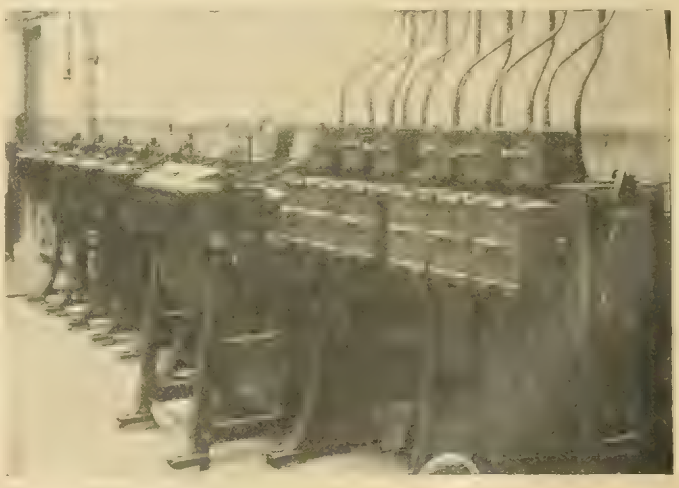

Fig. 2.—Three-phase Four-wire Power and Lighting Distribution Switchboard. Controlling Section of Weaving Shed.

The provision of an ammeter wherever possible is to be recommended. As an alternative suitable means may be provided on each motor panel to enable a wattmeter to be readily inserted in the circuit. The facility with which accurate power readings can be obtained when electrical driving is adopted is a great help towards the maintaining of machinery in good condition; it will also assist the management in arriving at a decision as to which make of machine is the most efficient for any particular purpose. A case came under the writer's notice some time ago of two similar machines of different make which were both engaged on the same operation, in which one required 37 per cent. more power than the other. This actually represented an unnecessary expenditure of over £10 per frame per annum, a serious matter when there are a large number of machines of the same type to be driven.

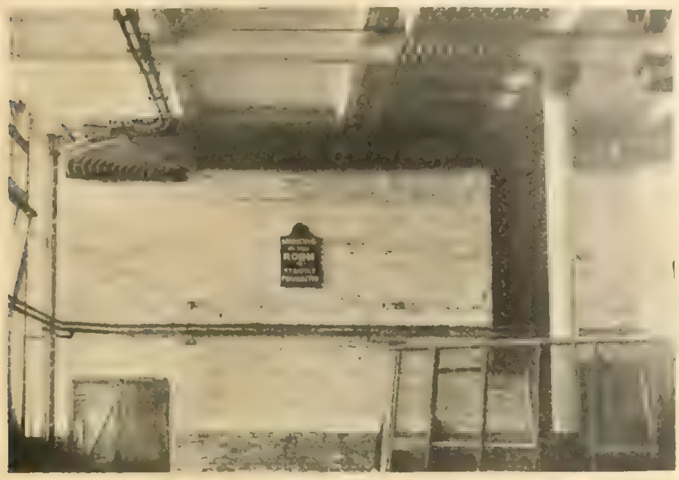

Fig. 3. Bank of 28 Power Feeder Cables in Spinning Mill, Showing Method of Supporting.

In laying out distribution systems, and cable runs, a separate circuit should be provided for each motor of about 70 H.P. and upwards. Where it is necessary to run power cables through card-rooms and spinning-rooms, three-core cables, single-wire armoured with galvanised wire left bright, are most suitable, as they will be kept clean and free from fluff more easily than cables jute served over all.

The Electrification of New Mills.

In designing the electrical driving equipment for an entirely new mill the engineer has the advantage that he can have incorporated in the design of the mill itself features which greatly assist the success of the equipment, and, on the other hand, owing to the great convenience of electrical transmission as compared with mechanical transmission, it is possible for the architect or mill designer to design a mill which is a decided step in advance of the usual design as arranged for mechanical drive.

In certain industries, particularly in the engineering industries, very marked advances have been made in factory planning during recent years, and it is not too much to say that these advances have been made possible to a great extent by the adoption of electric driving. In such instances the layout of the machinery is considered entirely from the point of view of maximum production and minimum handling of the product. Electricity is then made use of to drive the various machines, the positions of which have already been determined by more important considerations than the question of facility or otherwise of drive. In such cases the greatest advantage obtained from the use of electricity is perhaps the great convenience it gives in the transmission of power.

In the textile industry, however, it has frequently been possible to design a factory on such compact lines that mechanical transmission can be efficiently applied and, at the same time, a mill built the efficiency of which is high from the point of view of production. The Lancashire cotton-spinning mill is an outstanding example of this arrangement, and there is a tendency in the trade to think that finality in mill design has been reached. This view has also been encouraged by the fact that as far as running cost (*i.e.*, cost per horse-power) is concerned, it is sometimes difficult to show that any saving can be effected by the adoption of electric drive in this type of mill.

It is, nevertheless, true that the evolution of this type of mill has proceeded along lines which have been determined in no small degree by the possibilities or limitations of the various drives and transmissions available in the past. This is equally true in the case of the textile machinery itself. Further, in most of the cases in which electric driving has been adopted in new textile mills in this country, the layout of these mills follows more or less the lines usually adopted in the case of mechanically driven mills; indeed, in certain cases mills have been designed for steam-engine driving and built to those designs and the decision to drive electrically made after work has proceeded too far to admit of any serious alteration being made. Under these conditions one would not expect to obtain the whole of the advantages possible from the adoption of electrical driving; in other words, such mills are not true "electric" mills. Notable exceptions are found in the case of certain weaving sheds designed for and equipped with individual electric drive.

The Constant Speed Question.

In addition to the facility of transmission obtained by the use of electricity, it is possible to obtain constant speed and steady turning (*i.e.*, uniform angular velocity) with electric driving to a degree never realised in practice with the older systems of transmission. Both these features are of first-rate importance. To achieve these results in a textile mill it is necessary, among other things, to avoid very long line shafts and, at the same time, to run them at speeds which will

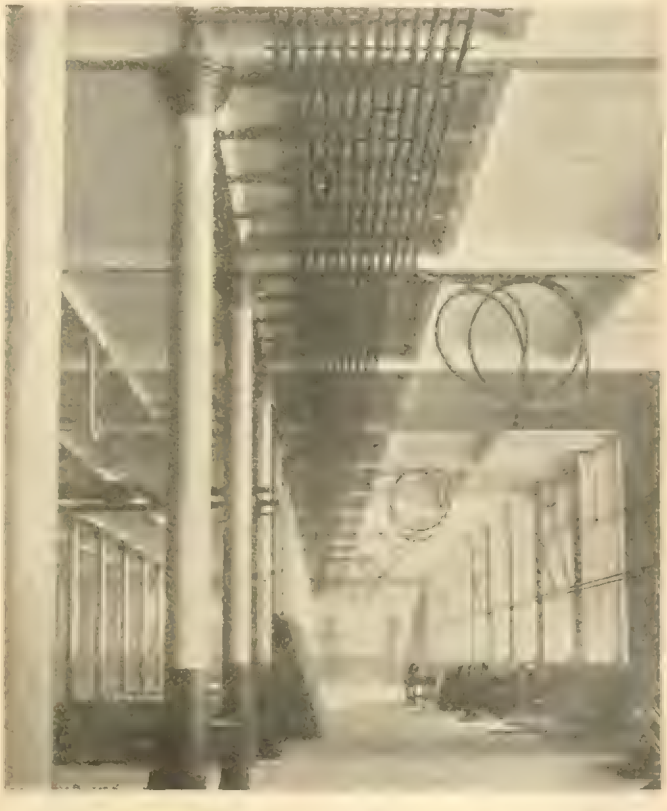

Fig. 4. Three-core Distributing Cables in Spinning Mills.

enable line-shaft pulleys of diameters equal to or less than those of the frame pulleys to be used in order to obtain the best driving ratios. Except when driving cards these conditions are hardly ever realised in mechanically driven mills, but they can readily be incorporated when electrical driving is applied to a new mill.

The Dunlop Mills.

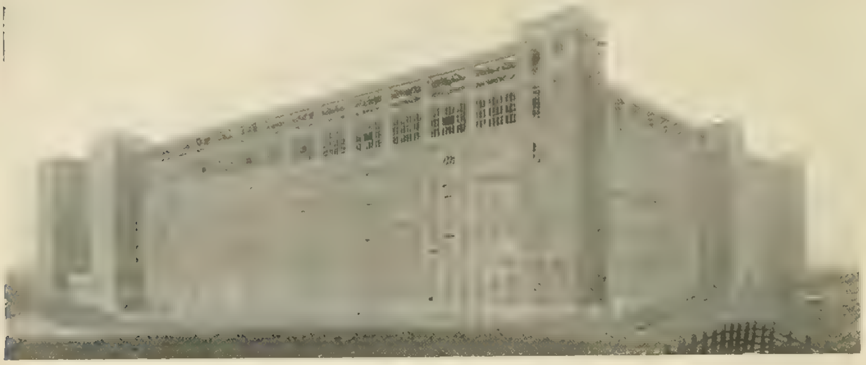

Fig. 5.—D. R. Cotton Mills, Rochdale. New Spinning Mills approaching Completion.

An example of a textile factory designed in the first place for electrical driving throughout is to be seen in the case of the mills belonging to the Dunlop Rubber Company, which were built to manufacture tyre fabric. The original spinning mill and weaving shed were built in 1914, and important considerations led to a design being adopted in which efficiency could only be obtained by the use of electricity. Results have unquestionably proved the wisdom of adopting electrical driving in this case. Extensions now nearing completion include a very large ring spinning and doubling mill, the design of which would have been impracticable but for electric driving, while at the same time decided advances over the usual design of mill for ring spinning have been possible. These include uninterrupted daylight on all sides of the mill and in every room (except the basement) while allowing floor areas sufficiently large to give a layout of machinery which reduces the carrying of the product to a minimum in a case where the quantity of material to be handled is very large. Two very large mills of the usual type with steam engine drive would have been required to house the necessary number of textile machines in this case. In such a case as this it is possible for all the advantages of electrical driving to be made full use of both from the textile and engineering points of view. Views in these mills are given in Figs. 1 to 5.

The Balancing of Group Drives.

In the case of group drives, each group can be arranged so that it balances with the corresponding group of machines for the next operation, thus, in effect, dividing the mill into a number of sections, each of which is complete in itself as far as processes are concerned. This not only tends to the minimum interference with production in the event of a breakdown occurring on any portion of the plant, but also enables the number of different sizes of motors to be reduced to a minimum and at the same time standardised, which is an important consideration in a large mill when interchangeability and the number of spares is considered. Provision can also be made when the mill is being built for the fixing and handling of motors in such a manner that should it be necessary to change a motor at any time it can be done with the minimum of inconvenience. Suitable arrangements may also be made for the running of the distributing cables, an important matter where the power to be transmitted is large and the number of cables considerable. These points not only result in a neat installation, but also tend to greatly reduce maintenance costs in the future.

In the case of the mills mentioned above power is obtained from the Corporation, who purchase in bulk from the Lancashire Electric Power Company at 10,000 volts. Owing to the great length of the mills, two sub-stations stepping down from 10,000 to 400 volts, are being provided at suitable points. From these substations feeder cables are run to low-tension distributing switchboards of the ironclad industrial type in the various sections.

In the original mills, which are of the shed type, standard protected type motors were placed in special motor cabins or corridors; in the new spinning mill, however, where the majority of the lighting is side light as distinct from roof light, pipe ventilated motors carried on suitable supports have been adopted.

Electric Handling.

To handle rapidly the laps and yarn, &c., between the various floors, electric lifts running at 150 ft. and 250 ft. per minute have been installed. These speeds are much faster than those possible with the ordinary belt-driven hoists usually installed in cotton mills and result in a considerable saving of time. The longest line shafts in the card rooms and ring rooms in this mill are less than 150 ft. long, and are only 3 in. diameter at the driving end. Further all shafts have been arranged to run at speeds which give the most suitable driving ratios, and the power is applied where it is required.

It may be of interest to compare this with a typical modern steam-driven ring spinning mill in Fig. 6. This shows the general arrangement for a mill of about 70,000 spindles, the ring room of which is driven by one medium speed line shaft, in this case approximately 400 ft. long, 5¾ in. diameter at the driven end, tapering to 3¾ in. diameter at the other end, and transmitting about 1,100 I.H.P.

Tests have shown that in the case of such long line shafts running at comparatively slow speeds there is invariably unevenness of turning on the portions furthest from the rope race.

A careful study of the various points which arise in driving a textile mill leads one to the conclusion that there is considerable scope for co-operation between mill designers and electrical engineers, and that as full a knowledge as posible of the manufacturing problems which occur is necessary. More co-operation is also desirable between English textile machinists and electrical engineers. It may be mentioned that there is now at least one American textile machinist who supplies an automatic loom complete with motor forming a unit. It is unfortunately probable that for economic reasons few new mills will be built in this country for some time. Sooner or later, however, additional machinery must be required, and the demand will be met by the most progressive nations; it is therefore up to everyone concerned to fully investigate all possible means of improvement from the broadest points of view.

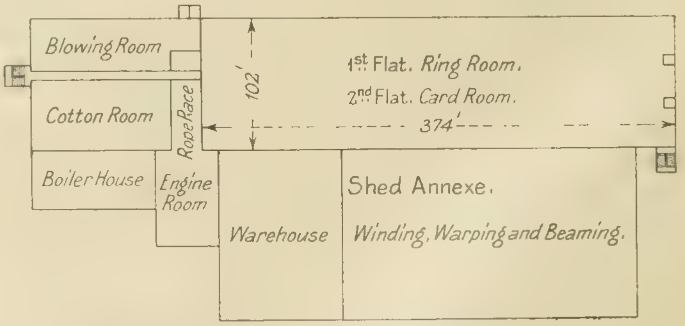

Fig. 6.—Outline of Typical Modern Ring Spinning Mill for about 70,000 Spindles (1,600 1 H.P. Motors).

The Individual Electric Drive.

Recent Developments in the United States.

By FRANK NASMITH.

IT would be manifestly unfair to state that all the recent improvements in what may generally be termed the motor drive for textile machinery have been discovered or invented in the United States, but we must recognise the fact that in that country mills have more readily adopted this form of drive. No doubt this is due to the fact that the mills there are newer than ours. The spinning and weaving industry in the United States has made enormously rapid strides during the past twenty years—approximately the period during which electric driving has been developed. Further, especially in the Southern States, hydro-electric plants of enormous capacity have been laid down and current from these have been bought by the majority of mills. Therefore, we have two factors which tend to the adoption of electric power—no existing steam engine and mechanical transmission and comparatively cheap current. It has been estimated that textile mills in America are to-day using electric motors of a capacity of 750,000 h.p., or about one-third of the total power required for the textile industry of that country.

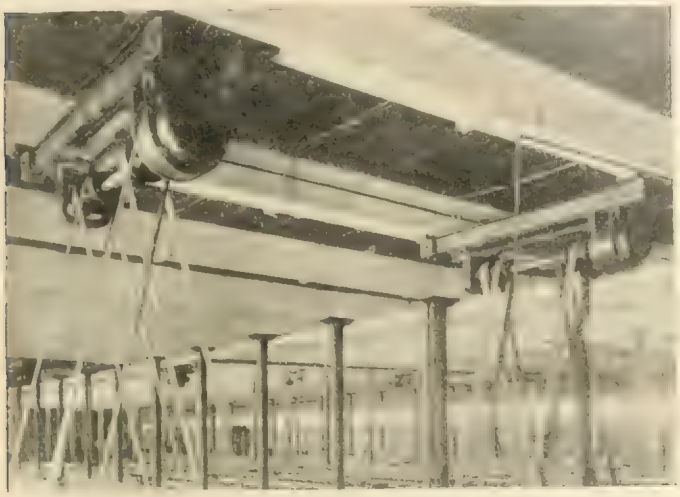

Fig. 1.—Type KT-4-15-1,800-550-volt Ball-bearing Four-frame Motors Driving Four 208 Spindle Warp Spinning Frames. Former Type Four-frame Motors in Background. Everett Mills, Lawrence, Mass.

The Advantages of the Electric Drive.

Naturally, as in Germany prior to the war, the electrical industries have been given an enormous impetus, and have been called upon to deal with problems which have widened their scope and developed their resources. In the early days the use of the electric motor was the mere substitution of large motors for belts or ropes to drive main shafts, and group driving was the result. The old shafting and belts were employed with all their faults. But with the improvement of the individual motor the order of things changed, and it was discovered that various advantages, not before realised, were obtained. It has been stated that motor driven textile machinery benefits the operative, the product, and the shareholder. The operative is benefited by better light and ventilation due to the removal of shafting and belting. Lint and fluff always present in a textile mill are constantly kept in a state of circulation by shafting and belting, and the problem of supplying pure air is difficult. Further, if we consider the "safety first" movement the advantage of removing the shafting and belting is patent. Finally, the operative is benefited by the increased earning capacity of his machine.

The mill product is benefited by the better general conditions of cleanliness always secured by the motor drive. Absence of oil drips, fluff thrown on to the cloth, &c., results in a motor driven shed. There can, of course, be no doubt as to the increased earning capacity of a textile machine driven directly by a motor. Textile machinery requires, as far as possible, uniform driving. If this is not forthcoming the material produced will suffer, and if what I might term the "swing" of the machine is not maintained, then also the machine itself will suffer. That there is considerable variation in speed even when the group electrical drive is employed can be readily proved by tests made. In one case, a single loom—driven from line shafting and belt—was tested at a particular hour each day, so that the conditions were as nearly identical as possible, and the variation in thirteen working days at three o'clock in the afternoon was 157·1 to 166·2.

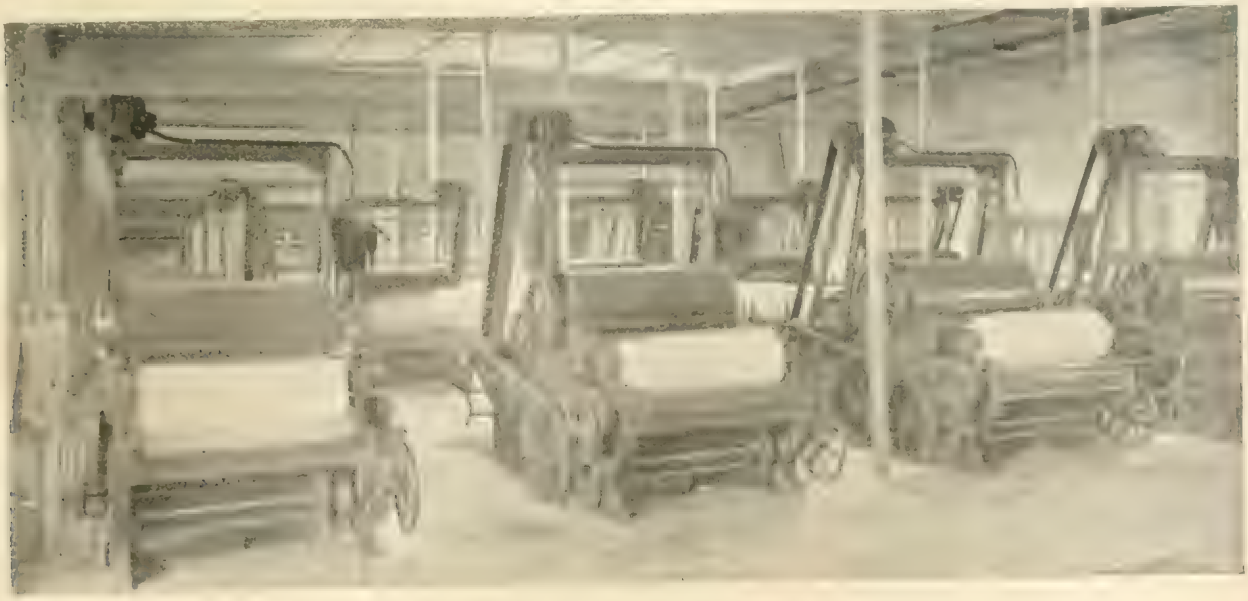

Fig. 2.—KT 4-5 1,800-500 volt Motors Driving Pickers, or Openers, Pacific Mills, Lawrence, Mass.

The Automatic Loom.

Where automatic looms are employed—that is looms which automatically replenish the weft in the exhausted shuttle—the "swing" can be so well maintained that high efficiencies can be secured. Every time a loom stops there is a certain release of tension of the warp threads, and the sudden starting up will certainly cause breakage of such threads—maybe not at the exact moment of starting, but later. Now, with the automatic looms and a steady running motor, this disadvantage is very materially reduced. At the Naumkeag Steam Cotton Company, Salem, Mass., U.S.A., where nearly 3,000 looms are driven individually, friction clutches are employed, the motor running constantly.

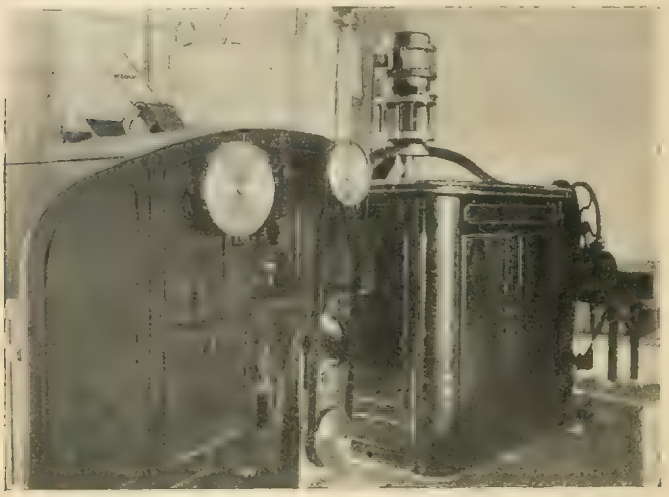

Fig. 3.—Crighton Opener, Driven by KT-181-8-5 h.p. 900 R.P.M. Vertical Motor. Pacific Mills, Lawrence, Mass.

As a matter of interest, the General Electric Company of America inform the writer that in this installation which they supplied, and which has been running for years, the total upkeep on it all has been only $75. Records kept over a considerable period show that 97 per cent. of the theoretical production was obtained, *i.e.*, that the amount of cloth produced at the end of the week is 97 per cent. of what it ought to be if the loom was running 48 per hours per week without interruption. This is certainly a remarkable percentage and no doubt the 3 per cent. loss was due to breakage of warp threads. Even so, the loss is very small in comparison with the idle time of many looms in this country, for example. Bearing out a point made previously, the repairs on looms in this particular shed are less than they were when driven by belts.

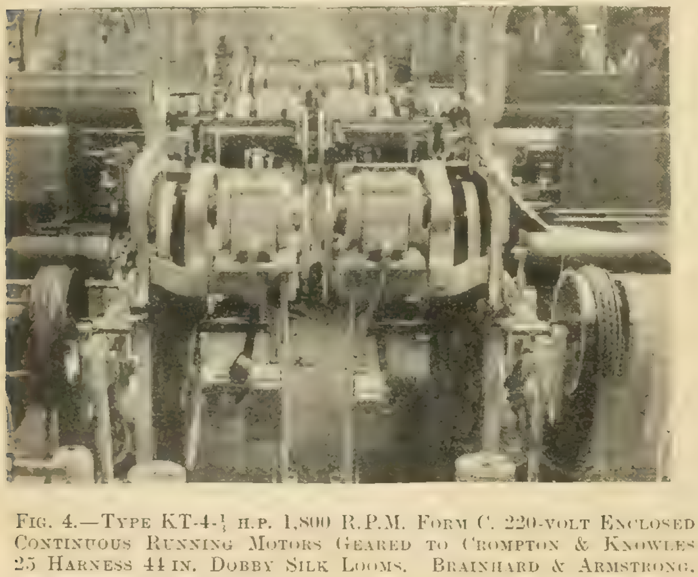

Fig. 4.—Type KT-4-⅓ h.p. 1,800 R.P.M. Form C. 220-volt Enclosed Continuous Running Motors Geared to Crompton & Knowles 25 Harness 44 in. Dobby Silk Looms. Brainhard & Armstrong, New London, Conn.

Throughout the United States the continuously running motor, friction clutch and gear drive are becoming almost universal. Recently I examined a pinion that had been working on a loom so fitted for five years, and was surprised at the slight wear exhibited by the teeth. No gear wheels in this particular mill were replaced on account of wear, but naturally in the production of different qualities of cloth they were changed to alter the number of picks to the inch.

Where the Individual Drive is Not Used.

It is a curious thing that even to-day, although it can be distinctly proved that the motor drive gives the best efficiency, all ring frames are not so driven. What might be termed the predecessor of the individual ring frame drive—and no doubt one that still persists—is shown in Fig. 1. It will be noted that comparatively short lengths of counter shafts are employed driven by a motor. The four frame driving ends are brought together and belts convey the motion of the shaft to the pulleys of the frames. This is quite a good method of driving, and should not materially reduce efficiency except in relation to the slippage of the belts.

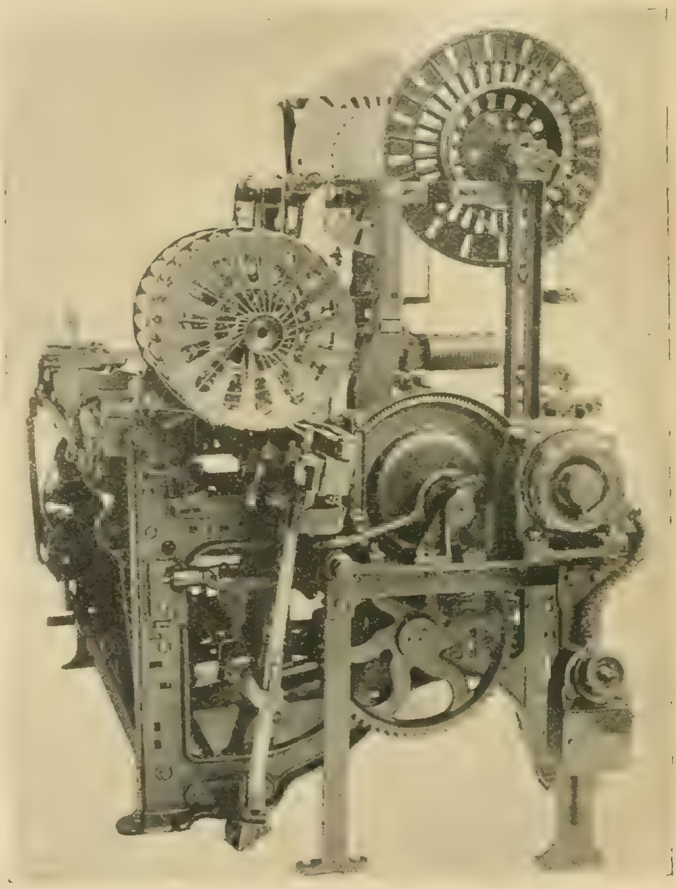

Fig. 5.—Method of Mounting Motor and Clutch on Northrop Automatic Loom.

Methods of mounting and carrying motors are interesting, and if the series of illustrations, Figs. 2, 3 and 4, are examined, it will be seen that in the first, pickers, or, as we term them, openers, are driven by motors supported on the framework of the machine. The motor is certainly out of the way. An interesting installation is that shown in Fig. 3, where a motor is mounted on the vertical shaft of a Crighton opener. In Fig. 4 the motor is carried on an extension of the loom-framing. Sometimes the extension on one loom is on the level of the slay or shuttle box, and on the next or adjoining loom it is at the level of the warp beam bearing. It is all a question of reducing the space between each loom, and when in the Duncan Mill, Charlotte, S. C., the writer noticed that the loom framings had been specially designed to carry the motors so that on each adjacent pair of looms they dovetailed, the looms being comparatively close together. Before leaving looms, the method of mounting the motor and the clutch previously referred to is shown in Fig. 5.

Mule Driving.

Mule driving is illustrated at Fig. 6. It will be noted that a fly-wheel is introduced. This is by no means necessary, and, as a matter of fact, it is a moot point whether it could not be removed with advantage. In mule spinning, a certain amount of slip and flexibility is not to be despised, and it is advocated that the highest spinning efficiency—apart from actual driving efficiency—might be better secured from the removal of the fly-wheel.

An undoubted advance has been secured from the application of motor drives to calico printing and tentering or stretching machinery in place of the small type steam engine previously employed. Variable speed motors are used for this work, also for driving paper-making machinery. The motor speed is controlled by a series of push buttons, and the results are most excellent. Certain classes of printed fabrics absolutely require a variable speed at certain periods of their production. Attempts to secure the results when mechanical transmission has been employed have proved futile, and, in cases, almost deplorable. Blotches have resulted, but with the variable speed, which can be obtained with these special motor drives, printers have got over their difficulties. In connection with calico-printing machines, the push button system is used, but where tentering machines are being driven, the brushes are moved by means of a lever and wire connections.

A Variable Speed Installation.

One particular drive once shown in this country, but now we believe developed in the United States, is most interesting. It concerns the Brown-Boveri method of varying the speed between the base and the nose of the cop or bobbin—in this particular case Northrop or automatic loom bobbins. At a mill in Saratoga, the Brown Boveri controlling method is applied to 94 ring frames, having 240 spindles each, $1\frac{3}{4}$-in. ring, 5-in. lift, and the said controlling device actuates variable speed motors supplied by the General Electric Company, of America. The spindle speed variation secured is from 9,800 revs. per min. down to 8,000 revs. per min. The method of carrying the cables to the looms varies. Sometimes the overhead system is used and the wires brought down tubes, and—in new mills particularly—the wires are laid in conduits formed in the floor.

In the writer's opinion we are only passing through another phase of electric driving. In the future, I firmly believe, we shall see the more direct actuation of textile machine parts by electrical means. For example, in the production of design in woven fabrics—especially the simpler forms—there is no reason why a modification of the means adopted to produce electric sky signs should not be utilised. But this, and other developments, are things to be considered when the electrical and textile engineer get closer together.

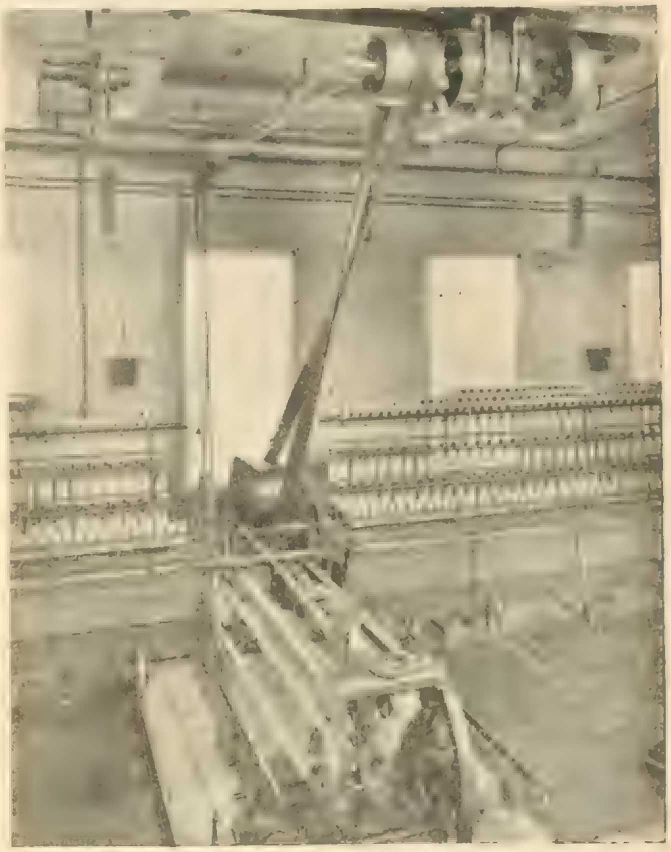

Fig. 6.—KT-6 15-1,200 550-Volt Mule Motor. Otis Company, Ware, Mass.

Modern Methods of Driving Machines in Jute Manufacture.

By T. WOODHOUSE and P. KILGOUR.

(Dundee Technical College.)

The problem of an ideal drive for jute mills, factories and calenders (finishing departments) has engaged the attention of spinners, manufacturers, and finishers for a considerable time. Since the period when water power formed practically the only source of power for driving machinery, there have been installed in these mills elaborate and efficient power systems employing various types of engines, such as the marine, steam turbine and the like. Within the last two decades, however, that very important system of motive power—electricity— has made considerable headway.

The various systems involving steam and electricity are well understood by the readers of The Electrician, but there requires to be a distinct understanding between the engineer on the one hand and the manager of a textile establishment on the other as to how the best results are to be obtained, for production is largely influenced by the particular way in which the machines are driven.

The Drawbacks to Extensions.

Most of the difficulties encountered in mill driving are due to defective arrangements caused mainly by periodical extensions of an original mill. Extensions are usually made to an existing shafting, or else the motive power is carried by means of rope drives, chain drives, or belt drives to the new departments, and these often use up the small margin of power which the engine possessed.

It should be stated, however, that the methods adopted were probably the most efficient at the time of the change or extension, and that most of these installations were made when the experience of electric driving for textile establishments was very scanty. Although the principals of many firms gave a considerable amount of thought to electrification the data concerning its efficiency and reliability was not sufficient to justify such a radical change from the well-tried and efficient steam drives. The recent successes in electrical driving are due, in no small degree, to those who were brave enough to introduce the electric system.

The Expansion of the Electric Drive.

A large amount of electrical energy is now used in the Dundee jute trade, most of this being supplied from the Corporation Generating Station at the high pressure, say, 6,000 volts. On the other hand, a few firms generate their own current. For example, one firm introduced a complete plant, including a Zoelly turbo-generator, which has been at work for a number of years in a large jute mill. It is a 1,000 kw. installation, and it has been so successful that at the present time an extension of the plant is in progress. With one exception, all the shafts are driven at 485 revs. per min. by 250 H.P. motors; a similar motor is used for the shaft of the preparing department, but the speed of this shaft is reduced by suitable rope gearing to approximately 170 revs. per min.

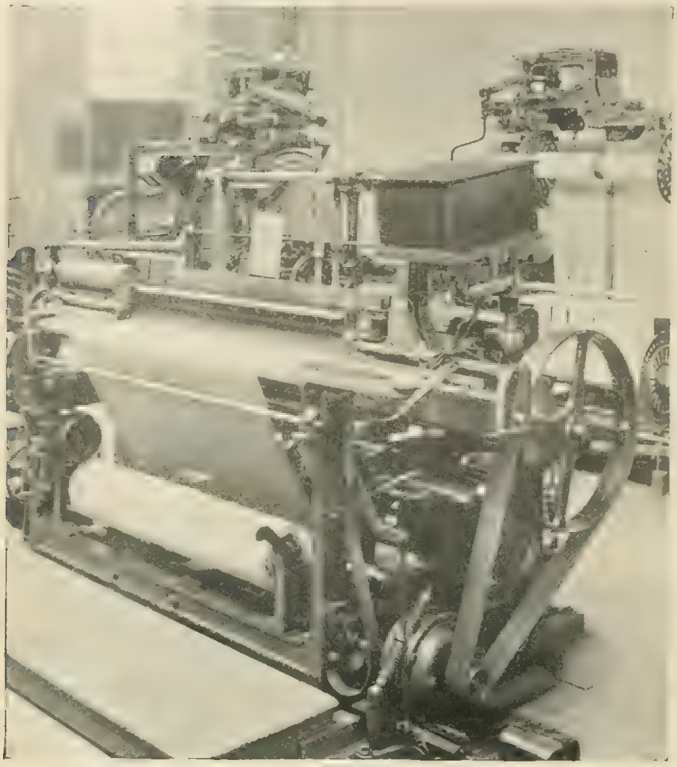

FIG. 1.—MOTOR AND LAMINATED BELT DRIVING 46½ REED SPACE JUTE HESSIAN LOOM.

Saving by Waste.

The spinning shaft is direct driven inside the machine room, and gives very steady operation; indeed, the drive is so reliable, giving practically no trouble during long periods, that it is estimated that the saving in waste will soon pay for the installation. A motor of 210 kw. capacity has been tried coupled direct through a flexible coupling to a spinning shaft and running at 485 revs. per min.; the shaft had ball bearings, and a slight saving in power was noticed over that of the ordinary plummer block.

Systems of Driving.

In case where a supply is obtained from the Electricity Department the current at a pressure of 6,000 volts is reduced to 400 volts by transformers at the mill. Current at 400-volts then passes from the switch-board through distribution cables to the various departments of the mill. The motors, as already mentioned, may either be connected directly to the shaft or by ropes or in other ways. In many cases it is desirable to preserve the original shaft speed, in which case a reduction in speed from the motor to the shaft is essential.

Chain drives and belt drives are also used in conjunction with electrical operation, and it is always wise policy to install the motors, if possible, in a separate room in order to prevent the dust and fibre from finding their way to the rotating parts; it is difficult to keep the parts free from foreign matter notwithstanding all the possible precautions. The danger is obviously minimized when the power room is separated from the working room.

Many multiple-storied mills had originally vertical shafts with bevel gears adapted to drive the horizontal shafts in the various flats. And since these vertical shafts were usually housed in special compartments, the latter afford excellent facilities for motors when changing from steam to electrical drives. It is possible to effect such a conversion with a minimum loss of time.

The Advantages of the Electric Drive.

Perhaps one of the most advantageous results of the introduction of electric driving is the fact that there is a choice of large group driving, small group driving, and individual driving. It is well known, as already stated, with what ease a large group drive can be installed with little structural alterations. This subdivision of power is exceedingly valuable where certain groups of machines have to be worked intermittently, or where a few out of a group have to be employed, while the rest are idle. At times like the present the division of power is much appreciated, for it is certainly an advantage to be able to use a small fraction of the total whenever one is called upon to do so. A short time ago the writers observed that in a firm provided with power up to 300 kw., only about 10 kw. were being utilised at one particular moment.

The Speed Problem.

In many existing mills a very important problem was raised in regard to the speed of the motors and the line shafting after it was decided to adopt the electric drive. Suitable designs of motors were submitted to run at 450 to 500 revs. per min. And for the sake of standardising the motors it was suggested by the makers that the line shafts should all be run at a speed of, say, 485 revs. per min. This created a real difficulty in that most of the mills were designed to give shaft speeds of, say, 160 to 180 revs. per min. for the preparing rooms, and 220 to 250 for the shafts in the spinning, winding and reeling departments, while the shafts in the weaving department ran at approximately 150 revs. per min.

Little difficulty was experienced in regard to the shafts of the spinning department, and an agreement was quickly made to increase the speed of these shafts to suit the motor-speed. In this case it was, of course, a question of group drive, with the motor fixed either at one end of the shaft or about midway between both ends. There was more difficulty,

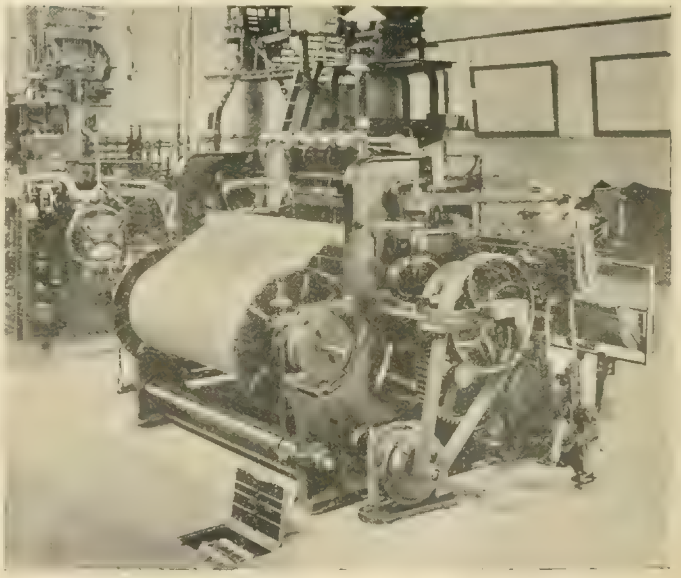

FIG. 2.—AUTOMATIC SHUTTLE CHANGING LOOM (HATTERSLEY'S TYPE) WEAVING JUTE HESSIANS.

however, in the preparing department, and the matter now stands as under :—

(*a*) The original speed of the line shaft has been retained, a motor running at 185 revs. per min. used, and adapted to drive the preparing room shaft by ropes and rope pulleys. In this way uniformity in both sections has been maintained.

(*b*) The shafts of the preparing room are driven direct, usually each by its own motor, and suitably-sized drums and pulleys fitted to the shafts and to the machines to obtain the desired speed of the latter. This method did not readily commend itself to the persons involved with the working of the machines.

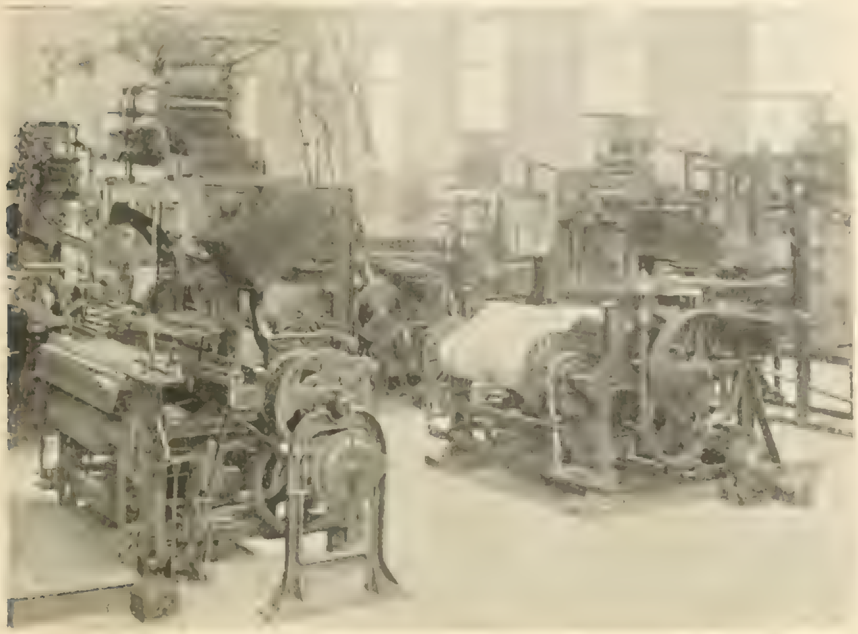

Fig. 3. Gear driven and Belt-driven Looms (Small Motors).

The former shaft speeds allowed the use of drums and pulleys of approximately the same size, but the new conditions meant a ratio of a 1-to-3 drum and pulley. One of the troubles expected was that caused by placing the heavy 6-in. belts of the carding machines on the small drums Where this system was adopted it was found best to increase the size of the pulleys on the carding machine, in order to introduce a comparatively large-sized drum on the shaft.

In spite of the difficulties involved in the respective speeds of motors and line shafts, it must be admitted that the possibility of group drives forms an important phase in driving.

Methods of Driving.

It has been shown that, neglecting individual drives, there are three distinct methods employed in jute mills and factories :—

(1) Motor fixed direct on line shaft.
(2) Motor connected by ropes and rope pulleys to line shaft.
(3) Motor connected by belt and pulleys to line shaft.

Chains are also connected between the motors and shafting to serve a similar purpose to that performed by ropes and belts.

Some time ago the authors had the opportunity of looking round very extensive mills which had been enlarged from time to time until there were several units of engine and boiler spread over a wide area. These units were ultimately replaced by electrical power with an almost incredible economy. It is practically impossible to install several such units and to operate them economically, and the chances are that the great saving which accrued after the above change was made was due to the very inefficient conditions which existed under the multiple-unit system as compared with the electric system

Requirements of the Various Machines.

It may be advisable at this stage to consider the requirements of the various machines and to suggest what kind of drive appears to be most satisfactory. The machines used in the batching department are the bale opener and the softener. Both machines treat the fibre in its compact form, and the nature of the drive has little effect upon the resulting condition of the fibrous layers. The bale opener, with its heavy, deep-fluted rollers, loosens the solid-like masses of jute heads ; the compact condition of the latter is due to the enormous hydraulic pressure used in the packing of the bales in India. This bale opener is, in general, used intermittently, but since the power consumed is approximately 2 to 4 h.p., it might, with advantage, be driven from any suitable line shaft. Incidentally, the fibrous layers are made softer and more flexible, and this process is continued, more scientifically, in the softening machines. The addition of oil and water to the fibre as it passes through the softener, or before it is introduced to this machine, aids the bending action of the oblique fluted rollers of the softener to deliver the fibre in a satisfactory condition for the carding engines or machines. For softening machines with eight sections, that is, 63 pairs of fluted rollers, the power required may be approximately 20 h.p. The nature of the work is not sufficient to claim an individual drive, unless it is desired to reverse the motion in the event of choked rollers. A defect of this kind is usually met by raising the obstructed roller. The machine may thus be driven from the same line shaft as the bale opener.

Carding Processes.

In the carding department there are usually several breaker and finisher cards, each provided with a number of rollers covered with pins, the function of which as a whole is to comb, split and break the fibres. Each machine when running absorbs approximately 4 to 5 h.p., and requires at least double this amount to start. Hence, if individual driving were adopted, it would be necessary to in-

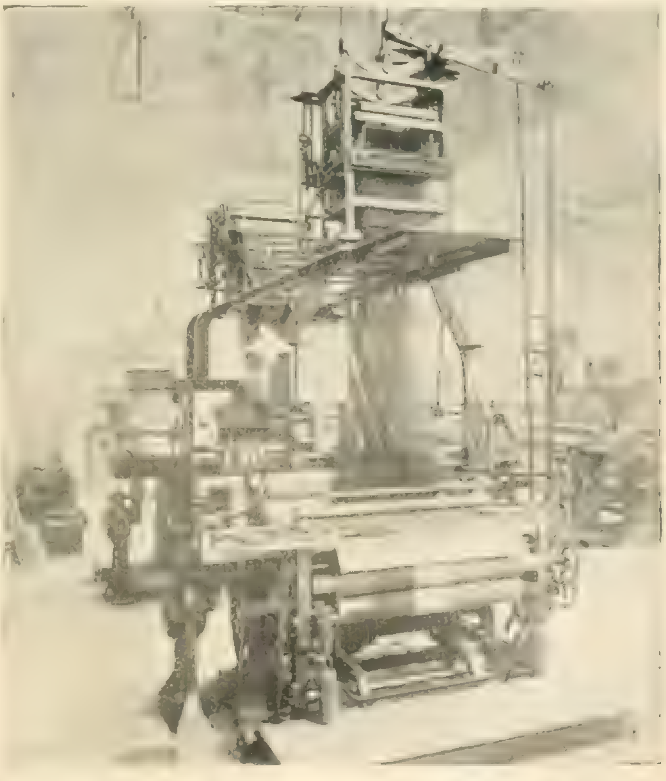

Fig. 4.—Double-lift, Single-cylinder Jacquard Loom and Single-lift, 25-row Twilling Jacquard Loom Gear driven from Small Motors.

troduce a considerable margin of power over that which is actually required for real running. In practice, it is usual to start, say, two or three machines at a time until all are at work, and in this way the available power need not be much more than that demanded by the machines at work. A line shaft drive is therefore quite suitable for these machines, such shaft being driven by any of the methods already discussed.

The material leaves the cards in the form of a sliver, or broad, flat, ribbon-shaped combination of fibres, and a little more consideration of the nature of the drive is perhaps required from this stage onwards, because the masses of material are much smaller ; they begin to assume shapes which more and more approximate to that of a thread, and ruptures or breakages become more frequent. Thus the slivers are compounded, drawn out, and delivered as more uniform slivers from the various sets of drawing frames. The final sliver from the last drawing frame is still further drawn out in the roving frame, but, in addition, it receives a slight twist for the first time, and is thus made more or less circular in section ; simultaneously, the twisted sliver, termed the rove, is wound on to a rove bobbin.

Fig. 5.—Part of the Weaving Department, Dundee Technical College and School of Art.

The final treatment of the material in the shape of a continuous rove takes place in the spinning frame, where the circular yarn is drawn out considerably, a large number of turns per inch or twist introduced, and the finished thread —warp or weft, as the case may be—is wound on a spinning bobbin.

All branches of this work are extremely important and each presents its own particular difficulties during the manipulation of the partially manufactured product. Nevertheless, in all these machines the work is continuous, and the power required from moment to moment is approximately constant. Consequently, if, after stoppages for meals and the like, the restart is performed somewhat similarly to that mentioned for carding, group driving will be found to suit the work admirably, because a minimum amount of power would be necessary.

Starting Problems.

The very nature of the above and several other processes demand that the machines should be started very slowly, and gradually increase in speed until the normal rate of running is reached. Any irregularity in speed, or jerkiness of motion, is bound to result in an increased amount of breakages, with a consequent loss of production, imperfect goods, and dissatisfied workpeople. Hence, if the function of the machine does not demand an immediate start to full speed, as is the case of a loom, every endeavour should be made to obtain a smooth motion and regular acceleration to the yarn until the maximum speed desired is reached.

Apart from the actual particular nature of the method of starting the various textile machines, it is an acknowledged fact, almost an axiom, that regularity in speed is the first consideration for high production, perfect goods and satisfactory conditions in general. It is an old saying, and a true one, that the strength of a thread is measured by its weakness. The adoption of an average strength is not permissible, for each thread relies on its own merits, and sustains the stresses or breaks under the load according to the existing conditions. Moreover, it is not only the case of a single broken thread, for if the weakness is not immediately detected, other and much more serious damage quickly follows, and this often happens in spite of the many praiseworthy automatic stop devices which are used for minimising breakages and other faults.

The very nature of certain processes makes it almost impossible to obtain these ideal conditions, but if irregularities are present due to peculiar conditions, such irregularities are accentuated when the drive to the machine itself is irregular. We refer now to the many methods of preparing warp and weft yarns for the looms.

Preparation of the Warp and Weft.

Consider, for example, the formation of so-called rolls, spools or cheeses in the warp winding department. However regularly the main shafts may run, each spool-driver operates on the yarn independently of the others, and when, after a break, the yarn is mended, the roll reaches its maximum speed almost immediately it comes into contact with the roll driver, and is subjected simultaneously to two forces almost at right angles to each other. This is practically the state of affairs in all systems of winding. In bobbin winding, however, where the traverse is slow, the treatment in the horizontal direction is more gentle.

Cop Winding.

The conditions are even worse during the operation of cop winding. The yarn is again subjected to two simultaneous forces almost at right angles, and, in addition, the speed of the yarn is constantly varying because it is being deposited on varying diameters of the nose of the cop with a constant spindle speed. Unless a radical change takes place in the method of winding cops, this variable speed of the yarn will continue to hinder the adoption of higher speeds. Consequently if the character of the operation defies, as it were, the elimination of irregularity in speed, the only improvement to be obtained appears to be an absolutely uniform speed of the main shaft itself. The conditions under which this slight advantage can be achieved are best met by individual driving, and next by group driving of machinery where the work is more continuous than intermittent.

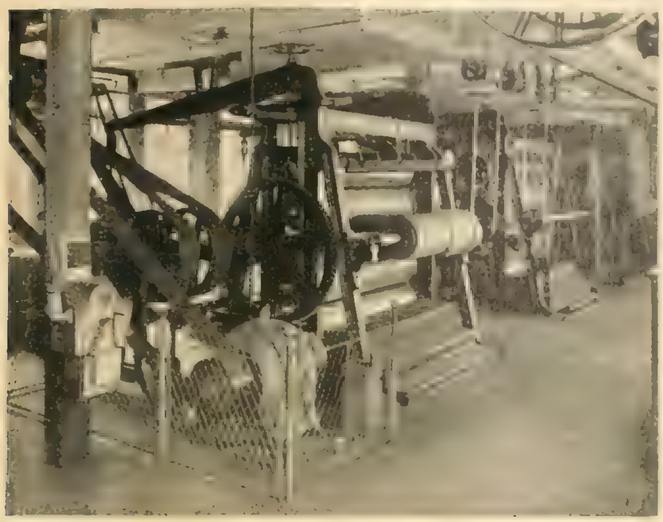

Fig. 6.—45 h.p. Motor and Laminated Belt Driving a Line Shaft from which Calenders are Operated.

The statement regarding the individuality of threads in regard to their resistance to rupture, may, in some respects, be slightly modified in certain schemes of group formation, *e.g.*, the reeling of yarn into hanks, the formation of chain warps as obtains on the warping mill or on the linking machine, or the simultaneous hauling, starching, drying and beaming operations as practised in the modern dressing machines. In the process of warping chains on a linking machine, the rolls, spools or cheeses, amounting in all to a few hundreds, are housed in a bank or creel, each roll being capable of rotating freely as the yarn is drawn off. After the group of yarns has passed through the leasing apparatus, and between the rollers of the hauling, measuring and marking machine, it is formed by ingenious mechanism into a linked chain.

In such and similar machines or operations one or more comparatively weak threads might pass through the cycle of operations without breakage, and especially if these weak parts appear when the machine is working smoothly. If the thread is weak throughout, there will certainly be trouble with it. There will also be trouble if, on starting the machine, the parts immediately assume full speed. With belt drive, or cone-friction drive—especially with the latter—the maximum speed is soon reached, but with a suitable motor, *e.g.*, a variable-speed motor or slip-ring motor, sufficient smoothness of running may be achieved, and the drag effect on the yarn reduced to a minimum.

The Drive of Dressing Machines.

So far as the authors' knowledge goes, very few dressing machines are individually driven, except perhaps those in Technical Schools and Colleges; at the same time we are of the opinion that this is one type of machine from which advantages would accrue with a reliable uniform drive. It must not be lost sight of that a warp beam of several cuts or pieces, say 10 cuts of 100 yds. each, may be, and often is, completed in about an hour; this same beam may be in the loom for weeks, depending upon the number of shots or picks per inch in the cloth, and in the great majority of cases requires more than one week for the weaving operation. Now it is a very easy matter for a weaver to lose more time in the weaving of one piece than it takes the dresser to fill the beam. Not only so, but every stoppage to remedy defects means loss of production, loss of wages, loss of profit, increased dissatisfaction amongst the workpeople, and an inferior piece with perhaps pieces which can only be sold at remnant prices.

In spite of the great advances which have been made in the process of dressing, and the preparation and use of the materials for this purpose, we still consider that this department is capable of being improved. As a matter of fact, our idea is that one of the essentials of perfect work and high production is the efficient control of the dressing department. One way to improve the conditions for all concerned in this and subsequent processes is to introduce a uniform drive, and one which will treat the yarns as gently as possible. There is, of course, little variation in the power from second to second during the operation of dressing, and hence the only other essential requirement for satisfactory starting up is a constant-speed motor.

The Peculiarities of the Loom Drive.

The phases of the power required, and the particular times of the variation of power consumed, are unique in the case of a loom. The full output is required instantaneously, and it is in connection with this essential feature that an individual drive is important. On the other hand, a somewhat similar quick motion can be obtained by means of cone-friction drives, while a certain acceleration is possible and often unavoidable in the case of belt drives where the belt has to be transferred from the loose pulley to the fast pulley. In addition to the necessity for immediate full speed, it is very desirable that the speed of the prime mover should be uniform. Since the

Fig. 7.—Feed Side of Calender Driven by [illegible] Dressing Motor.

force required in a loom is constantly changing in the cycle, and varies between high and low limits every revolution, it is quite possible that with group driving considerable variations may take place. One can scarcely expect all the looms to be rhythmical in times of motion, but it is quite possible for a maximum number to be picking at the same time, and thus demanding the maximum amount of power. It would probably be just as bad if a minimum number of looms were requiring the maximum power (picking time) at a particular moment. In both cases a disadvantage occurs—in the first instance, if the power is not well above that required for normal values of consumption, the looms will be knocking off; in the second instance, the pick will be too strong, with a result that the weft will come down in coils, and be deposited in the cloth in lumps, while, in addition, shuttle-rebounding and a high rate of wear and tear will prevail. As a matter of fact, it is a common occurrence in factories to experience a considerable amount of knocking-off on resumption, and this naturally weakens the various parts, wears out the protector elements, and obviously causes more time to be devoted to repairs as well as increasing the number of stoppages.

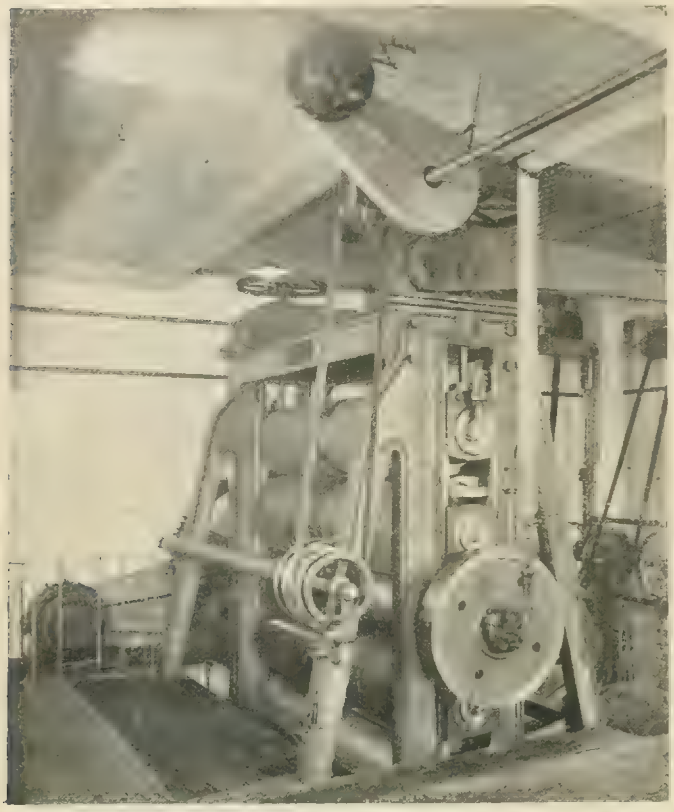

Fig. 8.—Delivery Side of Calender Driven by 16 h.p. Reversing Motor.

Some Interesting Installations.

The loom in the foreground in Fig. 1 is a typical jute hessian loom individually driven by a small $\frac{3}{4}$ h.p. motor and a laminated belt. The arrangement constitutes an ideal smooth drive. Sufficient resiliency is obtained by means of the spiral springs which also offer a method of adjustment of the belt if necessary. The cover of the contact switches has been removed and is lying on the right. It should be noted that the usual long check strap or martingale has been replaced by a short fibrous strap and a patented buckle.

An automatic shuttle-changing loom of the Hattersley type with warp stop motion is illustrated in Fig. 2. In this case the motor is started by means of a small foot-lever at the front of the loom, and the laminated belt runs continuously. The loom is started by the control rod and cork insets on the face of one of the friction discs coming into contact with the face of the other friction disc, and of course, the loom is stopped by separating the two discs. The distribution box, full open, and its plugs are clearly visible in the foreground.

Two different types of individual drive are shown in Fig. 3. The one on the right is similar to that in Fig. 1, but connected to a sacking loom, while the one on the left is gear-driven and attached to a loom fitted with a dobby and 4-box drop motion of the enclosed eccentric type. A small pinion on the motor shaft drives the large fine-pitch wheel on the crankshaft positively, but between the large wheel and the usual driving pinion of the loom is a friction clutch, powerful enough to drive the loom when all is in order, but capable of slipping in case the loom knocks off from any cause.

Two similar gear-driven motors are shown coupled up to two looms in Fig. 4. The first loom is a double-lift, single-cylinder jacquard, while the one immediately behind is a 25-row single-lift twilling jacquard.

There is, perhaps, no textile machine more suitable than a loom for being individually driven; indeed, the loom and the self-acting mule are the outstanding machines to which individual drives are specially suitable. The great drawback to individual driving of looms is the immense number of motors required, but the arrangement yields a uniform drive, high production, light factory structures, efficient overseeing, saving in artificial light and loom furnishings, and the great advantage of using power only for productive machines in slack times or for overtime.

The Dundee Technical College Equipment.

Fig. 5 shows the bulk of the looms in the textile department of the Dundee Technical College, as well as a small motor on the wall adapted to drive the line shaft from which the winding and beaming machines are operated. The view emphasises the attractive appearance of a shed without long belts; underground shafting obviously yields the same effect, but it lacks many of the other advantages possessed by the individual electric drive. The electrical equipment is by the English Electric Company, Ltd.

There is, perhaps, not the same kind nor extent of trouble in the finishing department as in the other departments with respect to the consideration of the rupture of the products. The constituents, weak or otherwise, are already firmly combined so that the chief trouble will probably be that of eliminating friction, reducing the average load required, and introducing facilities which enable inertia to be overcome satisfactorily.

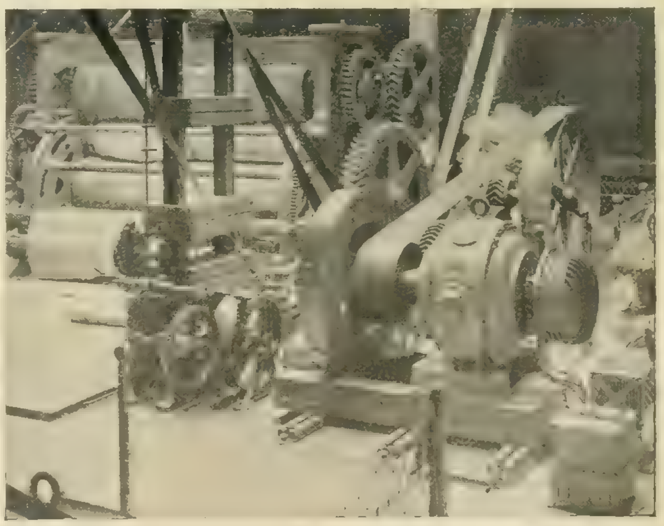

Fig. 9.—132 in. Hydraulic Mangle, Driven by 70 h.p. Motor and Provided with Heavy Flywheel to Level the Peaks.

The chief machines where the efficiency of a drive may be most variable are the cropper, calender, mangle and press. In the latter two, especially, high variations in the power required are found. Each of these machines, however, may be required to be in operation at certain times when the others are standing; and, when the normal power required is very high, say, in the case of a wide hydraulic mangle, the question of an individual drive becomes more pressing, or at least more desirable, than in most other cases.

A uniform speed to the rapidly rotating spiral knives of a cropper is bound to leave its effect upon the character of the cutting or cropping, but while the machine is at work the motion is continuous, and the consumption of power almost constant. The machines are operated in a more or less intermittent way, but a satisfactory line shaft drive should prove quite beneficial for such machines.

The same or similar remarks might be adduced in regard to calendering, either ordinary or glazing; when, however, chesting on either of the two top bowls is practised, it becomes necessary to alternate the directions of rotation. This reversing action is usually conducted by means of friction clutches even when the power itself is supplied from a motor and the driving of the main wheel continuous. In such cases, crossed and open belts are used to obtain the two directions of rotation.

Calender Drives.

Fig. 6 shows a 45 h.p. motor, driving a line shaft from which the usual belt drives are taken to a row of three calenders. In the foreground the cloth is shown on the stripping roller having been wound from the upper bowl of the calender after the chesting operation was completed. It has already been stated that for "chesting," the calender has to be driven alternately in two directions; the open and crossed belts are supplied for this purpose to work in conjunction with a friction clutch which can be placed in gear with either of the pulleys at will; these two belts are seen in close proximity to the laminated belt from the motor—the latter, of course, runs continuously in one direction while the current is on.

The feed and delivery sides of a similar 5-bowl, 96 in. calender are illustrated in Figs. 7 and 8, but in this case a 16 h.p. reversing motor is used, and the connection to the calender is by means of a chain. This arrangement obviously eliminates the open and crossed belts which, up to the present, have been invariably employed for these machines. We understand, however, that the reversals with the motor are made quickly and satisfactorily, and if this is the case, this type of drive will probably be extended for such purposes.

The stripping roller in Fig. 7 is empty, but it will be understood that it is used to wind the cloth from the calender bowls. In the illustration the several layers of cloth are seen distinctly on the top bowl. This stripping roller is driven from the line shaft, and the latter in turn is driven by a chain and by the small motor fixed to the roof. The above shaft would provide means for operating the stripping rollers of several calenders in a row.

Hydraulic Mangle.

A modern 132 in. hydraulic mangle is illustrated in Fig. 9, and all these machines are provided with automatic mechanical reversing motion. There is a great variation in the load during the cycle which takes place repeatedly. This particular machine is driven by a 70 h.p. motor shown on the right, and a laminated belt conducts the power to the main shaft of the mangle. It will be observed that there is a heavy flywheel to the left of the belt; the function of this flywheel is to enable the stored energy to equalise or reduce the peaks due to the sudden transference of the load from one friction ring to the other. Thus a minimum amount of current is necessary, and without such an equaliser a much higher power motor would be essential for the work. The last process in the trade is that of packing up the goods into bales by means of a hydraulic press. In some cases, a motor drives the pulley on the shaft and a friction clutch is then used to start and stop the pumps.

Continental Practice in the Electrical Driving of Textile Factories.

By W. DUNDAS FOX.

SINCE electricity was first brought into use as a motive power in the textile factory, rapid strides have been made in its application. The functions of the majority of textile machinery demand an even rotary motion, without speed variation (cyclic or otherwise), and individual drive by means of constant speed alternating current electric motors has proved to be an ideal method for obtaining this condition. Electrical engineers on the Continent have for many years specialised on this particular problem, and the well-known German firm of Messrs. Max Schorch & Company may be taken as one of the leading Continental specialists in this class of work. Owing to war conditions, there has, during the past few years, been little improvement in the matter of the application of individual drive to textile machinery, but the following particulars may be of interest, as giving some idea of the general practice, at the present time prevailing on the Continent. These particulars were kindly furnished to the writer during a visit to the works of Messrs. Max Schorch & Company. It is recognised that it is not possible to make a general recommendation in favour of individual driving for all textile machinery, and when considering the electrification of any factory each separate group of machinery must be investigated, in order to arrive at the best and most economical driving arrangement.

Openers and Scutchers.

Owing to the high speed of openers and scutchers, the individual electric drive is usually adopted, a three-phase 50 period squirrel cage motor being in many cases direct coupled to the machine, but frequently the individual belt drive is chosen, as this arrangement does not limit the speed beaters, and at the same time constitutes a considerably better protection to the motors and the machine, against the consequence of shock, caused by momentary overloads. This belt-driving arrangement, in comparison with the direct-coupling arrangement, also offers the advantage of the better utilisation of floor space.

Revolving Flat Cards.

Speaking generally, revolving flat cards are handled on the group-drive system, the motor being direct coupled to a high-speed transmission shaft. There are, however, occasional instances where individual cards are erected, or the limited floor space produces difficulties in mounting the shafting, &c., and in such cases the single individual drive forms a convenient alternative.

Drawing Frames.

The individual electric drive is considered an ideal drive for drawing frames, and is generally recommended. Ordinarily the motor is mounted on the floor within the machine itself and is coupled to the latter by means of gears. The control switch for starting and stopping the motor is directly connected mechanically with the self-acting stop arrangement on the machine in such a manner as to stop the motor automatically in the case of the breakage of the yarn.

Flyer Frames.

Flyer frames are usually individually driven, and as it is important that they should start smoothly, free from shocks of any kind, special care has been taken in designing a motor to meet this requirement, without the employment of slip-ring motors, and the consequent external control resistances. The motors employed for this duty are specially constructed squirrel cage motors for which the electrical conditions are chosen, in such a way as to bring the motor up to its normal full load speed in 5-7 secs. A reference to Fig. 1 plainly demonstrates that the other qualities of the motor are in no way impaired by this special feature. As a rule the motor is simply coupled to the frame by means of tooth gearing, and the operating switch on the motor is connected with the operating handle of the flyer frame.

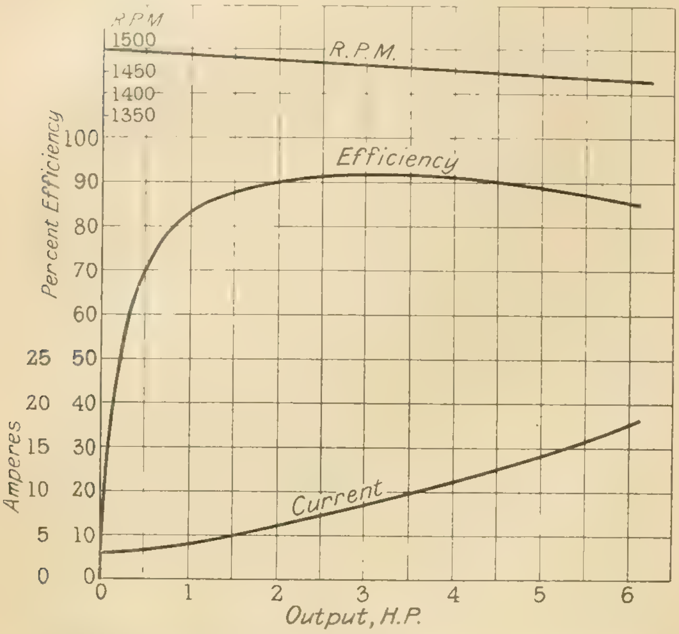

Fig. 1.—Operation Curves of the Schorch Squirrel-cage Motor.

Mules.

Fig. 2 shows the peculiar curve of a mule, and Fig. 3 exhibits the capacity curve of a motor manufactured by Messrs. Max Schorch & Company, and designed specially for the individual drive of cotton mules with 1,000 spindles. The efficiency under a load of 4 b.h.p. is as much as 80 per cent.; between 8 b.h.p. and 27 b.h.p. about 90 per cent. is attained; and the highest value of 92·5 per cent. is reached, under a load of about 15 b.h.p. A reference to Fig. 2 will show that the average efficiency of this motor, when driving the mule, is about 89 per cent.

It has been found impossible to guard against the possibility of very heavy speed variations, when handling the drive of spinning mules on the group system, owing to the frequent synchronism of the maximum or minimum power required by the several mules, while the heavy transmission shafts being easily subjected to whip and swinging, causes great changes of speed. Individual drive is usually recommended, and it is found that considerable advantages acrue therefrom, each individual mule works separately from its neighbour, and the speed during each operation being consequently found to be quite constant. The result is a considerable increase in production, and a better quality of material.

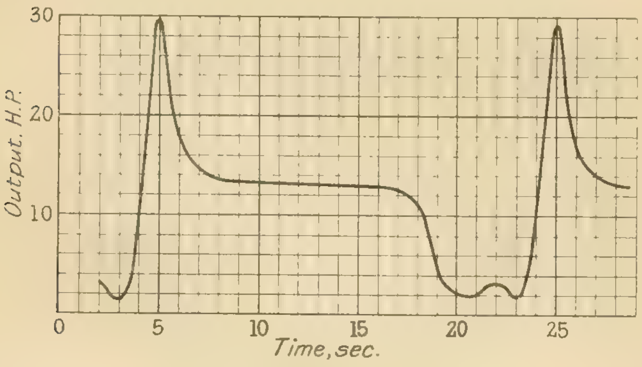

Fig. 2.—The Load Curve of a Mule.

Ring Spinning Machines.

The even power consumption obtained by the regular spinning and winding process, the simple construction of the machines and the high speed of the driving shaft, makes the ring spinning machine highly suitable for the individual drive. Electrical engineers on the Continent have devoted a considerable amount of time to the problem of determining the most suitable method of electrical individual drive for the ring spinning machine, and several methods have been tried and are in successful operation.

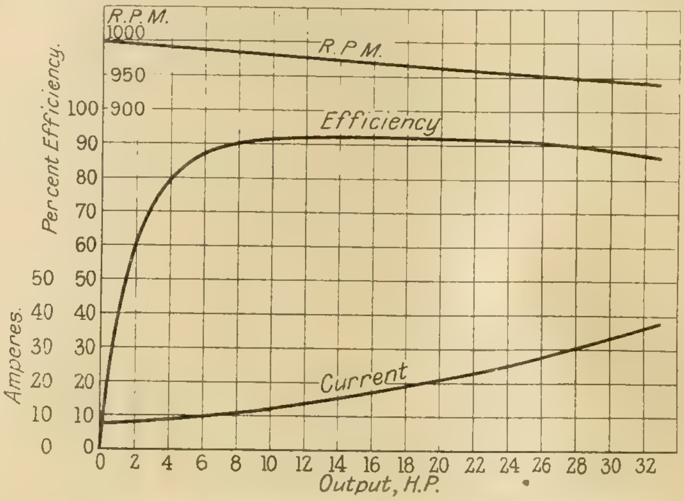

Fig. 3.—Curves of a Schorch Motor for Individual Cotton Mill Drives.

Considering the peculiar manner of operation of the ring spinning machine, a spindle moving constantly at a fixed number of revolutions per minute would be the medium of producing variation in the tension of the thread, between the ring and the cop, and between the eye and the drawing frame, corresponding to the diameter of the winding up. The first named deviation would cause irregular formation of the cop, whilst the second one would produce an uneven drawing of the thread (thus causing a depreciation of the quality and consequently an enhanced liability to breakage). In order to produce a uniform tension of the thread, it is vital to obtain rising periodical variations in the speed progressing with the diameter of the winding up process, as illustrated in Fig. 4. At the beginning of the winding, the average speed increases, the periodical variation amounting to about 20 per cent. With a drive permitting a periodical variation of the revolutions, an average speed of 90 per cent. of the highest speed during the time of spinning the cylindrical part (Line B) is attained, whilst a drive with constant speed does not surpass the lowest

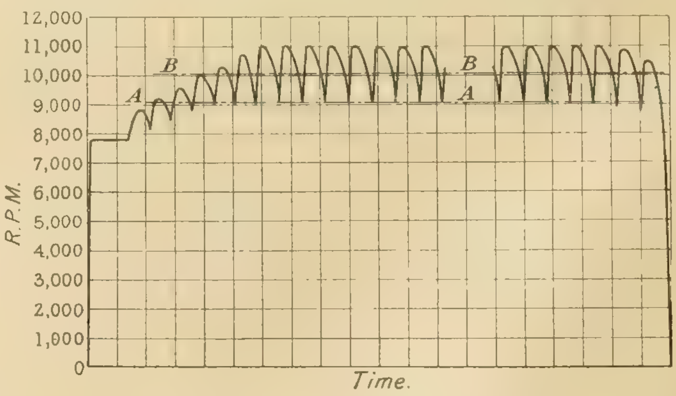

Fig. 4.—Power Curve of Ring Spinning Machine.

line (B) as far as working speed is concerned. In view of the reduced speed at the beginning of the process of winding up, it is correct to say that the average number of revolutions and consequently the production at a periodically variable speed, works out at roughly 10 per cent higher than when spinning at a constant speed. The highest permissible speed is dependent upon the quality and count of the yarn required, and this makes it necessary that the motors utilised for the individual drive of ring spinning machines should possess both heavy starting torque and also the following special characteristics: (1) The possibility of a periodical variation of the speed in order to obtain a uniform tension of the thread throughout the process; (2) capacity to run at a variable speed according to the class of material in progress of manufacture.

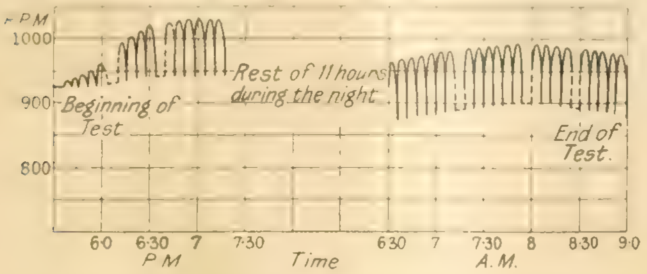

Fig. 5.—Variation of Speed in a Ring Spinning Machine.

There are three types of motors which nearly provide these requirements, viz.: (1) The asynchronous alternating-current motor with resistance regulator; (2) the three-phase alternating-current motor with a pole-changing device, and (3) commutator motors.

Different Types of Motor.

The above motors are used in connection with an automatic speed regulating device, which varies the speed according to the position of the ring, in one case by working and cutting out the resistance, and in another case by simply moving the brush rocker. Also by means of varying the gear between the tin roller and the motor, the number of revolutions can be altered at will. Generally direct coupling of the commutator motor to the tin roller is employed simply because this arrangement permits a speed variation over a wide range by means of a simple brush displacement device, and this circumstance is often responsible for the commutator motor being preferred to any other system. Amongst these are the three-phase commutator motors, which possess the advantage of a high output, and equal distribution of the load in a three-phase network. This type of motor, however, has some disadvantages, which are: (1) The comparatively high original cost; (2) the low efficiency requiring a high consumption of power and not permitting a simple enclosing of the motor, but demanding artificial water or air cooling; (3) the great attention required for the commutator; (4) the frequent breakdowns.

In the case of a machine requiring frequent changes of speed, due to large variations in the sizes of counts to be spun, a slip ring motor combined with tooth gearing is employed. Such an equipment shows an efficiency of about 80 per cent., and yet includes the losses of resistance, and equals at least that of the commutator motor. It has been found that the pretension as to the superiority of the commutator motor, compared with the slip-ring motor, on account of the easy regulation of the speed without loss, lacks justification.

Speed Variation Problems.

The commutator losses arise inside the motor, and those of the slip-ring motor, outside the motor. Therefore, it is quite permissible to totally enclose the slip-ring machine, without being put to the necessity of constructing it in a large size, or resorting to artificial cooling. As mentioned before, in practice it is not possible to attain the ideal regulation corresponding with the theory of the changing tension of the thread, not even by an automatic speed regulating device. Small irregularities in the mechanical equipment, which are transmitted to the brush rocking device, may be the means of serious deviations from the desired speed, as a commutator motor is most sensitive in regard to the speed as affected by the brush displacement. This is clearly shown by reference to Fig. 4. A commutator motor possesses, without exception, the same characteristics as a series machine, that is, even at otherwise stationary conditions, its speed is to a large degree dependent upon the load. At each working pause, the motor consumes a greater amount of energy on account of cold bearings, &c., than it will do after the machine has been running for some time, therefore, it is quite impossible to obtain in practice such a fine and exact working as is shown in Fig. 4. Even small overloads, such as may be occasioned by a broken spindle cord catching a neighbouring cord, will not remain without influence upon the speed. A very interesting illustration of the variation in speed is shown in Fig. 5, such as may be caused solely through the conditions in the bearings of the machine. This diagram demonstrates the variation of speed on two successive days, in completing a given job. As may be seen, the speed in the evening shows variations from 875 to 965 revs. per min. It must be pointed out that the tachograph diagrams were registered during the summer, on a machine that had been running some considerable time, therefore, variations in power consumption, caused by the changes of the temperature, are not so strongly pronounced as would be the case in winter. It is, therefore, impossible to attain the theoretically correct speed, and as the commutator motor possesses the disadvantages indicated, it has been replaced by an arrangement, the result of which may be seen by reference to Fig. 6. This scheme aims at running one and the same speed for the beginning of the cop, and also for the spinning of the bobbin end, reserving a higher speed for the spinning of the cylindrical part. The change from one speed to the other is effected either mechanically or by hand. This arrangement permits of an increase of production of about 5 per cent. In order to obtain the speed regulation shown in Fig. 6, either slip-ring or squirrel-cage motors with pole-changing devices are used. The latter have many a drawback, their price being high and they have a very low efficiency and power factor. This scheme is not usually adopted except in isolated cases, where a few machines only are to be driven. Where groups of ring-spinning frames are to be driven together, the firm of Max Schorch & Company have worked out a scheme of their own, in which the variation of the speed is obtained by means of squirrel-cage motors, which, on account of their simplicity, great economy, and last but not least, their cheapness, surpass all the other electrical drives. The Schorch system has the great advantage that the speed of a three-phase motor is exactly in proportion to the frequency of the supply circuit. Supposing current is supplied to the motor by two separate sets of mains, the latter supplying a current of less frequency, then the motor will run more quickly or slowly according to the line which it is connected to. An auxiliary generator or frequency transformer, producing a current of the lower frequency, is also in circuit. This can be of quite small dimensions, as it works only during a limited fraction of the spinning period, only just the time when the reduction of the speed becomes a necessity. A simple

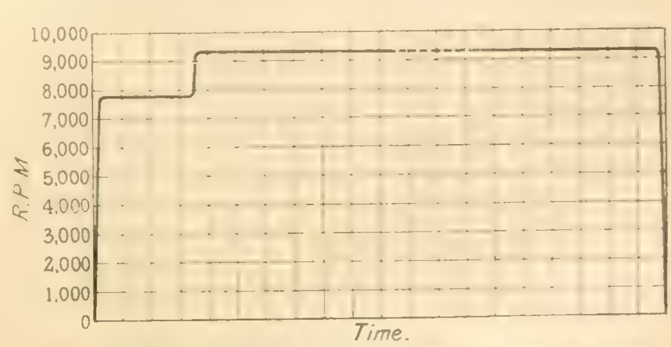

Fig. 6.—Speed Variation Obtained with Improved Driving Arrangements.

change-over switch is all that is required in the way of apparatus. The high efficiency motors of the Schorch make are all totally enclosed, and work with an average degree of efficiency of 89 per cent. This figure includes the losses occasioned by the frequency transformer. It is interesting to note that in spite of that, the cost of this installation is not as high as that of the motors with pole-changing device, taking into account the indispensable forced cooling.

Looms.

Little or no improvement has been made during the past few years in the electric drive of looms, but it is interesting to note that after numerous trials and experiments, Messrs. Schorch & Company have discarded the individual gear drive, excepting in special circumstances, and as a general rule the well-known type of totally-enclosed loom motor, with belt drive and spring belt-tightener, is installed.

The Use of Gears and High Speed Motors in Textile Mills.

By GEORGE S. SHARMAN.

Gearing in one form or another has been widely employed in the textile industry from the very earliest days. When the slow moving beam engine was in vogue, the main drive from the engine was generally by spur gears, which in many cases was incorporated with the fly-wheel. The wheels were of great size and weight, and it was quite a common thing to have a 20-ft. wheel on the engine driving one or more smaller wheels on the second motion shaft or shafts. These were ordinary cast-iron gears of a very coarse pitch, and naturally set up a good deal of noise and vibration. In order to reduce the noise, the cast-iron flywheel gear was often used in conjunction with a smaller wheel having inserted wooden teeth, and it must be confessed that some of these gave most excellent service.

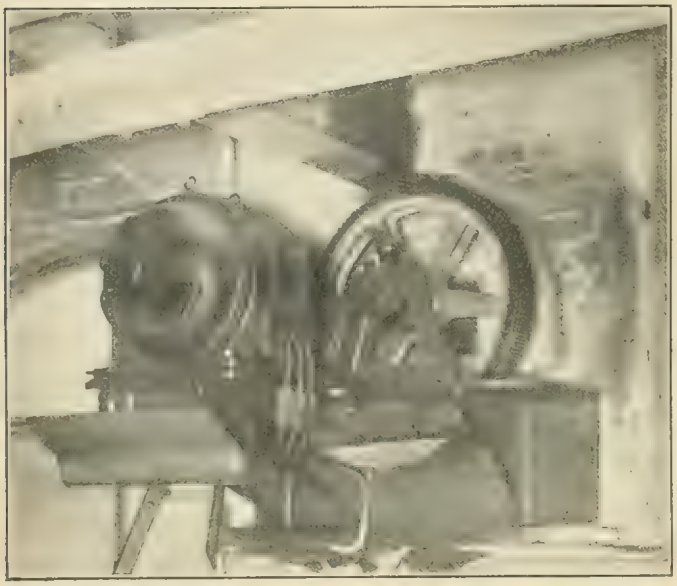

Fig. 1.—Gear-driven Line Shaft, Motor Outside Weaving Shed.

The writer saw such a pair of gears only a few months ago in a large factory in Belfast devoted to the spinning and weaving of flax. These gears had been in use for fifty years, and are still giving every satisfaction, the quietness and smoothness of the drive being astonishing. The wooden teeth of course are replaced from time to time, but they appear to last for about three years, and then may be turned round and run on the other side of the teeth for about twelve months. The cast-iron flywheel gear had teeth of 4 in. pitch, and ran at a velocity of 2,000 ft. per min. There was very little wear indeed on the teeth after 50 years use, and their surface was polished smooth and hard like glass.

In the old mills the use of gearing did not by any means stop at the second motion shaft, but on the contrary it formed the most important feature of the whole system of power distribution throughout the mill, a fact to which many old-fashioned mills scattered throughout the textile manufacturing districts of the country continue to bear witness—but by no means silent witness—to-day. Spur wheels transmit the power from the engine to second motion shafts, bevel wheels thence to upright shafts, more bevels to various horizontal shafts on different floors, and in very many cases still more bevel gears or whole series of bevel gears are interposed before the power is ultimately delivered to the shafts to which the machines are belted.

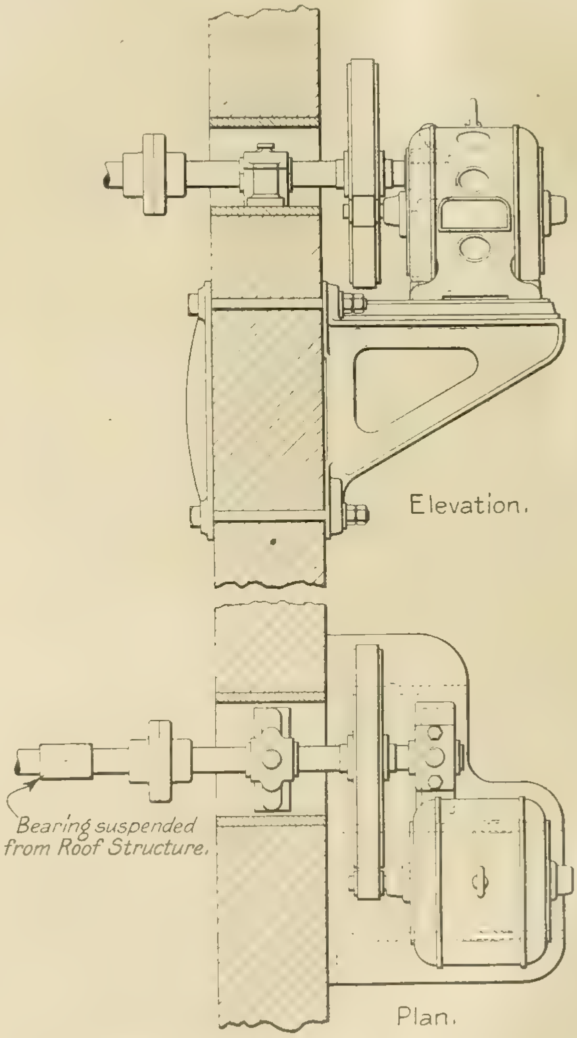

Fig. 2. Diagram of an Excellent Arrangement for Geared Line-Shaft Drive when Motors can be Supported on Wall Brackets.

Friction Losses.

It must be borne in mind that practically all the old gearing is of cast-iron with unmachined teeth, and it cannot be wondered at that the percentage of power which is lost in friction in some of these old mills is very high, reaching 30, 40, or in very exceptional cases even 50 per cent. of the total power developed. In modern steam driven mills spur gearing has almost entirely given place to rope driving, and a very high degree of overall transmission efficiency has been attained. This is partly due to the particular adaptability of the rope drive for transmitting power from a slow running prime mover to a number of parallel shafts grouped one above the other on the different floors of the mill, and partly due to the greatly improved and simplified general layout of the mills.

In weaving sheds the old-fashioned gearing has held its own against the encroachment of rope driving since the conditions do not favour the latter, as they do in the many-storeyed spinning mills. The old-fashioned method of driving is to run one main shaft down one side of the shed and connect it successively at intervals of about 10 ft. through bevel gears to the ends of the numerous cross shafts. This method of driving persists extensively to-day in steam-driven weaving sheds. The desire for its abolition is often an incentive to adopt electrical driving, as the looms can then be divided into groups and driven from motors without heavy mechanical transmissions.

Gearing and the Electric Drive.

The introduction of electrical driving into textile mills has radically changed the problems of mechanical transmission which have to be faced. This is due to two principal causes: Firstly, the electric motor is essentially a high-speed machine, whereas hitherto slow-speed engines have been used almost exclusively; secondly, when the old prime mover has been dispensed with, there is no necessity to drive the mill from one central point, but on the contrary it is far more advantageous to split up the power and bring the motor as close to its work as practicable. The consequence is that as far as mechanical transmission is concerned, the power to be dealt with is of a comparatively small order, considerable speed reductions have often to be effected, and compact drives are generally desired. It will be seen on examination that these conditions particularly suit mechanical gearing, and one result of the extension of electrical driving is undoubtedly an increased use of toothed gearing as opposed to rope and belt driving.

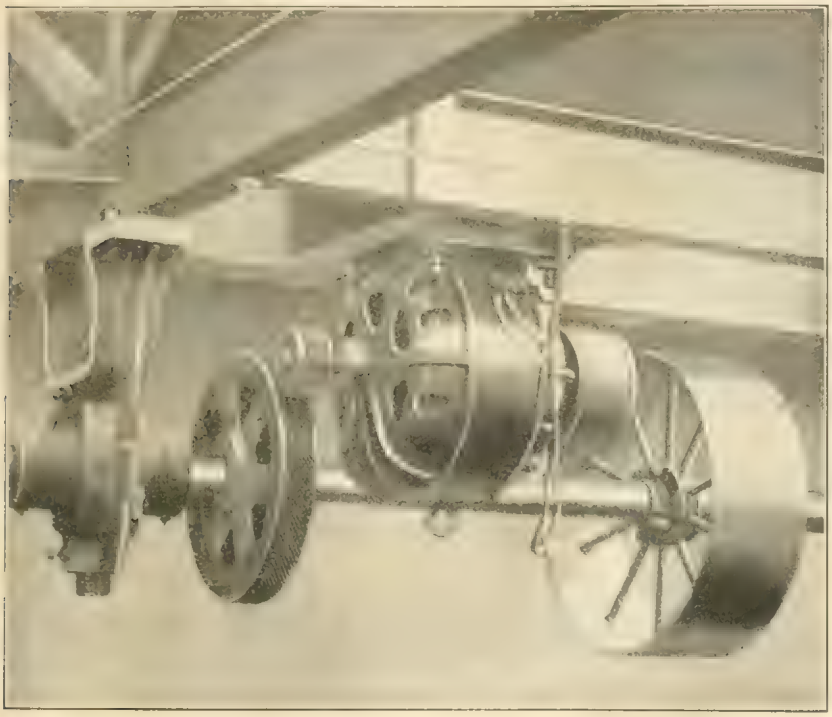

Fig. 3.—Gear Drive to Line Shaft. Motor Suspended Upside Down from Roof Girders.

The Advantages of the Gear Drive.

The great advances which have been made in recent years in the manufacture of machine cut gearing has enabled this form of transmission to be applied to motor drives with great success. The advantages of a gear drive may be briefly stated to be, shorter centres, thus saving valuable space, greater efficiency (provided the gears are accurately made) and longer life. Gearing also gives a more positive drive, and is of great value in many textile operations where it is important that no speed variations should occur. There can be no slip with gears, and the ratio between the driving and the driven shafts remains constant. The objections to gear drives have been very largely on account of noise, but during the last few years a great deal has been done to overcome this, and a special gear is now produced which gives a silent drive at ordinary motor speeds.

The application of totally enclosed double helical gearing for speed reduction on motors of large horse-power is well known, and very fine results have been obtained with this class of gear. This type of drive, however, is not very common in textile mills, and the writer does not propose to enlarge upon the subject.

The modern tendency in electrification is for group driving with motors of medium horse-power, as the liability to stoppage due to breakdown is very much reduced, and certain groups of machines can be run quite independently and irrespective of others. This method of driving calls for the use of motors of a moderate horse-power, and if these motors can be run at a reasonably high speed there is an initial saving in the cost of the installation and an increased efficiency from the motors themselves. Moreover, as the motors used in textile mills are invariably alternating current machines the question of power factor comes in, and from this point of view it is extremely desirable to use fairly high motor speeds. When gearing is used in connection with high speed motors, the gears must of necessity be of the best quality, and it is essential that they should be machine cut, for the absence of noise and vibration is largely dependent upon the accuracy of the manufacture of the gears.

During recent years it has been found possible successfully to gear motors directly to line shafts, and in many cases a higher speed motor can be used than if a belt drive had been employed. This is due to the fact that a bigger reduction can be obtained in a limited space with a gear than with a belt, as in the case of the latter it is sometimes found that a large enough pulley cannot be fitted to the line shaft on account of the roof clearance or other obstruction.

In order to reduce noise in the gears, special pinions are often employed composed of some other material than metal. Perhaps the best known of these is raw hide, and on many drives these have proved highly satisfactory and have run for years without giving trouble of any description. They are, however, sometimes affected by atmospherical conditions, and care must be exercised in deciding the drives for which they are suitable. Other pinions are made from compressed paper, and there is a special pinion composed of compressed cotton which goes under the trade name of "Fabroil."

The Laminated Staggered Tooth Gear.

The all metal silent gear previously referred to is a laminated staggered tooth gear manufactured by Laminated Gears, Ltd., Sheffield. It consists of a series of high carbon steel plates (having a tensile strength of 50 tons per square inch) assembled on a central cast iron hub. After the teeth are cut the plates are staggered relatively to each other, alternate plates being moved half a pitch forward. This gives double points of contact, eliminates backlash and vibration, and it is claimed by the makers that a smooth and steady drive results. It is not necessary to run these gears in an oil bath at normal motor speeds as the grease is retained in the spaces between the teeth. An additional advantage is the allowance for end play which is made by inserting thin distance plates between the toothed plates, which enables the motor armature shaft to float. With these gears considerably higher ratios of reduction can be obtained than with ordinary spur gears, and this is of particular advantage in enabling higher speed motors to be installed. Reductions of 7, 8, 9 and even 10 : 1 are often obtained by this gear for drives of moderate power.

Totally enclosed worm reduction gears are often used in textile mills, and they give a much bigger reduction than spur gearing, although with a certain loss of efficiency. They are also somewhat costly, but for certain purposes they make an exceedingly compact arrangement and give a very smooth and steady drive. In this connection it may be mentioned that worm gears have proved entirely successful on calender drives where the speed reduction is great and where a perfectly smooth and steady drive is of great advantage.

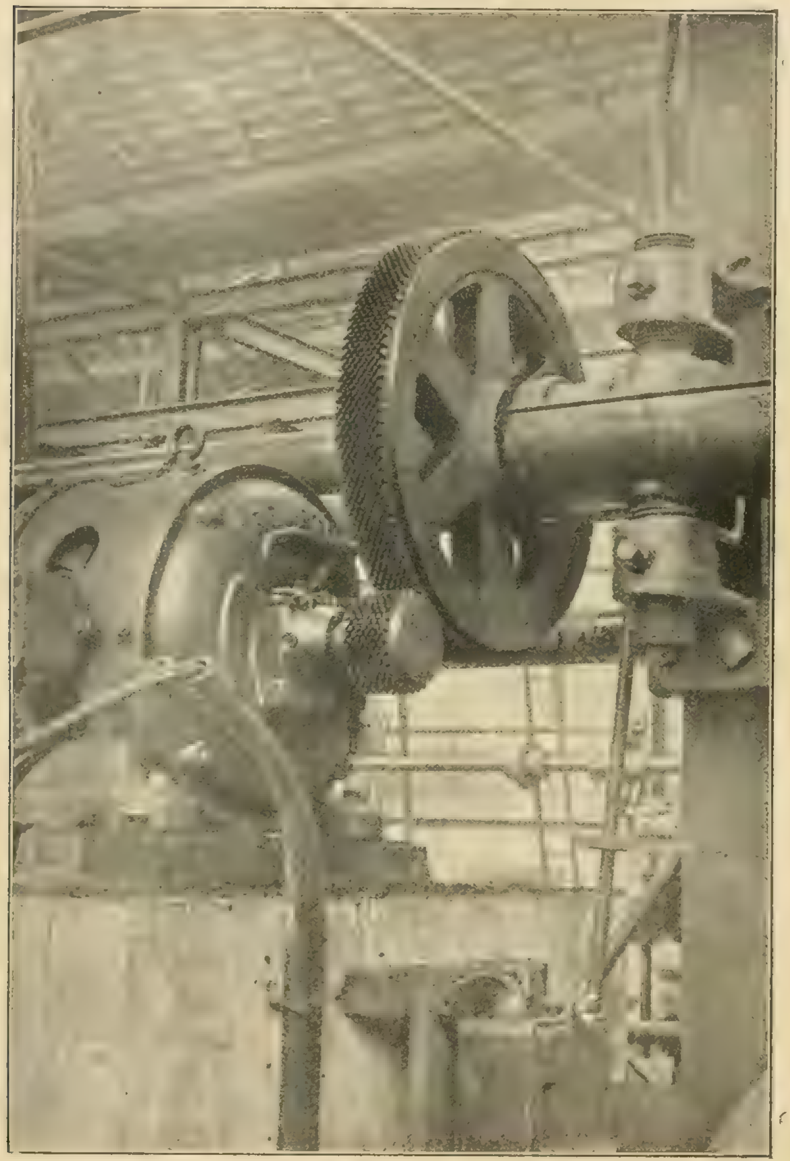

Fig. 4.—High-speed Motor (1,440 revs. per min.) Mounted on Concrete Pillar with Gear Drive to Line Shaft.

Gear-driven Line Shafts.

A few remarks regarding gear-driven line shafts may prove of interest. Fig. 1 shows one of 40 geared motors driving the cross-shafts in a weaving shed. It will be seen that the motor is mounted on a bracket securely fastened to the wall. The motors are all outside the weaving shed, and the large wheel is keyed on to a short length of shaft which is attached by means of a solid coupling to the main length of shaft just inside the shed. This short length of shaft greatly facilitates erection and is strongly to be recommended where possible. It is swelled in the middle where the spur wheel fits, and the shaft itself is carried on two bearings, one a wall box and the other a bearing of the usual Plummer block type carried on the same bedplate as the motor. The pinion is keyed direct on to the motor shaft and is overhung, and slots are provided for the holding-down bolts of the motor which enables correct alignment to be easily obtained. The motors are 20 h.p. running at 960 revs. per min. and reducing to 145 revs. per min. on the line shaft. These gears are of the laminated type previously referred to. An excellent arrangement where the motor can be supported on wall brackets is shown in Fig. 2.

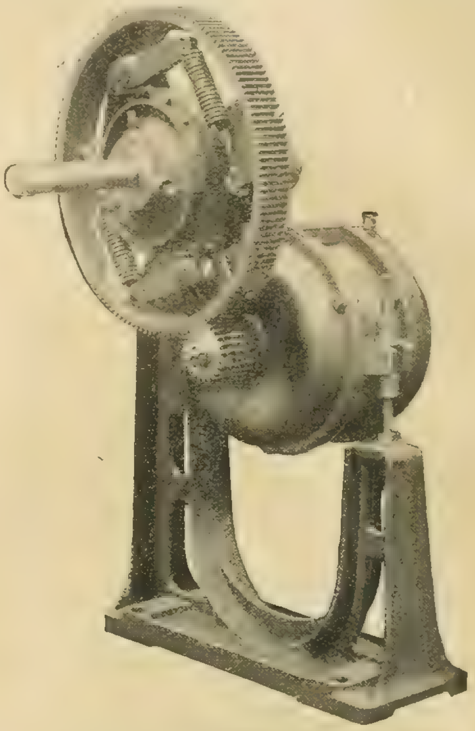

Fig. 5.—Motor for Individual Loom Drive, Showing Reduction Gears.

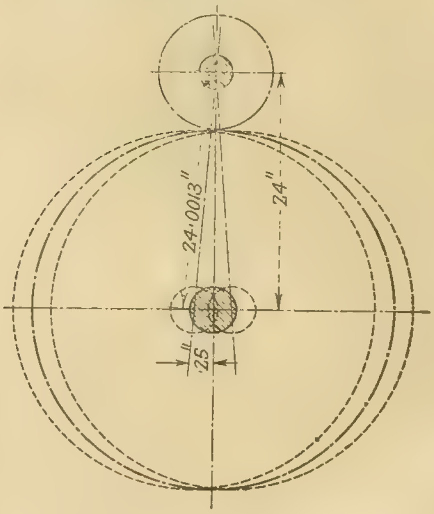

Fig. 6.—Diagrammatical Sketch Illustrating Remarks on Horizontal Drive to Calender Bowl Shaft.

In some cases it is not possible to carry the motors on wall brackets, and if the roof is sufficiently strong they may be suspended upside down as shown in Fig. 3. There are many other ways of erecting motors for line-shafting drives, but the main principle to be observed is that the supports for the motor should be as rigid and strong as possible, and that the spur wheel should be keyed as near as possible to the bearing. Fig. 4 shows a 15-h.p. motor running at 1,440 revs. per min. on a concrete pillar and driving through gears on to a line shaft. It will be noticed how close the spur wheel is to the bearing.

LOOM DRIVING.

The driving of looms individually by means of small motors offers scope for the use of gearing. Fig. 5 shows a motor of this description with its reduction gear, and this combined type of drive has been successfully fitted to a large number of looms in this country. Six-pole 3-phase motors are employed, and on the usual 50-cycle supply the speed is about 1,000 revs. per min. and the gear reduction varies between 5 : 1 and 9 : 1. The spur wheel is machine-cut cast iron, and the pinion may be raw hide, paper, bronze, mild steel, &c., &c. The pitch, of course, is small, being about 8 to 10 diametral pitch or its equivalent metric pitch. In America a very large proportion of the looms are individually driven, and in practically all cases through gears. The motors used are mostly four pole, and as the supply is usually at 60 cycles, the motor speed is something like 1,750 revs. per min. The motor is geared direct to the loom crankshaft, and this obviously necessitates extremely high gearing ratios. Apparently these installations are quite successful, and this method of driving is extending.

CALENDERS AND PRINTING MACHINES.

Calenders and printing machines are very often driven by gears, and with great advantage both as regards economy in space and smoothness of drive as compared with belt. On printing machines in particular belt-slip is liable to give a somewhat uneven drive, the effects of which are noticeable on the finished work. The speed reduction required on calender drives is generally considerable, and worm gear is often used for this purpose. Owing to the constant alterations in the position of the bowls, great care should be exercised in the design of the transmission. When using spur gearing the reduction may be arranged in one step if it is not too great, or, alternatively, double reduction gears can be used. It is advisable where possible to mount the final wheel on a separate shaft and attach it to the calender bowl shaft by means of a universal coupling. This enables the bowl to alter its position without affecting in any way the distance between the centres of the gears, for no wheels can be expected to give their best results if the centres at which they run are not accurately set and maintained.

In some cases, however, it is not possible to adopt the above method, and it is necessary to key the wheel on to the bowl shaft, and as this bowl is raised or lowered the gears will go in and out of mesh accordingly. In order to minimise as much as possible the effect of this movement, a slightly larger pitch than usual should be employed and the drive arranged as a horizontal one so that the pinion is on a level with the centre of the bowl shaft when the bowl is in its normal position. A vertical movement of the bowl will then only have a slight effect upon the distance between the cêntres of the two gears. This will be clearly understood by reference to the diagrammatical sketch, Fig. 6.

Ring doubling frames and ring spinning frames, where individually driven, are, of course, directly coupled to the motor wherever the speeds can be suitably arranged, but occasions do arise where the frames cannot be run at any of the possible speeds of an induction motor and it is necessary to have a speed reduction. The difficulty in driving these frames is the heavy starting torque, and this is sometimes met by the introduction of a clutch coupling, and experiments are now being conducted with a combined laminated gear and special clutch-coupling drive to doubling and ring spinning frames.

In conclusion, it would seem that gears will appear in textile mills in increasing quantities, but gears of the highest class and designed for a high efficiency and for economy. At the present time only a very small percentage of the textile mills in Lancashire and Yorkshire are electrically driven, and as the mills change over to electric power this form of transmission is bound to be increasingly used, as for certain purposes it still retains many advantages over any other method. Gearing is still the best means of obtaining a positive drive in the smallest possible space, and when correctly made and designed has a very long life, and maintenance and renewal charges are exceedingly low.

The Application of Electricity to Paper Mills.

By E. E. FULLER, A.M.I.E.E.

It is not intended in this article to describe in detail the process of paper making, though sufficient information will be given to enable a fair idea to be obtained of the production of paper from the raw material. The question of power-house plant and the steam distribution is also of so great importance that it amply justifies an article devoted alone to this subject; but the author has confined himself to the various sections of paper-making plant, and has given information regarding the power required to drive them, with curves which show the variations in load. These figures cannot be applied to all cases, as operating conditions vary considerably in different mills. They will, however, give reliable information of machines as used in a "news" mill.

In many of the existing mills, large slow-speed compound-condensing engines are used to drive the line shafting required for the existing plant. This arrangement necessitates long heavy shafting, numerous belts or ropes. It is often stated that properly constructed shafting does not consume more than 12 to 15 per cent. of the total power of the engine driving it. Under exceedingly good conditions, with accurate alignment, and belts or ropes neither too tight nor too loose, these figures might be obtained by the usual method of testing for friction load. This method, however, will not give the true friction losses when the shafting is running fully loaded. When converting industrial plants to electric drive, and eliminating the line shaft, it has been found from numerous tests taken before and after the conversion that the friction losses are from 25 to 40 per cent. of the power consumed, according to the condition of the plant. In applying electric power to paper-mill machinery every effort should be made to avoid the use of shafting; there is not a single machine that cannot be driven either direct or by belt or chain. One need not fear giving satisfaction provided each drive is carefully considered regarding the normal and possible overload condition.

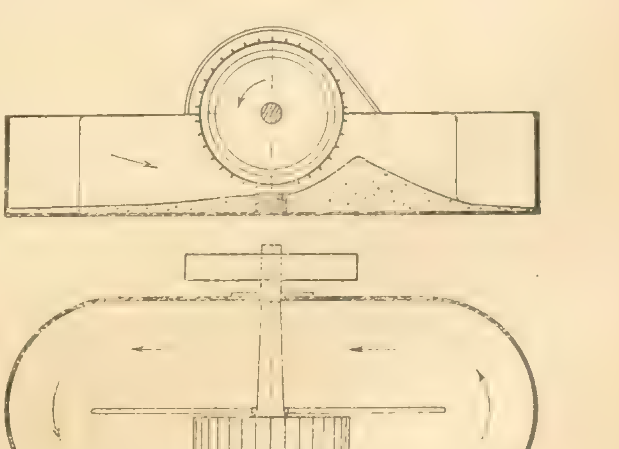

FIG. 1. DIAGRAMS OF ARRANGEMENT OF TANK AND BEATING CYLINDER.

Drip-proof motors, or in special cases forced ventilation, should be used. The windings should be impregnated with waterproof compound, to preserve them against the effect of the vapour.

THE POTCHER.

Raw material used in mills manufacturing "news," or the common class of paper, consists of two kinds. These are known as mechanical, or plain ground wood, and chemical pulp. The relative proportion of each depends upon the quality of the paper required. Canada and Norway import into this country by far the largest quantity of both classes of pulp. It is made up in bales of about 4 to $4\frac{1}{2}$ cwt.; this includes moisture, varying from 40 to 50 per cent. of the gross weight. The first machine to be used for beating the raw material into pulp is the potcher. It is in the form of an elliptical tank having a capacity of 8 to 10 cwt. There are larger potchers in use, but this size may be considered to be the usual capacity adopted, except for very large machine mills.

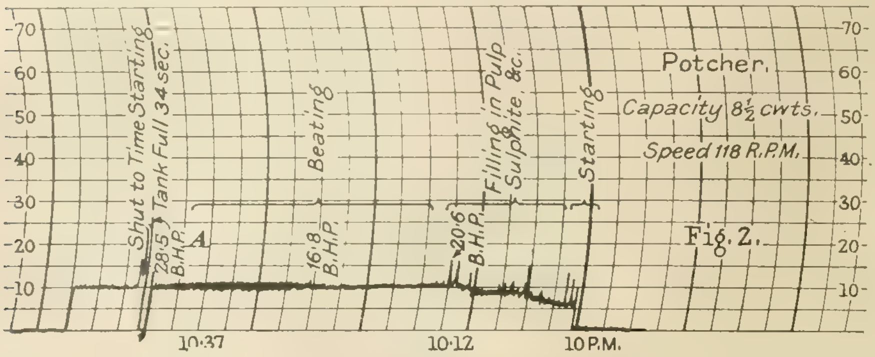

Fig. 2. Power Variations on the Potcher.

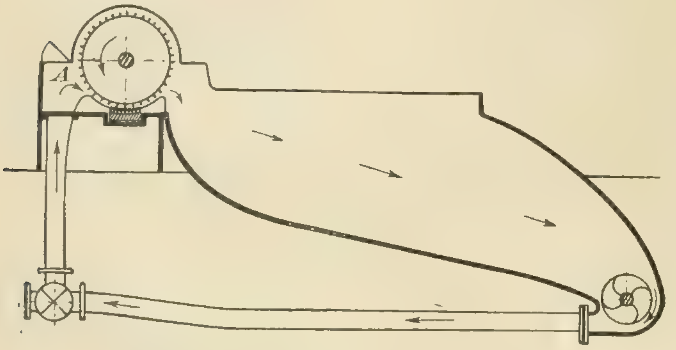

Fig. 3.—Diagram of the Taylor Beater.

The potcher tank is filled with its proper supply of water, then the raw material is fed into it in the form of sheets detached from the bales. Cuttings from the finished paper, broke from the machine, also returned newspapers in certain proportions, are used, as well as china clay It will be noticed from curve Fig. 2 that the filling in time occupies approximately 12 mins.

Fig. 1 will give some idea of the arrangement of the tank and beating cylinder. The number of blades or paddles on the cylinder varies considerably. For beating pulp for "news" a few blades only are required, generally 6 to 12; in the case of fine printing paper a much greater number of blades are used. The actual material used in a potcher having a beating capacity of 10 cwt. rarely exeeds $8\frac{1}{2}$ to 9 cwt. The normal speed of the cylinder is from 120 to 140 revs. per min. Whatever the speed is, it is not necessary to vary it, so that a constant-speed motor will be found to be quite suitable. Usually, the potchers are placed in pairs with the driving pulleys side by side. This arrangement enables a single motor with two pulleys to be used for driving the two potchers. In selecting a suitable motor for this drive, allowance must be made for starting up the potchers with the tanks full of stuff and water. To enable this to be done, it is necessary to provide a motor capable of exerting a starting torque of $2\frac{1}{2}$ times the full load torque. Assuming the bearings are in good condition and the beating is normal, the power required to drive a single 10 cwt. potcher would be 20 B.H.P. If the beating is forced or the raw material fed in rapidly, the power may be as much as 30 B.H.P.

The curve in Fig. 2 indicates the power variations with this machine. The worst condition to be met with is when starting up with the tank full as shown at *A*. From start to finish the time occupied is about 37 minutes. It will be noticed that the power after the feeding operation is finished remains practically constant.

THE BEATING PROCESS.

From the potcher the stuff is pumped to the beaters. The principle is practically the same as described for the potcher. The cylinder is lighter and smaller in diameter, and is provided with a greater number of blades. The clearance between the potcher cylinder and bottom plate may be 3 in. to 4 in., whereas in the case of a beater, the cylinder is adjusted by means of a screw gear, so that the blades can just clear the bottom plate by a few thousandths of an inch, theoretically there should always be a clearance; in practice, however, this is hardly possible. The usual design of beater will not permit of such fine adjustment, due to the fact that the blades wear unevenly, also due to the spring of the cylinder shaft between the bearings. This is a question which paper-machine manufacturers should consider. Better type of bearings and heavier shafts should be provided, so that fine adjustments may be made. A considerable waste of power and unsatisfactory beating is caused by the rubbing of the worn cylinder blades against the bottom plate.

Fig. 3 illustrates a Taylor beater. The stuff in a beater travels outward from the cylinder, and in a downward direction until it passes into the rotary pump chamber. From the pump it is delivered to the back of the chamber, *A*, and then passes between the cylinder and bottom plate. It is difficult to make a definite statement regarding the power required by a Taylor beater; so much depends on the position of the cylinder in relation to the bottom plate. If we assume the beater to be in a satisfactory condition, and the blades just rubbing the bottom plate, a beater having a capacity of 8 cwt. would require about 30 B.H.P. It is possible by screwing the cylinder hard down on to the plate, to absorb 50 B.H.P. The length of the cylinder was 5 ft. and 2 ft. 6 in. diameter, with blades spaced $\frac{3}{4}$ in. apart; the height of pulp in chambe *A* was 12 in.

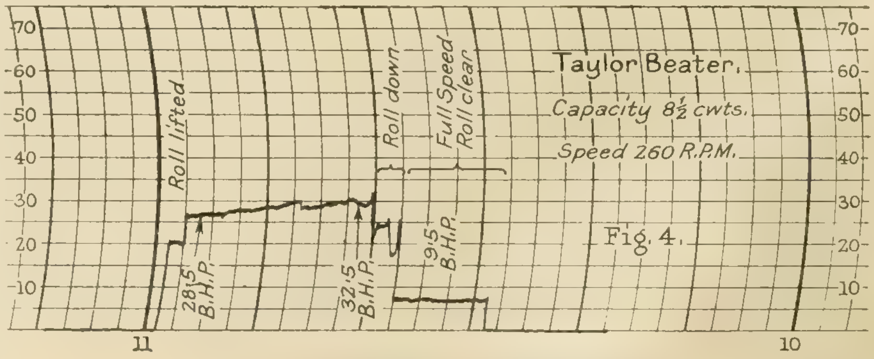

Fig. 4. Power Curve of Taylor Beater.

Fig. 4 is a typical power curve taken from a motor driving a Taylor beater. The beater was in a fair condition, and was beating stuff for "news." The cylinder was lowered until the blades were rubbing. The light load power recorded was 9·5 B.H.P.; this includes the circulating pump which is driven from the cylinder shaft. The power increased to a maximum of 32·5 B.H.P. then decreased to 28·5 B.H.P. The beating being sufficient for the requirements, the cylinder was lifted and motor shut down. The speed of the beater was 260 revs. per min.

Refiners or Jordans.

The practice of beating by potcher and beaters without the use of a refiner, is to be found in many mills, principally mills making fine paper. In "news" mills the refiner has practically displaced the beater. It is not intended in this article to deal with the advantages or disadvantages of the two types of beating machines.

Refiner can be started without load by screwing out the rotor cone, therefore it is not necessary to have a motor capable of more than the standard torque. When arranging a motor for direct coupling a flexible coupling with extended jaws may be used to take up the cone adjustment. Another method which has been tried, consists of using an alternating current motor with a special rotor. The iron core is made about 6 in. longer than the stator iron. This arrangement and also the sliding coupling enables the motor to be fixed to the sole plate. There are disadvantages in both cases; the sliding coupling is somewhat weak and the surface of the jaws do not wear smoothly. The special rotor required for the alternating current motor, also the effect on the efficiency and power factor due to the core being magnetically out of centre, neutralises the advantages of being able to fix the motor to the sole plate.

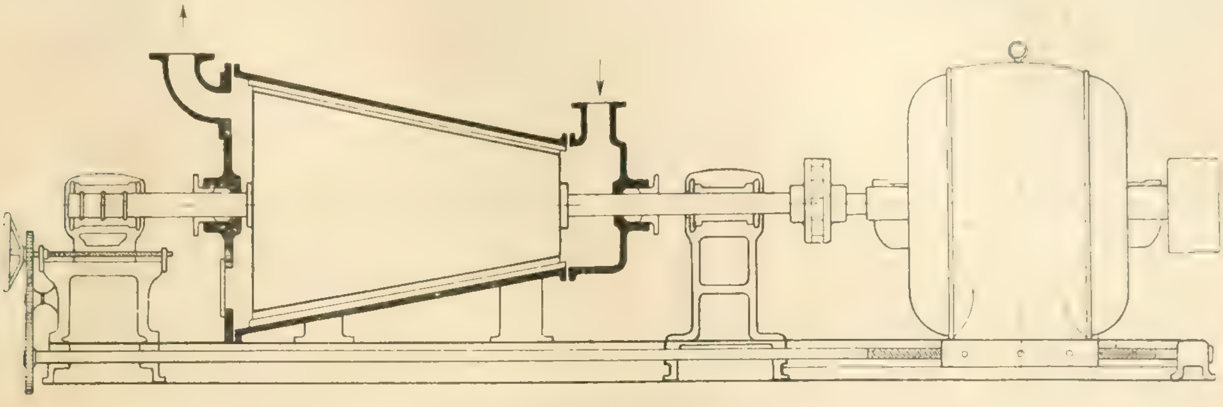

Fig. 5.—Diagram of a Refiner.

Refiners or jordans, as they are known in America, are beaters constructed in the form of a cone. The stuff which has already been treated in the potcher enters the refiner at the small end of the cone and passes up the cone to the outlet. Fig. 5 shows the general arrangement of the interior of a refiner. The internal cone or rotor is fitted with suitable blades. It is adjusted by a screw gear so that the blades will just touch, similar blades being fixed on the inside of the stationary cone. It will be seen that when the cones are in contact, the area of rubbing surface is considerably more than in the case of a beater. It is owing to this fact that refiners require much more power. If the blades are allowed to wear unevenly, the power will increase to a very considerable amount without doing useful work. Allowance for the wear of blades can be made by the screw adjustment. By this means the rotor cone can be pressed into the external cone. The maximum adjustment from the time when the blades are new and when they must be renewed is about 4 in. to 6 in. It is, however, advisable before this amount has been taken up to have the blades replaced. When considering the question of driving refiners which are already in operation, it is only a question of arranging a suitable belt drive, and allowing for the adjustment by means of wide pulleys. Belt-driven refiners in general use have a speed ranging from 250 to 300 revs. per min. Unless a direct-current motor is to be used, this speed will not be suitable for direct coupling to an alternating-current motor. The author considers the American practice the best to adopt for new refiners; that is, to operate the refiner at 375 revs. per min., and use an alternating-current motor either of the squirrel cage or slip-ring type. There does not appear to be any information of speeds higher than this being employed. It would be interesting to know the results of a direct-coupled refiner having a speed of 480 revs. per min., the peripheral speed of the cone blades remaining the same as at present. The cost of the set would be less, and more efficient from the power point of view.

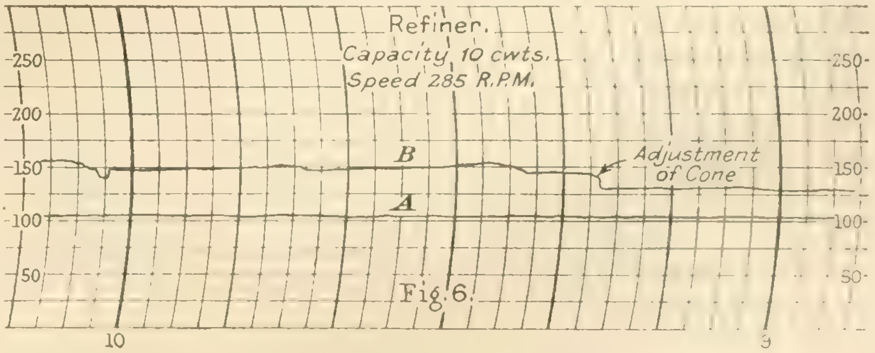

Fig. 6.—Power Curve of a Refiner.

The most satisfactory method is to use a standard type of motor bolted to a sliding base attached to the refiner sole plate. A square thread-screw spindle is fitted to the slide base and extends down the centre of the sole plate to the adjustment end of the refiner, where suitable gear wheels are provided to connect it to the hand-wheel spindle. The operator when making adjustments on the cone also moves the motor at the same time. This arrangement is shown in Fig. 5.

In considering the question of the power required it is necessary to obtain some idea of the capacity and size of cones. There are a number of refiners of small size, having a beating capacity of about 7 cwt. per hour, which may be driven by a 75 B.H.P. motor. There are larger sizes of 15-cwt. capacity, requiring 150 B.H.P. Still larger sizes are used for "news" beating, which will absorb 200 B.H.P. So much depends on the condition of the blades and adjustment. It is quite possible for the operator to screw the refiner cone in to such an extent that 100 per cent. overload will be placed on the motor. The refiner must be in an exceptionally good condition and the beating easy to obtain the pulp capacity given. With the deterioration of the blades the beating capacity is reduced and the power considerably increased; under these circumstances it is difficult to give any very reliable figures which may be accepted for general use; each case must be considered carefully, both as regards the capacity required and method of running the rotor cone in relation to the stationary cone. The author has met with cases where for a beating capacity of only 10 cwt. per hour the power has been as much as 150 to 200 B.H.P. It is clear that a motor must have ample capacity to drive such refiners.

Fig. 6 is a curve taken on a large size refiner operating on "news" stuff and beating approximately 10 cwt. per hour. The power line *a* is very steady and represents satisfactory operation. *b* power line indicates an adjustment of the cone causing an increase in power. Fig. 7 is a curve taken on the same machine. It is obvious from this curve that the refiner is not working satisfactorily; it also indicates the wide variation in load that may be created by faulty operation and worn blades.

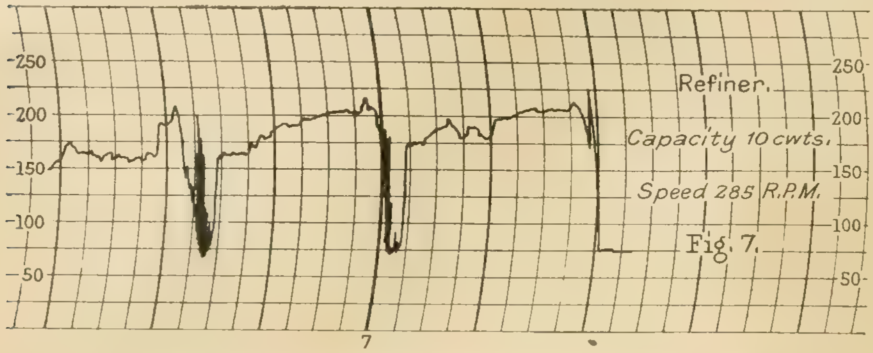

FIG. 7. POWER CURVE OF A REFINER SHOWING UNSATISFACTORY OPERATION.

Agitators or Storage Tanks.

The stuff has now passed through its beating process. From the refiner, or in some cases beaters, it is delivered to the agitators, where it is kept in constant agitation by means of revolving paddles. Usually agitators are driven from the line shaft. If, however, they are to be driven by a separate motor, 7½ B.H.P. should be allowed for a pair. Unless a suitable clutch is provided for disconnecting the agitators, so that the motor can start up on light load, it would be better to adopt a slip-ring type of motor, capable of two and a half times full load torque to enable the agitators to be started when full of stuff. It may be necessary to increase this power to 9 B.H.P. if the stuff is heavy.

Strainers.

The stuff is now ready for the machine. It is pumped by a stuff pump of the plunger type to the mixing box in the machine room, where it is mixed with a large volume of water to suit the operating condition of the machine. Before passing on to the wire of the machine, the stuff is strained by passing it through a number of revolving drums suitably perforated. The strainers are generally operated at a constant speed, and may be driven by a belt from the wet end pump shaft or by means of a separate motor. To be on the safe side, ¾ to 1 B.H.P. should be allowed for each strainer.

Wet-end Pumps.

Before describing the machine drive, it would be well to study the drive of the wet-end pumps, which are required to deal with the stuff, water, return water and vacuum boxes. It is not necessary to describe the function of each individual pump; they are usually grouped together, either in the basement or by the side of the wet-end of the machine. In either case the usual practice is to drive them from a short back shaft by means of a motor. Owing to the various sizes and types of pumps required, and the capacity of the machines they have to deal with, it is difficult to give definite figures regarding the power. We may take as a guide 60 to 90 B.H.P. for "news" machines of sizes from 150 in. to 180 in. in width of wire and a paper speed of 550 ft. per min.

A margin for overload should be allowed in addition to these figures. Constant-speed motors are usually installed for this purpose. There are, however, cases where a moderate variation of speed would be of advantage.

(*To be concluded.*)

Electrical Power in the Textile Industry.

Some Views from Rochdale.

By F. H. RUDD.

THOSE who have been associated with the electricity-supply industry during the last 20 years will best appreciate the great changes that have taken place during that period and the large amount of work that has been accomplished in the application of electric power to industry generally. The fight has been against conservatism, prejudice, animosity and ignorance. The supply engineer, in order to increase the service value of the undertaking, has been in the front line of battle, and, with the help of the manufacturer and the technical Press, now appears to be about to realise the result of his efforts.

Building up the Load.

The demand on the Rochdale power station has been gradually built up from the smaller power users such as engineers, joiners and others, whose requirements range from 1 H.P. to about 50 H.P., until the field for expansion in this direction has become practically exhausted. Many premises existed that were of no value as workshops, being without power. Owing to the ease with which this power could be purchased from the supply authority, it is next to impossible in this town to obtain vacant premises for a workshop of any kind. The further effect is an increased rateable value with which the electricity undertaking has not yet been credited. Many of these consumers are small traders who have started business on their own account with a hired motor and have, with very few exceptions, made good.

If the weight of evidence against the possibility of extending the use of electricity to the textile trades had been true, most Lancashire electricity supply engineers would have been now comfortably settled with a station of 2,000 to 3,000 kw. capacity, instead of being occupied all available hours working out the problems of ever-increasing demands. Such being the state of affairs, our friends the enemy are somewhat at a loss to find an explanation, although the reason is of a most simple character.

Reasons for Using the Electric Drive.

In the first place, the cotton manufacturer finds that in consequence of the reduction in the hours of working the output of his manufactures is reduced a corresponding amount, which he endeavours to make up by installing additional machinery. Seeing that engines and boiler-house plant in textile mills have been put down with no reserve available, he approaches the steam-engine maker for a price, and, on receipt of which his astonishment is great. He then approaches the local supply engineer, and after much argument and explanation of diversity and other factors, the value of which he suspiciously accepts, he arranges to take a supply of anything from 100 H.P. to 400 H.P. The result being, after a few months' working, he finds both as to cost and satisfactory running it compares favourably with any other means of power that could be employed and allows him the use of capital that would otherwise have been expended in purchasing and housing steam plant-to buy more productive machinery.

A number of such cases have occurred, in one instance a company, floated when money did not appear to be easily obtained for the purpose, adopted electric driving from the Corporation's mains. With the capital saved by not installing steam plant another mill was built, and, with the supply authority responsible for the power supply, extensions may and are being carried out almost indefinitely. In another instance a manufacturer approached the Rochdale Electricity Supply Department a few weeks ago for 400 H.P., as it was found that with his own plant there was no available power for expansion of the business. Ten years ago we were in negotiation for the load, but the steam engine triumphed. If we examine further the conditions surrounding this case we find an interesting situation. The coal consumption was 1,700 tons per annum at 47s. 6d. per ton, £4,037, the cost of carting being considerable, owing to the distance away from the coal siding. The maximum demand is 320 kw., which it is estimated can be driven from the corporation supply at a little more than the cost of coal. An interesting feature however, is that the amount of coal used by the corporation to drive the load wculd be about 900 tons, so that, allowing 100 tons per annum for heating, there is a saving of 700 tons.

Electricity Supply and Coal Saving.

Instances of coal saving are numerous, and the following will serve to show a state of affairs which, no doubt, exists throughout the country. A small manufacturer applied for our schedule of prices, with a view to adopting the electric drive. His antiquated but loyal engine is 40 H.P., and from a general survey of his works it was estimated that 25 kw. would do more than was actually necessary. The coal per annum required to drive only is 400 tons, costing £2 per ton or £800. The load factor is low, and the cost for electrical driving would be, at a maximum, £300, the amount of coal required to do the work being about 70 tons per annum, a saving of 330 tons of coal.

Arguments v. Solid Facts.

Arguments raised by the individual power plant enthusiasts are nought compared with the solid facts, especially to a manufacturer, as the following case shows. About six years ago a local firm were smitten with the "something for nothing" idea. There was a large amount of refuse of a combustible nature derived as a by-product from their manufacturing process, and the project decided on and put into operation was to consume the refuse in a Meldrum furnace and generate steam to supply the mill with power, a high-speed steam engine, with a generator of 150 kw. being installed. A few weeks ago the Electricity Department was approached and informed that if the cost did not exceed £1,500 per annum they would be willing to drive the mill by electricity from the Corporation's supply system. The fact was it took over 200 tons of coal per year to consume the refuse to maintain a steady steam pressure, and the high cost for maintenance and labour determined the firm in appealing to the Corporation. The transfer has now been completed and the actual average load to drive the whole of the mill from the Corporation's supply system is about 70 kw., which includes about 10 kw. for lighting purposes. The cost of driving from the Corporation's supply system will, as a matter of fact, not exceed half the figure given above, which there is reason to believe was in its turn much below the actual previous cost. The foregoing incidents are among some of the many causes for the textile trade looking to the public supply authority for assistance.

The chief of a public supply authority must be an optimist and at the same time collect facts to support his optimism. He is often asked why he is so certain that the demand is going to exceed the supply and why more plant will be required, say, two years hence? Let us review the situation, and as an approximation let us assume 10 per cent. more machinery will be required to equal the pre-war output. In Rochdale and its neighbourhood there is approximately 100,000 H.P. required in the whole of the textile industry, consequently another 10,000 H.P. will be required when trade becomes normal. As mentioned above, few steam engines are capable of taking on more load to make up for the loss of production due to the reduced hours of working.

Some Fallacies of the Steam Drive.

Formerly the cotton mills were privately owned and competition was not so keen. The proprietor of the mill took a great interest in the steam plant, going so far at the opening ceremony of the mill to make the chief event the christening of the engine. Along with his engineer, they gloried in the remarkable results which were sometimes obtained, consequently the low cost of coal per I.H.P. became a standard figure, whether obtained or no, in good or bad plants. They would not agree that the costs of driving included other items than coal, arguing that the cost of power was such a small proportion in the cost of manufacture that it was not worth endeavouring to economise in that direction. The abnormal cost of coal and labour at the present time has compelled them to look into the matter, and they now realise other advantages follow from taking the public supply and have a distinct monetary value. One of the results is that a mill manager is now able to concentrate on the manufacture of his particular product, instead of devoting a great portion of his time to the duties of engineer.

The large cotton mill steam plant, generally speaking, will continue to operate for a considerable time yet, owing to its position in the capital account; and further, the electrical supply authority has no power to spare. There are, however, many old and smaller uneconomical steam plants, which, if the power was available could be displaced immediately by the supply authority. Evidence of this is plainly visible in the number of requests for electric power which it is impossible to keep pace with. Comparatively few new mills will be built, the growth of the demand will be mainly by extensions to existing mills.

There are at present connected to the mains in Rochdale 30 large consumers engaged in the manufacture of cotton, woollen and asbestos fabrics, with a total maximum load observed at the power station of 5,680 kw., exclusive of a large number of small power consumers. The demand of one of our customers has over the period of the last six years exceeded 2,000 kw., and extensions are now in progress, which, when completed, will increase the demand to approximately 10,000 kw., the demand at present being 3,000 kw. The amount of potential power applied for in the textile trade only, and required before the end of the year, is approximately 6,000 kw. Beyond those of which we have definite knowledge, I cannot say, but I feel sure that the future is full of promise and that every shaft, pulley and machine in the town and district is a potential consumer, except where such will disappear with the present great amount of unnecessary friction load.

The Economic Results of the Electric Drive.

The economic result will be shared directly by the user and the supply authority. The nation's transport will be relieved, the national conservation of coal greatly assisted and the public health improved thereby, as the manufacturing towns will become cleaner. The workpeople in the mills already electrically lighted appreciate the greatly improved conditions and are demanding through their leaders more general use of electricity. The benefits derived from electric driving so far as production and quality are concerned is a question for the manufacturer to answer. In Lancashire anything that is worth having is no better than it ought to be, and consequently needs no talking about. It is when something has not come up to expectations that it is time to make a noise.

The station engineer has indirectly some knowledge of the increased output and improved quality of the product, but such knowledge has generally been obtained from some other source than the consumer. If there are no complaints, no other testimonial is considered necessary; what is most needed is that the Electricity Commissioners should push on with the provision of supplies and enable those manufacturing towns which cannot hope to erect super power stations, owing to local difficulties, to obtain a "cheap and abundant supply of electricity."

The Progress of the Electric Driving in Textile Factories.

By CHARLES D. TAITE.

It is probably the experience of all public supply electricity undertakings operating in textile districts that the demand for electricity for driving textile factories of all descriptions has outstripped the supply. Undoubtedly this is the case in the Lancashire cotton industry, and the writer believes it to be true of the Yorkshire textile industry also. The demand, which had been artificially held up by the war, began to develop in 1919, and by the autumn of that year it had reached a very high level indeed. Many applications have since been received, but owing to shortage of plant, and the length of time required to obtain motors, a large number of the applications accepted in 1919 have still to be connected to the mains.

There are several contributory causes to the great demand which has arisen for electricity, which demand, by-the-bye, is by no means confined to the textile industry; other industries, *e.g.*, paper-making and engineering, are just as keen on obtaining a public supply of electricity as are textile factories, but the huge extent of the textile industry has caused its requirements to somewhat overshadow the demand from other quarters.

The principal causes appear to the writer to be as follows:—

1. An awakening brought about by war experience to the adaptability of electric driving to all forms of power development.
2. The reduction in the normal factory working hours.
3. Labour unrest.
4. High rates of pay for labour.
5. High price of coal.

The Yeoman Service of Electricity Undertakings.

It is an undeniable fact that the yeoman service rendered by many electricity undertakings during the war, in the matter of supplying power for munition manufacture, brought the many advantages of electric driving into great prominence, and the undertakings are now reaping their reward. In many mills in Lancashire motors were installed owing to the impossibility of obtaining new boilers or engines, and these motors have done most useful pioneering work.

The end of the war was followed in a few months by the demand for a shorter working week, and in the textile industry the hours were reduced from 55, at which they had stood for many years, to 48. Without some counter-balancing influence this would have involved the mills in a reduced output of about 15 per cent. Mill directors were, therefore, faced with the problem of devising some means for increasing their output to the level obtaining prior to the reduction in hours, failing which a very substantial increase in the cost of the manufactured article would become inevitable. In old mills a reorganisation of the driving arrangements based on the adoption of electric motors was the obvious solution, and in new mills an extension of the mill buildings and plant has in many cases been put in hand; many mills have added a storey to their buildings, and in the great majority of such cases electrical driving has been adopted. In addition, where supplies are available, new mills are being designed for electrical driving from the outset, the most notable example being the Dunlop mills at Rochdale, which are being erected to manufacture canvas for motor tyres; these mills will take from 8,000 kw. to 10,000 kw. from the public supply mains.

Labour Unrest and the Electric Drive.

Labour unrest, and the high rate of pay for labour, have both worked to the advantage of the electricity undertakings, as manufacturers have been quite ready to dispense with the services of their power plant staff, if opportunity offered, owing to threats of strikes and the high rates demanded.

The great increase in the price of coal has also been an important factor in the development of electrical methods; this will be readily understood when it is realised that whereas coal prices have advanced to over three times pre-war rates charges for electricity only average about double those in force, before the war.

Apart, however, from any causes arising out of the war, there is no doubt that in the finer classes of work electrical driving has established itself on its merits as being superior to steam driving, as exemplified by the slow-speed Corliss engine, and at least one example is available in Lancashire, where a fair trial has been made by the management of the two systems of driving in adjacent mills, both modern, and practically identical in design and equipment, with results so favourable to electrical driving that a decision has been arrived at to electrify the steam-driven mill.

At the present time the textile industry, both in Lancashire and Yorkshire, is under a cloud of depression, but this is enabling electrification schemes decided upon during the late boom to be rapidly proceeded with, and when the inevitable improvement in trade takes place electricity supply authorities in those counties will not only find themselves carrying a very heavy textile load, but they will also be faced with the problem of dealing with a further big batch of inquiries.

Electrical Operation of a Small Textile Mill.

An interesting account of the improvements that can be effected by changing over the driving of a textile mill from steam to electricity is given by Mr. H. C. N. Ripley in a recent article in the "Electrical World." He deals with the new Victory Mill of the Evelastic Company, at Chelsea, Mass. The original mills of the company, three in number, were driven by a small single cylinder Corliss engine belted to a line shaft running the entire length of the building, the shaft being carried on wooden trusses to the several buildings. This engine has now been removed and one of the old mills has also been torn down to permit the reconstruction of the new building. The remaining mills, containing about 42 looms each, are now driven by 25 h.p. 220 volt, three-phase motor. In time these mills will eventually be replaced by other buildings which, like the new one erected, will contain a number of looms each individually driven.

The new mill, which is known as the Victory Mill, is an example of recent progress in textile mill driving, there being an entire absence of dangerous overhead shafting and long vertical belts. Each of the 52 24-shuttle extra heavy looms which it contains is driven by $1\frac{1}{2}$ h.p. 220 volts three-phase induction motor, which is controlled by heavy duty snap switches with cast-iron covers. All the wiring is done with conduit and the whole installation is very neat, up-to-date and safe. Other electrically-driven equipment in this mill are warping machines, winding and finishing machines. The lighting arrangements have also been carefully planned to give a nice illumination at a minimum expense.

Electricity Supply and the Textile Industry

By W. J. H. WOOD.

THE use of electrical energy for textile mill driving is developing rapidly, and the textile manufacturer, especially the cotton spinner in Lancashire, realises more and more the advantages to be gained from its use.

It is, in fact, not so long since it was necessary for the supply engineer, anxious to increase his power load, to go cap in hand to the textile manufacturer and argue the many advantages to be derived from electrical driving with the so-called mill engineer, a specialist in slow speed engines and Lancashire boilers, and who naturally was not keen on having anything to do with what one many times heard described as "new fangled ideas." The proof of the pudding is in the eating, and one feels quite certain that the cotton spinner who decided to adopt electrical energy as the motive power for driving his machinery does not regret the step taken, proved by the fact that he has extended its use, and that competitors have found it necessary to follow suit.

CONDITIONS FOR SUCCESS.

The success of electric driving in textile mills depends to a large extent upon the type of equipment installed, and in my opinion, it is not possible to lay down any hard and fast rule with regard to electrifying a textile mill. Each case must be carefully considered on its merits, the arrangement and size of motors, also the speed, depending upon the particular lay-out of the mill, and the class of yarn manufactured. Everybody knows that one of the chief advantages in electric driving is the saving effected in bringing the driving power as near as possible to the point of usage, that is, of course, by direct coupling the motor to the machine itself, eliminating all shafting and gearing. Although by direct coupling one obtains the highest mechanical efficiency, this method, in many cases, is not possible, especially in mule driving, owing to their particular construction. The alternative is group driving, and perhaps generally speaking, the most satisfactory results have been obtained by this method.

It is quite sound practice to direct couple the main line shaft on each floor of a cotton mill to a motor of suitable size and speed, and as far as possible to use a standard size of motor throughout the mill to enable spares to be stocked, in case of breakdown. Group driving also has advantages in the card room and preparatory machinery, but the grouping should be in accordance with the combined production required from this machinery, taking into account the general lay-out of the plant and shafting. It is advisable to house all the motors in a separate building or tower erected up the side of the mill, arranging for suitable means of access to each motor so as easily to effect repairs or overhaul when necessary. The motors should be entirely shut off from the different mill floors, only the shaft connection coming through the wall, although it is an advantage to have a fire-proof emergency door, on each floor, between the mill and the motor tower.

CONTROL ARRANGEMENTS.

With regard to the motor control gear, it is advisable to have a central switch room with switchgear controlling each circuit, and although as a rule the motor control gear is fixed adjacent to the motor, in many cases it is advantageous to arrange for remote control gear for starting each motor from the central switch room. In any case, it is advisable to provide an emergency trip gear in each room or section of the mill to stop the motor supplying the particualr section in case of emergency.

THE TENDENCY TOWARDS PUBLIC SUPPLY.

Now that the cotton spinner has become converted to the use of electricity for textile mill driving, it is also generally found that he prefers to purchase electrical energy rather than have his own generating plant, and one can quite understand this, as it is one of the chief advantages that the manufacturer need not worry about the production of the power he uses, it is a convenience he appreciates very much. It all depends, however, whether a cheap and efficient public supply is available, because naturally the manufacturer considers the matter from a commercial point of view, and it must pay him to buy power or he will produce it himself.

THE POSITION IN BOLTON.

As a matter of interest, although in the Bolton area of supply there are many textile mills electrically driven, with two or three exceptions, these are all supplied off the public supply mains. In fact, there are several textile mills which had electrical generating plant of their own, but these have now sold their private plant and are supplied by the Corporation. The mills still using their own plant, which they installed prior to the Corporation getting busy and catering for the textile mill load in the district, will no doubt change over sooner or later.

There are about 10,000 H.P. in textile motors connected to the Bolton system, and during the next 12 months it is estimated that this figure will be increased by a further 5,000 H.P.

Electrical Equipment of the Peel Mills, Bury.

Shortly before the war, the directors of the Peel Spinning & Mfg. Company, Ltd., an old-established concern, which has recently been re-constructed under the name of the Peel Mills, Ltd., decided to erect a new mill in addition to the two large steam-driven cotton-spinning mills which they already possessed at Bury. A supply of electrical energy was available from the Bury Corporation mains, and the question was, therefore, carefully considered as to whether this power should be used, or a steam engine drive of the orthodox type installed. Messrs. Kelly & Browning, of Manchester, were called in as consulting engineers, and it was finally decided to take power from the Corporation, and to drive the mill electrically, the contract for the motors and control gear being given to the British Westinghouse Electric & Mfg. Company, Ltd., now the METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD.

DETAILS OF THE SPINNING MACHINERY.

The mill is a mule-spinning mill, and takes the form of a six-story rectangular building, the basement being used partly as a warehouse and partly for the preparatory processes, the first floor for carding and the remaining four floors for spinning.

Dealing with the spinning machinery first, the method of driving adopted was one large group drive for each floor, and this was effected by arranging one line shaft down the centre of each room driving by belt directly on to all the mule countershafts. As the speed of the mule countershafts is fairly high, it was decided to run the line shafts at 585 revs. per min. and to couple them direct through flexible couplings to the motors. The latter comprise one machine with an output of 325 B.H.P., and three machines each with an output of 225 B.H.P., the difference in outputs being due to differences in the machinery installed on the different floors. To accommodate the motors, a tower was built up one end of the mill alongside the staircase and the floors in the tower were arranged at levels about 2 ft. below the line shaft centres, so that when the motors were fixed on these floors they lined up with the shafts they had to drive. These motors are 400 volt 50 frequency, three-phase slip-ring machines, and are started by means of motor-driven liquid starters operated automatically from the switch room at the base of the tower.

SWITCHGEAR.

The main low-tension switchboard in the switch room is provided with a separate automatic oil switch for each of the large motor circuits, each switch handle being connected to a small auxiliary switch fixed at the back of the panel, and connected up in such a manner that when the oil switch is closed, the small motor operating the liquid starter is started up, and slowly brings the motor up to full speed. When this point is reached, the starter operates a small switch which stops the small motor and reverses its connections; when the main oil switch is subsequently opened, the auxiliary switch on the switchboard puts the small motor in circuit again, and the starter is brought to the "off" position. Signal lamps are provided on the switchboard to indicate when the starter has completed its operation. It will be observed that this method of control is equivalent to the more modern method of automatic contactor control. It has proved entirely satisfactory, and well suited to the conditions in a mill where the motors are started up only twice daily. Since, however, automatic contactor gear is now very widely used in connection with all kinds of industrial plants, the Metropolitan-Vickers Company has adopted this type of control gear in the textile mill installations more recently carried out.

It will be observed that the motors are kept out of the hot and dusty atmosphere of the spinning rooms, and that they are under the control of the electrician and immune from interference on the part of the mill operatives. For purposes of safety, however, push buttons are provided in the spinning rooms, by means of which any motor can be stopped in case of emergency. The motor tower also accommodates one 120-h.p. motor running at 365 revs. per min., which is direct coupled on to a line shaft driving the roving frames in the card room, while the carding machinery is driven from two further parallel line shafts running at 365 revs. per min., one being direct coupled on to a 200-h.p. motor running at 365 revs per min. and the second shaft being rope driven from the first. This 200-h.p. motor is situated in a chamber at the end of the mill and is controlled in exactly the same manner as the five motors in the tower.

Blowing Room.

A direct coupled line shaft drive was adopted for the blowing room, which is situated in the basement. As the blowing room machines run at fairly high speeds, it was possible to fix the speed of the line shaft and motor at 580 revs. per min. The output of the motor is 75 h.p., and as it had necessarily to be situated in the middle of the mill building, a motor of the pipe ventilated type was adopted. This motor is arranged for local control, as it does not always run through the full working hours of the mill. Adjacent to the blowing room is the cotton mixing room, and this contains two small machines, one a bale breaker and the other a combined hopper feeder and porcupine opener. These machines are individually driven, the bale breaker by means of a 5-h.p. 950 revs. per min. squirrel cage motor fixed on the floor close to the machine, and belted to the driving pulley, while the combined hopper feeder and porcupine opener is similarly driven by means of a 10-h.p. squirrel cage motor.

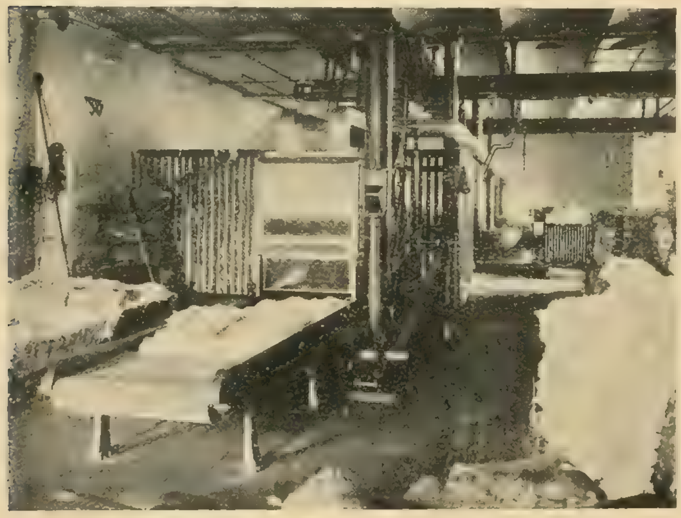

Fig. 1.—View of 5-h.p. 3-phase Squirrel Cage Motor running at 949 revs. per min. and driving Automatic Hopper Bale Breaker and Distributing Lattices.

In planning these drives mechanical transmitting agents have been reduced to the very minimum, and the transmission losses are consequently extremely low. Moreover, as the main motors are all large ones, their speeds could be adapted to sufficiently low line shaft speeds without sacrificing either efficiency or getting a low power factor. The plant has now been in operation for some years, and has given every satisfaction from all points of view. It illustrates very effectively the great possibilities of electrical driving where the electrical engineer is called in at the very beginning, and has reasonable scope to put his ideas into practice.

The accompanying illustrations are typical of the whole installation, and convey a good idea of the effective lay-out of the various drives. It is interesting to note that one of the bale breakers with delivery lattices is installed in one of the steam driven mills. It was found convenient to apply a separate electric drive to this machine during the war when the mill was running abnormally. During this period only part of the spinning machinery was required to run, but the carding and preparation departments were working at high pressure. One of the 225-h.p. motors driving one of the spinning rooms in the new mill was, therefore, temporarily transferred to the card room of one of the steam driven mills, and the 5-h.p. motor, mentioned above, was installed to drive the bale breaker. This arrangement enabled one of the large steam engines to be shut down and a large saving to be effected in power costs. The credit for this saving is due entirely to the flexibility of the electrical driving system, one of its incidental, but at the same time, very important properties.

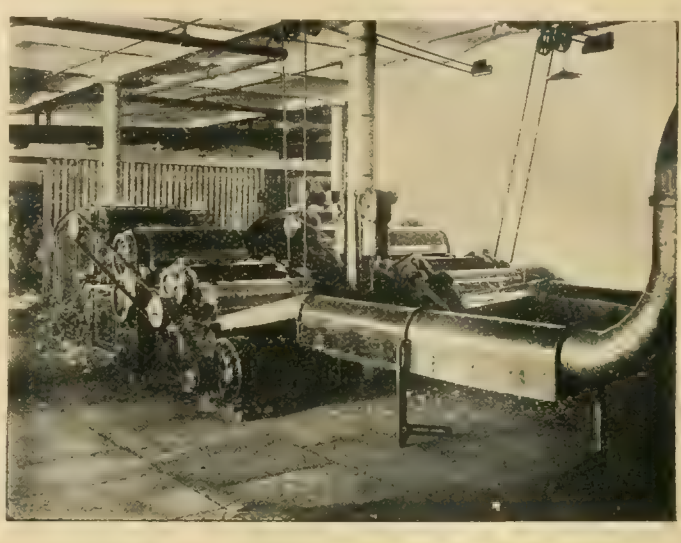

Fig. 2.—View of 10-h.p. 3-phase Squirrel Cage Motor running at 940 revs. per min. and driving Combined Hopper Feeder and Porcupine Opener.

Some Engineers' Opinions on the Textile Load.

The position with regard to electricity supply from public stations for textile purposes is not entirely satisfactory, although it is by no means altogether unsatisfactory. As we show in other places in this issue, war conditions led those responsible for textile products more and more to rely on the public electricity supply for energy for driving their mills, and this has meant a very satisfactory development during the past five or six years. Trading conditions at the present time have brought this development to what is undoubtedly only a temporary check, but we are optimistic enough to believe that even greater developments will take place in the future, especially if the supply of generating plant and motors can be accelerated to meet what will doubtless be a very large demand. A number of supply engineers in the textile districts have very kindly given us some information as to conditions in their areas.

Progress in Blackburn.

For instance, Mr. P. P. Wheelwright, of Blackburn, informs us that rapid progress is being made even now in the electrification of cotton mills in his district. He has applications on hand for no less than 10,000 kw. of extra power, which he will be able to deal with from his new generating station, and he believes that this large figure can easily be increased by canvassing.

Advances in Bury and Halifax.

At Bury, Mr. S. J. Watson informs us that of nearly 10,000 h.p. of motors connected to the mains rather more than 6,000 h.p. is for textile purposes. There is the usual shortage of power at the present time, but between 3,000 H.P. and 4,000 H.P. should certainly be connected up within the next 12 or 18 months, with as much more again to follow. Indeed, the principal difficulty, as far as Mr. Watson can see, will not be to obtain an industrial load, but to carry out extensions fast enough to keep pace with the demand, especially as manufacturers are more and more realising that it is not part of their business to produce power.

Mr. W. M. Rogerson, of HALIFAX, states that he has always found the textile manufacturer the most difficult power user to convince of the advantages of electric driving. Firstly, owing to natural conservatism, and secondly to the fact that most modern mills using over 200 H.P. are usually equipped with a highly economical steam plant whose power cost is so low that it makes it very difficult for electricity supply undertakings to quote a price sufficiently tempting to induce any change. Nevertheless, steady progress is being made and from 1,000 H.P. connected with 15 consumers in 1914, connections have now risen to 2,912 H.P. with 38 consumers, while applications are in hand representing approximately a further 700 H.P. We are glad to learn that the general tendency in the area is to take a supply of electricity from the public undertaking rather than to put down private generating plant, though there is one case in the area where a mill whose requirements exceed 3,000 H.P. is installing its own generators. This state of things, Mr. Rogerson thinks, is due largely to difficulties in the coal supply during the war period and to trade disputes. On the whole, he thinks the position is a very encouraging one and that the altered conditions brought about by the war have greatly favoured the extension of the electric drive in textile industries. Public supply undertakers would, therefore, be wise in providing for a demand which is certain to arise in the near future.

A PESSIMISTIC VIEW FROM HEYWOOD.

Mr. D. H. Davies, of HEYWOOD, a district where textile factories spin both fine and coarse counts, and there is as well a considerable amount of waste spinning for towel, carpet and other coarse weaving, and where dyeing and finishing factories and weaving sheds are to be found, states that where a spinning mill is driven with a modern steam drive and equipped with straight drive from the engine rope wheel to the various floors electric driving has little chance on the score of economy at present selling rates. Where, however, mills, as is the case in several places in Heywood, are driven by old beam or horizontal engines through wasteful gearing, and in certain dyeing and finishing factories where the work is carried out in groups of buildings, and in weaving sheds where the same conditions apply, the electric drive has every chance of showing its advantages. In Heywood, approximately 1,200 H.P. of motors are connected, and this is likely to be increased within the next few months by another 800 H.P.

In MANCHESTER, Mr. Pearce informs us the total horse-power of textile motors connected is 26,677, and this is likely to be largely increased when more stable conditions return to the textile industry, as the economies, convenience and greater output obtaining from the electric drive are fully appreciated by textile manufacturers in the area.

PROGRESSIVE SMALL FACTORIES.

At SHIPLEY also, the advantages of the electric drive are fully appreciated where, indeed, had not the present slump in trade occurred, it would have been difficult to keep pace with the demand for electricity. Mr. Redman finds that it is generally the smaller factories which are more anxious to come on to the mains, say, with demands up to about 500 kw. Larger ones still prefer to be independent units with a standby supply from the Corporation.

Mr. WOODHOUSE informs us that considerable progress is being made in the Yorkshire Electric Power Company's area in the employment of electric motors for driving textile machinery, and that more and more mill owners are adopting this method of driving by purchasing the necessary energy from the Power Company. The total amount of power for driving textile machinery connected to the Company's mains is now nearly 22,000 H.P., and there is a distinct tendency to dispense with private generating plants.

The Electrification of a Yorkshire Woollen Mill.

An interesting conversion from mechanical to electrical drive has recently been completed at Messrs. Rouse Bros. Vale Mills, Oakworth, a place situated in an isolated and interesting part of the West Riding of Yorkshire, known to literary historians as the Brontë District. These mills have utilised water power for driving their spinning and weaving machinery for upwards of 60 years. Within the last year, however, the methods by which the power has been converted have been revolutionised. If a comparison is made between Figs. 1 and 2, and 4 and 5, it will readily be appreciated how great the change has been.

The electrical equipment is unusual, as induction alternators are used to generate the current from power supplied by the turbines. The use of generators of this type does away with complicated synchronising switchgear and the skilled attention which it demands. Originally the water power was used principally for driving two large water wheels, one 43 ft. diameter by 9 ft. wide, and the other 42 ft. by 6 ft. wide, the former being seen in Fig. 1. In addition to these two large wheels there was a smaller one about 20 ft. diameter by 9 ft. wide. The water for driving the wheels comes from two different sources, one at a much higher level than the other. That from the higher level was first utilised for the smaller wheel, and then passed to the lower level supply, the whole supply then being used for the large wheels.

The water after leaving the wheels passed away in an underground tailrace about a quarter of a mile long. The power from these wheels was transmitted in the usual way by heavy bevel gear and upright shafts, some of which were 8 in. to 10 in. in diameter, to different portions of the mill. A typical example of this bevel gear is shown in Fig. 2. In addition to the water wheels, power was also obtained from a beam engine, which was capable of developing 600 H.P. It was connected to the main driving shaft by very heavy gears. In view of the hopeless inefficiency of the methods just described, it was decided to supplant the old water wheels by hydraulic turbo-alternators and to drive the whole of the machinery by electric motors. Fig. 1 gives a clear idea of the state of the building containing the water wheel, and the fact that this interior was completely dried out and made suitable for electrical machinery is worth noting.

The new turbine plant consists of three turbines, manufactured by Gilbert Gilkes of Kendal, two taking water from the lower level supply and one from the higher. The lower level turbines are of the single discharge spiral casing type, and develop 125 H.P. and 64 H.P.

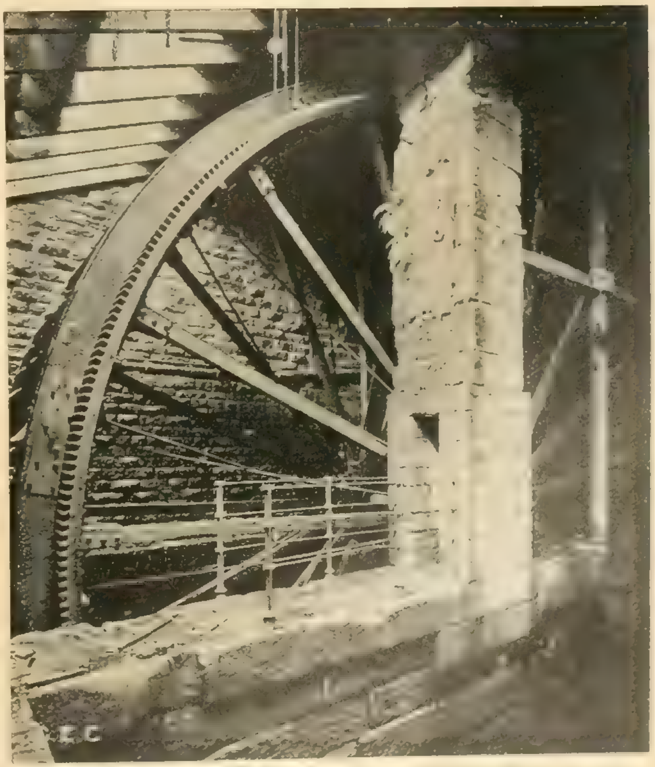

FIG. 1.—ONE OF THE ORIGINAL WATER WHEELS DRIVING THE VALE MILLS.

respectively on a head of 36 ft. when using 2,300 and 1,200 cubic ft. of water per minute, the speed being 428 and 600 revs. per min. The turbines are carried on cast-iron combination bedplates and direct-coupled to the generators.

The High Fall Turbine.

The high fall turbine is of the double discharge twin runner type, and is arranged so that in periods of drought the water may be shut off from one runner, thereby enabling the other runner to be operated at a much higher efficiency than would be otherwise obtainable. This turbine is also mounted on a cast-iron bed and coupled direct to the generator. It is designed to develop 150 h.p. on a working head of 50 ft. when using 2,000 cubic ft. of water per minute and running at 600 revs. per min.

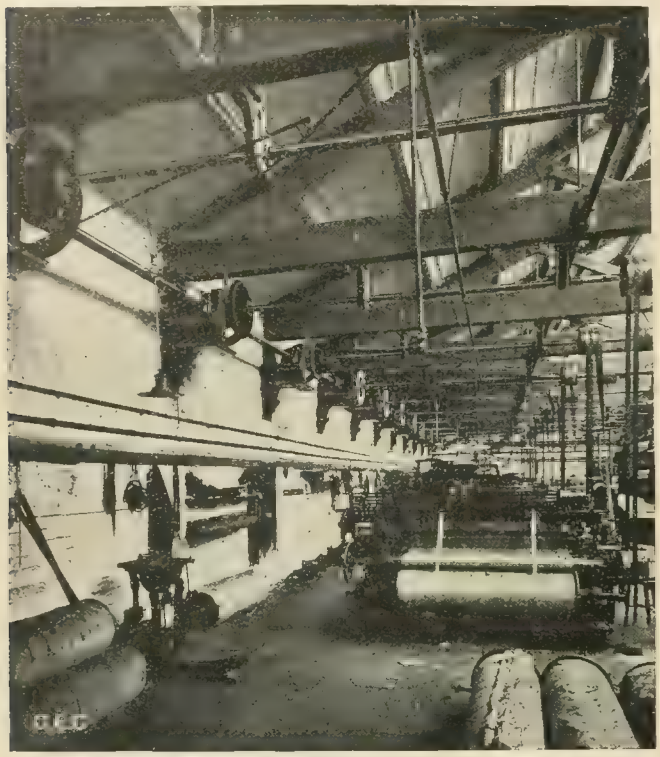

Fig. 2.—Bevel Drive and Shafting in Large Weaving Shed.

It is interesting to note that there is no governor gear, as the generators are run in parallel with the supply taken from the Keighley Corporation, and the speed is thereby maintained constant.

Fig. 3.—General View of New Mill Driven by Motor Shown in Fig. 4.

Simple Control Arrangements.

The simple manner in which these machines are put on circuit calls for special attention. First the distributor vanes on the turbine are opened to allow sufficient water to pass to run the turbine up to approximately synchronous speed; and secondly, the generator is switched direct on to the line, the vanes being opened fully out in order to allow the necessary amount of water to pass for the generator to develop its full output. This completes the operation.

Considerable difficulty was experienced in arranging the turbines in suitable positions without entailing excessive cost in altering masonry and pen troughs. This accounts for the peculiar angles at which the pipes run. Each turbine drives an induction type alternator, the outputs of which are 81 kw. and 43 kw. for the low-level turbines, and 103 kw. for the higher-level machine.

In addition to the electric power derived from hydraulic turbines, as already mentioned, a certain amount is taken from the mains of the Keighley Corporation, this being stepped down from 6,600 volts to 400 volts, by three 250 k.v.a. transformers, at which pressure it is distributed from the main switchboard which controls the alternators.

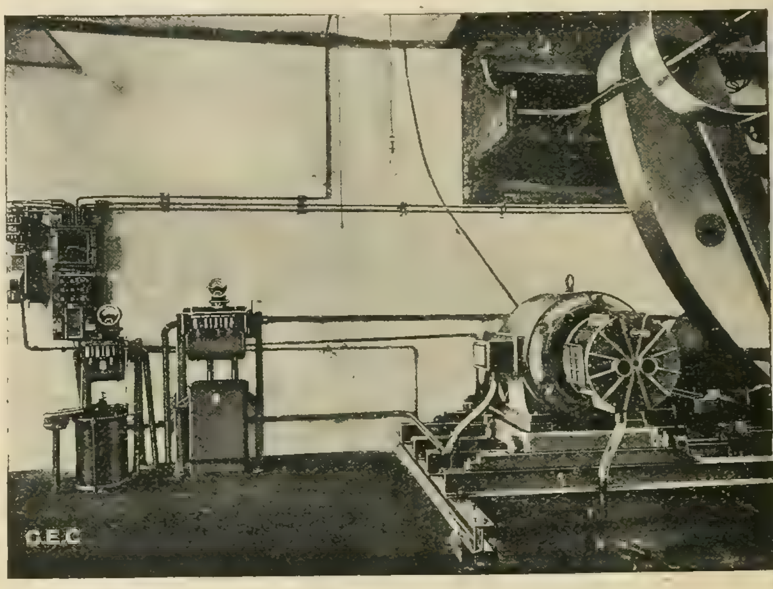

Fig. 4.—View of "Witton" Motors Driving New Spinning Mill.

Spinning and Weaving Machinery.

The mill is divided into two main sections, the new and the old. In the former both spinning and weaving machinery is at work, the latter being devoted almost exclusively to spinning. All the motors up to and including 60 h.p. are of the squirrel cage enclosed ventilated pattern, running at 580 revs. per min.; above this size they are of the slip-ring pattern. All the 60 h.p., 80 h.p. and 100 h.p. machines are fitted with third bearing shaft extension, and are mounted on substantial cast-iron bedplates.

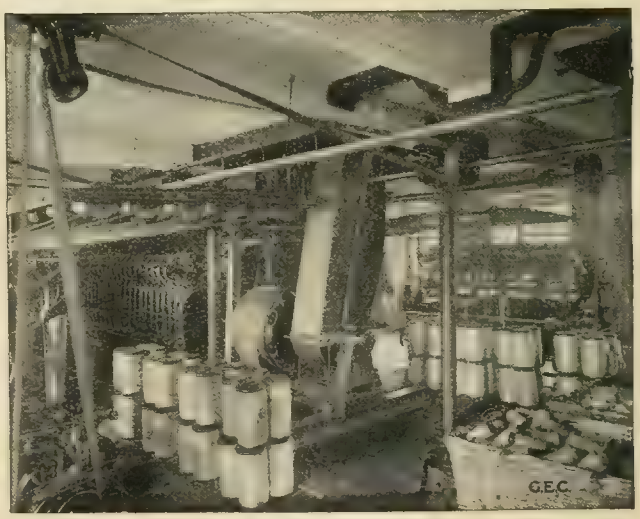

Fig. 5.—Part of the Old Mill with a 60 h.p. Witton Squirrel Cage Motor Driving Spinning, Drawing and Twisting Machinery.

The large weaving shed, contains upwards of 100 looms. Six 25-h.p. motors situated in the roof drive two shafts each, while another shaft is driven by a 100-h.p. machine, the auto-transformer starters for all these, and the other motors in the mill being manufactured by George Ellison, of Birmingham. The arrangement of driving the smaller weaving shed machinery is practically the same as in the larger shed, but only three 25 H.P. motors are required.

In the new mill the electrical gear has for convenience in operation been grouped on the top and ground floors. A reference to Fig. 4 shows the gear on the top floor, which consists of one 60 H.P. squirrel cage and one 80 H.P. slip-ring motor, together with their respective starting panels, each driving spinning frames through Hans Renolds chains. The 60 H.P. motor drives the top room (Fig. 3), and the 80 H.P. motor the room below. On the ground floor is installed one 100 H.P. and one 80 H.P. slip-ring motor, the latter driving the ground floor through chain and the former the first floor by means of ropes (the centre distance being too great for chain driving in this case). Machines of the same power are interchangeable together with their chains, &c.

A section of the old mill is seen in Fig. 5. This part of the undertaking calls for little comment, though it may be noted that the 60 H.P. motor shown is driving, in addition to spinning frames, a complement of drawing and twisting machinery.

The contract for the electrification of this mill was carried out by the GENERAL ELECTRIC COMPANY, LTD., through their Leeds Branch. In conclusion, our thanks are due to Messrs. Rouse Bros. for permission to take the photographs reproduced in this article, also for allowing the publication of the particulars.

Correspondence.

AN "ELECTRICAL" FATALITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Doubtless the attention of many electrical engineers will have been drawn to a case of a youth at Palmer's Green found dead in his bath, and as reported in the papers the general impression given by the headlines and brief report is that the cause of death was, or probably was, electric shock from a portable heater. The reports were so conflicting and the matter is of such importance that I have made inquiries, and although it is probably impossible to overtake the impression created in the mind of the public, I think electrical engineers should be put in possession of the facts so that they may answer anyone who raises this case in future.

At the first inquest the medical evidence briefly was, that as a small electric heater was found in the bath after the boy had been removed, the presumption was electric shock, a presumption based on no technical evidence or investigation, and apparently put forward because at that time no other cause had been found. At the adjourned inquest Dr. Spilsbury, the Home Office expert, who had in the meantime been called in, stated that the cause of death was the existence of the condition known as *status lymphaticus*, and he found no evidence of electric current having passed through the body. He added that this condition made sudden death possible from the slightest shock, such as fright or sudden immersion in hot or cold water. Unfortunately, this use of the word "shock" which in medicine has a general meaning, was no doubt interpreted by the reporters to suggest electric shock.

No witness was able to say that the heater was in the bath before the body was lifted out, and the coroner in summing up pointed this out, and with reference to statements made at the first inquest to burns on the body, Dr. Spilsbury stated that these were made after death, in fact, in the effort to resuscitate by application of heat. Expert electrical evidence was given disproving of the theory originally put forward.

It is evident, therefore, that Dr. Spilsbury was quite clear as to the cause of death and the fact that the predisposing cause was not equally clear does not affect the issue, which is that the suggestion of death from electric shock had no existence except as an hypothesis put forward to cover ignorance of the real cause.—I am, &c.,

LLEWELYN B. ATKINSON.

London, Jan. 31st.

An electrical fitter named **FREDK. W. BOYLE** pleaded guilty at Bolton on the 27th to charges of theft and was fined £5 on each of three cases. It was stated prisoner took advantage of his position as fitter to steal various articles whilst working on business premises.

W. Lancashire Electricity District.

During the week the Electricity Commissioners have continued their task of hearing evidence concerning the schemes for the reorganisation of electricity supply in the West Lancashire and Mersey Electricity District. The scheme for the formation of a Joint Authority for the whole area was first investigated, and after evidence had been given by Mr. T. C. [illegible], chairman of the Liverpool Tramways and Electricity Committee, and by Mr. Harold Dickinson, the city electrical engineer,

Sir JOHN SNELL intimated that the Commission wished to have from the promoters of both schemes a statement showing the equivalent capital expenditure which would have to be made by the existing undertakings if no co-operative scheme were introduced. Such figures would probably show very much to the advantage of the development schemes. Sir John asked also whether it had occurred to the promoters of the schemes to take actual load curves from the various undertakings operating, and to integrate those curves in order to ascertain the effect of combining all the separate loads into one system. The Commissioners themselves did that before provisionally determining the district, and found that, instead of 70,000 kw., a maximum load of only 40,000 kw. was required to meet all exigencies. In other words, by combination there was an actual saving of 90,000 kw.

Mr. DICKINSON said he had prepared some curves, which he would produce. The scheme would in its initial stages be of great assistance to the railways, and as it developed would become of still greater value to them. It should also offer great encouragement and facility in electrifying those systems not already electrified. It was essential that the scheme should be carried out in stages, and the first step proposed was the linking-up of the existing undertakings in St. Helens, Bootle, Liverpool, Birkenhead, Wallasey and Warrington; and as nearly all the undertakings were short of plant, the provision of a new capital station on the riverside. It would be a great advantage to the district if the Mersey Power Company were linked up, but as they had declined to co-operate they were not included in the scheme.

To meet the requirements of 1925 on the individual basis, he calculated that the existing systems would require new plant of 144,000 kw. Putting the cost at £25 a kilowatt (a figure very much below what it would be), the total would be £3,600,000. With a capital generating station and a linked-up system, the same supply would cost £4,461,260 in all. But, as against the excess of the annual capital charges in the combined scheme, there would be a much larger saving in working costs and coal costs. He calculated the annual expenditure for 1925 on the individual system as extended at £1,986,610, while on the capital station the annual expenditure (including capital charges) would be £1,709,710, or a saving of £276,000. As time went on the annual saving which would be effected would become more pronounced both in regard to working costs and in regard to coal consumption. He estimated a distribution of 460,000,000 units in 1925, under the co-operative scheme. Under normal conditions that would be furnished by the riverside capital station, supplemented by the Lister-drive and Warrington stations. Other existing stations would be held in reserve.

In answer to Mr. JEEVES (for Wallasey Corporation), Mr. Dickinson said that the capital expenditure on plant at the individual stations would be much higher than that proposed by the scheme. The conference of local authorities were hoping that the Ministry of Transport would undertake the scheme, but even if they hadn't had that expectation, he believed they would have still gone on with it.

FURTHER PARTICULARS REQUIRED.

Sir JOHN SNELL said the Commissioners would like some statement which would show the constructive programme of the Joint Authority if the scheme were approved. That statement should show how much of the programme would be carried out in the first, second, and third year, and so on; how much money would be spent, and how it was proposed to meet the expenditure.

In answer to further questions, Mr. DICKINSON said the whole of the scheme was based on taking over the existing stations; they would have to come under the control of the Joint Authority, but they would not be taken over except by agreement. In his calculation of the capital charges on the combined system in 1925 he had not included any figure for the capitalised interest during the period of the construction of the capital generating station.

On the 27th inst. Mr. HONORATUS LLOYD, K.C. (for the promoters), said that they had tried to draw up and submit the statement required by the Commission, but they had found it impossible. Until the Joint Authority was in being and able to ascertain the amount of co-operation to be expected from the local authorities, any figures would be purely fanciful. There were many ways in which by co-operation the transfer of the generating stations could be effected, but the local authorities would not brook the dictation of Liverpool.

Continuing his evidence, Mr. DICKINSON said that he assumed by 1930 the Mersey Power Company would have been taken over and would supply 11,000,000 units to the joint system, while the United Alkali Company, on the other side of the river, would be sending out 58,000,000 units. The scheme was based on the joint authority having control over all the undertakings. All the undertakings taken over by the joint authority would get their supply of electricity on the same basis. Of his total estimated annual saving of £276,900 under the scheme, £120,740 was the saving on coal.

Mr. JALLAND (for the United Alkali Company) said that, so far as the company were concerned, they were willing that the joint authority should either take over their station or a supply of energy in bulk—it was immaterial which. Provided the premises were utilised in one way or the other, it seemed clear that an advantage would result under the scheme.

Mr. Tyldesley Jones: If the United Alkali station is transferred to the joint authority, that authority would not be able to supply the United Alkali Company with energy, because they were in the Mersey Power Company's area.

Witness further stated that in his tables he had estimated for the joint authority undertaking the existing capital charges on the various undertakings taken over, but no allowance had been made for payments already made for the extinction of debt.

Mr. Jeeves suggested that the rateable value would be not less than 5 per cent., and that they would have to pay at least £120,000 a year for rates, and not £21,000. He asked if he had any figure for the rates on the transmission mains on which they were going to spend £1,500,000.

Witness admitted there was nothing for that. He did not know what figure to put down. In re-examination, he said that co-operation was absolutely essential to the success of the scheme, and that involved absolute control by the joint authority. If the scheme was to be regarded as merely providing a stand-by supply, it would be hopeless to spend money on it. Experience had definitely proved that large supplies, with unity of control, were economical.

Sir John Snell: If the river Mersey did not exist as a geographical barrier between Liverpool and the Cheshire side, there could be no possible division of opinion about the wisdom of including the Wirral area in the combined district. I would not conceive of anybody suggesting it. Do you think the Mersey Tunnel capable of conveying the transmission mains?

Witness: Quite capable. The Tunnel Company, while preferring to have nothing but their own apparatus in the tunnels, say that there would be no difficulty about carrying the cable through. It would be practicable and safe for the Wirral area to rely on electricity supplied by cables through the tunnel. He saw no danger about it. The tunnel was high, and the cable could be carried at the top. The omission of Southport would not be a disadvantage, and its inclusion would be no immediate benefit to Southport.

Mr. Charles D. Taite, engineer and manager to the Lancashire Power Company, said that he thought the scheme was very necessary for the Merseyside and West Lancashire area, which in many respects was backward in electrical development. The costs in the various stations were undoubtedly too high and required rectifying. The majority, if not all, of the undertakings were short of plant, and were expecting a big demand on their resources. A very excellent site was available on the river side. No division could be based on the Mersey, having regard to the existence of the tunnel, and there was no reason for separating the proposed area into two districts. That would be a most unfortunate thing, for both sides of the river were part of one commercial district likely to develop simultaneously. The separate district for Wallasey and Birkenhead was not large enough to make it a commercial proposition. The demand of 21,000 kw. would be extremely useful to the large scheme, and if that were allowed to be withdrawn the whole scheme would have to be reconstructed. He added, "It is quite time parochial boundaries in these matters were abolished, and a comprehensive scheme should be prepared for the whole of a district which has a common interest."

In cross-examination, Mr. Taite said the whole tendency was for private generating stations to come to an end. The whole of the proposed area was within the district of the Lancashire Power Company, which obtained bulk supply powers in 1900. Their powers were limited, and they were very busy in the area they had developed. The Company hoped to get a supply in bulk from the joint authority and help to develop the area.

In reply to Mr. Lackie, witness said the Mersey Tunnel was the first method of laying the mains to Birkenhead he should adopt, but in addition there was the bridge at Widnes. He should also consider the possibility of laying cables on the bed of the river.

Sir John Snell: Having regard to the past development and the experience of all the industries during the war, is it your view that there will be an acceleration of electrical development in future?—That is my firm conviction. As former electrical engineer to Southport, Mr. Taite expressed the view that in the long run it would be an advantage to Southport to belong to the joint authority when the railway companies took a supply in that direction.

It was submitted that the electrical interests of the northern part of the West Lancashire Rural District should be excluded from the joint district, if Southport were excluded, and included if Southport were included. Similar submission was made on behalf of Ormskirk and of Lathom and Burscough.

Mr. Rounds, for the British Insulated and Helsby Cables, Ltd., pointed out that of their total output last year of about 9,000,000 units, the company itself—the largest manufacturers of cables and electrical equipment of that nature in England—consumed 8,092,000 units, so the undertaking was practically a private one. They wanted to help to make the scheme a success, but asked that the company's undertaking should be excluded if that would not interfere with the success of the scheme.

Sir Thomas B. Morgan, consulting engineer, gave evidence in support of the scheme on behalf of all the collieries in the St. Helens area. They had, he said, recognised the present system of generating electricity on a comparatively small scale was ineffective, and they welcomed a proposal which would make it possible to obtain an ample supply from somewhere.

The Wirral Scheme.

On behalf of Wallasey, Mr. Jeeves submitted the case in support of the scheme for the Wirral. It was proposed to form a joint authority for the area, with one station at Wallasey. There was complete agreement between the promoting local authorities, and the effective station would fully provide for the needs of the future as far as they could be forecasted. The area included comprised the boroughs of Birkenhead and Wallasey, the urban districts of Bromborough, Higher Bebington, Hoylake and West Kirby, Lower Bebington, Ellesmere Port and Whitby, Neston and Parkgate, and the rural district of Wirral. The first stage of the scheme involved the interlinking of the generating stations of the authorised undertakings of Birkenhead and Wallasey, from which extensions would be carried out as necessity arose. At a later stage it was proposed to link up the joint authority's undertaking with the stations of the urban district of Hoylake and West Kirby, Port Sunlight, Messrs. Cammell, Laird and Company's premises, the Mersey Railway Company, and the Mersey Power Company. The scheme would provide for tramway and railway requirements.

Mr. Chas. Pratt Sparks, an ex-president of the Institution of Electrical Engineers, gave evidence on behalf of the scheme, and criticised the Merseyside and West Lancashire project, particularly in relation to the suggested site, which was to be on the river front at Otterspool, as there was quite inadequate provision of means to prevent siltage. To deal effectively with it would add greatly to the working costs and the capital required, and he criticised also Mr. Dickinson's figures in relation to the saving in coal consumption, which was based on a price of £2 per ton. The saving under this head was bound to be reduced, as the price of coal was certain to come down. He gave details of the Wirral proposals, and expressed the opinion that for a long time to come it would be in the interests of Wirral to be independent of the Lancashire scheme. He admitted that it was possible that if the Lancashire scheme developed on a big scale inter-communication between the two might be set up at a future date. He compared the problem of conveying electricity across the Mersey to that of conducting a supply round a large pool of water with 22 miles circumference, inasmuch as the only places where the Mersey could be crossed were at Runcorn Bridge and through the river tunnel.

On Saturday Sir John Snell remarked that the Commissioners felt the promoters of the scheme should put in some financial evidence of the methods proposed.

Mr. Honoratus Lloyd, K.C.: I am afraid I cannot do anything of the sort to-day, but I shall be glad to put at the disposal of the Commissioners as much financial evidence as I can.

Mr. Miller (for Birkenhead Corporation) said his clients had been influenced by the financial possibilities of the big scheme, and should have an opportunity of considering and, if necessary, criticising any financial suggestions which might be made.

The Chairman: We recognise the difficulty of the promoters, which arises from the fact that they have no financial powers, but it is very desirable that the promoters of any scheme should expound to the Commissioners the provisional arrangements which may have been made between the conference and the constituent authorities as to the method of financing the undertaking.

Proceeding, Mr. Sparks said it was intended to close down by stages the three stations at Birkenhead, and as a first stage to extend the plant at Wallasey from 12,000 kw. (including 5,000 kw. set in hand) to 16,000 kw. At a later stage further extensions of two 10,000 kw. sets were proposed, making a total of 36,000 kw. The capital expenditure on the first station would be £440,000. The potentialities of the district were very great.

In cross-examination witness said that having regard to the high price of money and the consequent danger of stereotyping electrical charges at a high figure, he thought it best that electrical combination should proceed by way of the formation of small joint districts, extending later into large districts. He agreed that the problem of an abundant and cheap supply of electricity was one of the greatest national importance. The suggestion of Liverpool taking the whole financial responsibility for the generating station was against the spirit of the 1919 Act. He admitted that he had not critically examined how the West Lancashire district ought to be treated if Wallasey and Birkenhead remained outside.

For Messrs. Lever Bros., Mr. Hamilton said their power station was not a public or semi-public undertaking, and they reserved full liberty of action to do just what they wished with their own private property.

In reply to Sir Harry Haward, witness said that the Wirral scheme involved a capital outlay of £1,000,000 for two moderately-sized county boroughs. He agreed that the bigger the scheme the better.

Ultimately the inquiry was adjourned to a date to be fixed later, and which will not be before the end of this month.

Engineers' Club.

The following names have been added to those constituting the Provisional Committee of the proposed Engineers' Club:—

Mr. W. A. Agnew, Mr. Harry Allcock (Vice-President, B.F.A.), Dr. J. F. Crowley, Mr. A. L. Churchill, Mr. F. R. Davenport, Mr. C. Dally, Mr. J. Fearn, Mr. T. Coulden (President, Institution of Gas Engineers), Mr. S. J. Harding, Mr. F. W. Jennings, Mr. C. W. Jordan, Mr. John King, Mr. E. P. Martin, Dr. W. R. Ormandy, Mr. T. Peterson, Mr. H. C. B. Sainsbury, Mr. Norman Scorgie, Mr. S. Tweedale, Mr. H. C. B. Underdown (President, Association of British Motor and Allied Manufacturers), Mr. J. S. Webb (Chairman of Committee, the Engineers' Club, Manchester), and Mr. H. James Yates.

Commercial Topics.

Bonuses to Encourage Production.

The New Zealand Industries Act of 1914, which was passed in order to encourage the manufacture in New Zealand of pig iron, iron bar and steel, and provided for the payment of bonuses for production, was allowed to lapse during the war. In a Bill to amend the Act it is now proposed to renew the offer of bonuses by extending the time during which the original Act was operative. No claim was made for the payment of bonuses under the 1914 Act. There are, however, deposits of iron ore in the Dominion, but there are no well-established iron works, and the Industries Committee in 1919 pointed out that the Dominion's geographical isolation and remoteness from overseas supplies should compel the adoption of a policy that will enable New Zealand to rely on her native resources for iron and steel. It also recommended that the value of all iron deposits throughout the Dominion should be thoroughly examined by an expert metallurgist.

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Reviving Trade in Central America.

In regard to Cuba, the latest reports indicate signs of a speedy revival of trade, and strong hopes are expressed that British manufacturers will do all in their power to give such credit and other facilities as may be possible to ensure an increase of trade with Great Britain. There is a prejudice against United States goods in the island. Hardware of every kind will be in request, and in view of the large number of buildings which are being erected there is certain to be a demand for structural steel and iron work. Many miles of new railways are under construction or contemplated, and in the near future there will be a demand for all kinds of electrical plant, including generators, switchboards and switchgear, high-tension transmission lines, motors, transformers and all kinds of electric cables and wires, lamps and wiring sundries. Catalogues (in Spanish) should be well illustrated, and give full details, with prices.

There is also a good prospect of an immediate revival of trade in Guatemala, where the new Government is displaying strong business proclivities. A good deal of construction work will be commenced in the spring, and there should be a demand for all kinds of machinery. Here also catalogues and price lists should be in Spanish, and be, if possible, profusely illustrated.

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Trade Credits for Europe.

Various schemes for regaining lost markets and for developing the export trade with Europe have been put forward. Though the subject is one of first-class public importance and of great urgency little progress seems to have been made. One of the most interesting of the schemes is that of Sir Edward Mountain, Chairman of the Eagle, Star & British Dominion Insurance Company, who points out that, in order to start an effective scheme for insurance whereby our merchants will be enabled to dispose of their surplus stock to those countries who at present are unable to pay cash and whose credit has become weakened owing to the war, it is essential that a syndicate should be formed in this country of overwhelming financial stability. This can only be done by getting all the leading banks and insurance companies into the group.

Sir Edward Mountain's proposal is that the Government should allocate £13,000,000 out of the £26,000,000 voted to assist trade with the Central European countries, as a fund with which they would guarantee the members of the syndicate against ultimate loss. He thinks it would be possible to form a syndicate which could conduct the business by employing a qualified manager and having a committee to meet daily to go into all questions that may arise. The committee would consist of the ablest brains available in the City.

The syndicate would take any profit made out of the insurance transactions and would pay all expenses of carrying on, offices, managers, clerks, &c. If the Government accepted the proposal the syndicate would get to work immediately, and would get into touch with such countries as Roumania, Serbia, Austria, &c., where similar syndicates would be formed by the leading bankers in those countries, who would give their guarantee for what it is worth to the English syndicate.

Sir Edward is of opinion that, barring the risk of financial collapse of a country, or a country being seized by Bolshevists, and the Bolshevists repudiating their debts, under the scheme the Government would never be called upon for a penny, and even if the Bolshevists seized any of the countries and repudiated the debts, in all probability at some date in the future the money would be recoverable. If either of such events were to occur, however, the Government would lose heavily in any case. The proposals would not interfere with Ter Meulen's scheme The latter would probably take some months to get into order, whereas the Mountain scheme could be put into operation almost immediately and would give our own traders a good chance to get the pick of the markets first, while the Ter Meulen scheme would give an equal start to all nationalities.

Among the advantages of the Mountain scheme are that it would cost the Government (if anything at all) very much less than giving unemployment doles or expending money on forced work; the assistance of the bankers and leading insurance companies would all be entirely at the Government's service, and it would immediately start trade going and have a very beneficial effect on the Exchanges.

The argument that when merchants can insure the due payment of their bills they will be careless in trading does not seem to be very cogent, because the committees which would control the insurance would easily be able to ascertain if merchants were selling their goods at an undue profit. Also, if the bankers in the buying country guaranteed the payment, it would be up to them to get their security from their own people.

Electricity Supply.

Bingley Urban Council has applied for sanction to a loan of £3,000 for distributing mains.

Huntingdon Guardians have appointed a committee to consider the advisability of adopting electric lighting.

Worthing Corporation has received sanction to a loan of £2,100 for a feeder cable to the Broadwater district.

The Willesden Electrcity Committee propose to extend the supply mains in Kilburn and Brondesbury Park at a cost of £7,000.

Llandaff and Dinas Powis Rural Council has received sanction from the Electricity Commissioners to borrow £3,782 for the electric supply undertaking.

Todmorden Corporation has received sanction to borrow £31,600 for supply mains and converting plant, in connection with their scheme for taking a supply of electricity in bulk from the Yorkshire Electric Power Company

The Breconshire Main Roads Committee has authorised Messrs. Harold Elston & Company, of Brecon, to erect poles on the highway to carry cables for supplying electric current to Sennybridge.

Malling Rural Council not only does not object to Maidstone Corporation extending its electric cables to Snodland, but it is anxious to have a supply of electricity in the district.

The net profit on the year's working of the Darlington electricity supply undertaking for the year ended March, 1920, was £5,365, compared with £3,539 in the preceding year.

The following increases in the charge for electricity have been made by Lowestoft Corporation: Power ¼d. per unit, heating 1¼d. per unit, and cinemas and other places of entertainment using motor generators 1¾d. per unit.

Kingston-on-Thames Town Council have received sanction to loans £14,230 for various works, and have applied for sanction to a further loan of £19,750 for extensions of plant, the latter sum being in excess of the engineer's original estimate of £45,000. The charges for electric current have been increased.

West Hartlepool Corporation intend to apply to the Electricity Commissioners for a special order to extend its area of electricity supply so as to include part of Stranton, in the Hartlepool Rural District. Objections must be lodged by Feb. 12.

The Wareham Electric Supply Company, Ltd., has applied to the Electricity Commissioners for a special order to authorise the company to supply electrical energy in the borough of Wareham and parts of the parishes of Arne and Wareham St. Martin's in the rural district of Wareham and Purbeck.

Bedford Corporation has authorised the borough electrical engineer (Mr. R. W. Phillips) to arrange for an additional supply of 370 kw. to Messrs. J. & F. Howard, and to obtain the necessary transformers, switchgear, &c., at an estimated cost of £1,600. A new sub-station (kiosk design) is to be provided for the Queen's Park district.

Heywood Electricity Committee, having received a report from their engineer on the capacity of the e.h.t. transmission line from Bury to Heywood, have decided to duplicate the line, and the tender of the British Insulated & Helsby Cable, Ltd., has been accepted for the completion of the work.

Ealing Corporation has applied for sanction to a loan of £30,000 for three years' requirements of mains, services, meters and transformers. The estimate provided for extensions during the next two years, as well as for the past year. The money will be found by re-investing the £10,000 a year, which has hitherto been paid off the debt.

The Blackpool Municipal Houses are to be wired for the electric light. The Housing Committee recently received a request from the Electrical Contractors' Association that the Corporation should only entertain tenders for the work from members of the association, but no action was taken. At a subsequent meeting, the tenders of the Blackpool Electrical Association were accepted.

Bedford Electricity Department's accounts for the year ended March 31 last show income £61,310, and working and general expenses £43,697, leaving gross profit £17,613. After providing for capital charges, there was a net surplus of £2,628, which has been placed to reserve. Units generated were 6,072,530 and sold 5,020,383. Total maximum demand was 3,130 kw.

The accounts of the Bolton Electricity Dept. for the year ended March 31, 1920, show revenue £200,569, compared with £138,671 in previous year, and working expenses £140,248 (£91,622), leaving £60,321 (£47,049) gross profit. Cost per unit was 0·826d. (0·626d.) exclusive and 1·205d. (1·041d.) inclusive of capital charges. Units generated were 30,198,380 (29,093,680) and sold 24,944,906 (23,715,040).

Newport (Mon.) Corporation has applied to the Electricity Commissioners for a special order to extend its area of electricity supply so as to include Caerleon Urban District, and certain parishes in St. Mellons Rural District and Magor Rural District; to increase the maximum price of electrical energy, &c. Objections must be lodged with the Commissioners by Feb. 15.

Among the proposed municipal loans are those of Salford and Birkenhead Corporations. The former propose to raise £170,000 by the creation of stock, of which £100,000 is for the electricity undertaking and £50,000 for the tramways department. Birkenhead Corporation has also agreed to issue £1,000,000 6 per cent. stock, of which more than £900,000 will be expended on housing, electricity supply, &c.

Extensions of the Limehouse generating station of the Stepney (London) Borough Council are to be carried out in three parts, so as to keep pace with the development of the undertaking. The first part involves an expenditure of £281,160, the second £128,480, and the third £82,500, a total of £492,140. The Council has approved an estimate for the sum of £281,160, and application has been made to the Electricity Commissioners for the necessary sanction.

As the new power station at Belfast will not be completed before the winter of 1922, the Electricity Committee propose, in order to make provision for the demands for supply, to erect the second 6,000 kw. generating set, which is on order for the new station in the temporary station on Messrs. Harland & Wolff's premises. Application for sanction to a loan of about £24,000 has been made in order to cover the cost of installing it in the temporary station.

The accounts of the Hove Electricity Department for the year ended March 31 last show revenue from sales of current £28,339, against £21,250 in previous year, and rental of meters £2,096 (£1,438). The balance carried to net revenue account was £14,376 (£9,020), and the ultimate net profit was £3,920 (compared with a deficit of £2,025). On the Aldrington section the revenue was £2,560 (£1,548), and the deficit £435, reducing the profit on the joint undertaking to £3,485.

The accounts of Edinburgh Electric Lighting Dept. for the year ended May 15, 1920, show revenue £234,247, and working and special expenditure was £162,020, leaving £72,227 gross profit. Interest required £14,193, contribution for liquidation of debt £39,991, and income tax £7,492; and the net surplus was £10,551. Unites generated were 30,115,737, compared with 25,599,789 in previous year, and sold 24,401,273 (20,565,249).

The advantages of electric lighting and power are appreciated by the directors of the National Safe Deposit Company, who have found it necessary to install new motors to work the hydraulic machinery for closing their vault doors and to provide a new and thorough system of ventilation, and propose to adopt electric power instead of steam. The chairman has stated that this will greatly improve the atmosphere of the building and add to the health of the staff and to the comfort of the safe holders when visiting their safes.

The Mexborough Urban Council has authorised the electrical engineer (Mr. J. B. Feltham) to complete arrangements for taking electricity in bulk from the Yorkshire Electric Power Company. The Company agree to supply the Council with current as cheaply as Rotherham Corporation, and also to lay the necessary mains. The Yorkshire Electric Power Company, which holds powers for South Yorkshire, where supply powers are not held and worked by local authorities, can now extend eastward to Doncaster.

The financial position of the electricity department of the Poplar (London) Borough Council appears to be very satisfactory. During the past quarter the units sold were 5,739,731, an increase over the corresponding quarter of the previous year of 665,277 units. The net income increased by £12,815, working expenditure by £5,675, and gross profit by £7,140. After providing for interest and other charges, the net surplus was £2,152. The surplus for the half-year ended December was £3,866, against a deficit of £4,981 in 1919.

Col. F. A. Cortez Leigh, chief electrical engineer of the L. & N.W. Railway, contended that direct representation should be given to the railways on the joint authority without financial responsibility. The railways in the future had great hopes of being larger users of electricity than they were at present.

It was decided that the railway companies should each have two representatives. Criccieth Council, considering the new authority to be too unwieldy and that district authorities would lose their identity as distributors, and as there was ample power in Carnarvonshire for the whole of the electricity district, has resolved, subject to proper safeguards, to support the scheme submitted by the North Wales Power Company

At a conference of sixteen local authorities in Carnarvonshire on Monday fourteen voted in favour of the scheme proposed by the North Wales Power and Traction Company.

A conference of local authorities and large consumers of electricity considered recently the Chester Corporation scheme for the creation of a Joint Electricity Authority for the North Wales and Chester area. An outline of the scheme appeared in a recent issue of The Electrician, and Ald. Pritchard, of Carnarvon, who presided, said that the favourable way in which it had been spoken of by the Electricity Commissioners, and the fact that copies had been asked for by other areas, indicated that it had been well prepared.

Mr. E. Noel Humphreys, of Chester, was desirous that there should not be a false impression that it was merely a Chester scheme. The distinction between the two schemes that had been laid before the Commissions was that theirs was a public authorities, and the other was a private scheme submitted by the North Wales Power & Traction Co.

Mr. Tilby, Clerk to Flintshire County Council, attached the greatest importance to the constitution of the authority regarding representation of every area, and a sub-committee was formed to consider the constitution. Members asked whether the local authorities would be compelled to join in the scheme or whether it would be voluntary, and in reply it was pointed out that Sir John Snell had recently stated that the Joint Electricity Authority must be a voluntary one. The Town Clerk of Chester held that the whole basis of the constitution of the authority was entirely voluntary, and at present they could not say what authorities were going to join, but he hoped there would be a considerable number to start with. The question of the supply of electricity must proceed slowly; it would be impossible to get the supply of electricity over the whole of those vast districts within even five years.

Electric Traction.

Cardiff Corporation is recommended to allow about 100 blind persons in the city to travel free on the tramcars. The concession means a loss of only £750 in revenue per annum.

Leeds Tramways Committee propose to apply to the Minister of Transport for an order to empower the Corporation to raise the fares to 1½d. per mile for all classes of passengers. At present the maximum fare is 1d. per mile, and ½d. per mile for "artisans, mechanics and daily labourers."

The accounts of the Newcastle-on-Tyne tramways department for the year ended March 31 last show revenue £504,053, compared with £472,094 in the previous year, gross profit £81,838 (£165,604), and net surplus £1,404 (£45,000). Passengers carried were 101,967,141 (101,631,660) per car-mile, and car-miles run were 6,027,870 (5,856,829).

Denton Urban Council has notified Manchester Corporation that it desires to exercise the powers and assume the obligations imposed on the Corporation by the Manchester Corporation Act, 1920, in relation to the construction, maintenance and use of the tramways situate in Denton area.

The accounts of Salford Corporation tramways department for the year ended March 31 last show revenue £495,024, compared with £425,383 in the preceding year, gross profit £119,527 (£130,882), and net profit £37,609 (£42,672), of which £20,000 (£25,000) has been contributed in relief of rates, and £11,609 (£17,672) placed to depreciation and renewals fund. Average total revenue per car-mile was 19·929d., and working expenses were 14·729d. Passengers carried were 80,587,359, and car-miles run 5,961,197.

The Sunderland Tramway estimates show that, compared with 1914, the wages of motormen and conductors have risen from £13,797 to £46,000, rates and taxes from £2,697 to £11,800, and income tax from £637 to £8,150. The Tramways Committee is unable to pay anything towards relief of rates, or give the £13,000 which is due to the reserve and renewals fund. The workmen's unremunerative fares are to be abolished, and the advertisement rights have been let for £2,000, against £150 for partial rights.

The Ministry of Transport has called a conference in order to consider a proposal that the London County Council should take over and operate the tramways owned by the Erith, Bexley and Dartford Councils. The Erith tramways practically join the L.C.C. route at Abbey Wood, and run 5 miles through Belvedere and Erith to Northumberland Heath and the Bexley system. There are only 5 miles of the Bexley lines which join the L.C.C. track at Plumstead and run to the Crayford boundary, whence the Dartford system runs 11 miles to Horns Cross.

Several Orders for Electric Vehicles for refuse collection have recently been given out. These include an order by Islington Borough Council for 10 Edison electric vehicles to Electricars, Ltd., and one Orwell vehicle from Messrs. Mossay & Company. The Manchester Electricity Committee has accepted the tender of Electromobile (Leeds), Ltd., for an electric tipping truck. Glasgow Cleansing Committee propose to purchase from Electric Vehicles, Ltd., a 2-ton electric chassis, and Wolverhampton Corporation Electricity Committee has ordered a renewal battery for a 3½-ton Orwell vehicle.

Imperial and Foreign Notes.

Central Illawarra (N.S.W.) Council has under consideration the purchase of the Port Kembla Amusement electric generating plant. The supply of electrical energy to private consumers in the town is given at present by a company which purchases in bulk from the Electrolytic Refining & Smelting Company.

The Commercial Secretary to H.M. Legation at Christiania states that the Norwegian Government has granted a concession to "A/S Akersbanerne" to construct an Electric Railway from Majorstuen through Taasen to Sognsvandet and from Taasen to Sagene, a suburb of Christiania. Work in connection with the levelling of the route is to be put in hand immediately, but it will not be concluded until next autumn, and invitations to tender will not be issued until the end of the year. An opportunity should then arise for British firms to submit tenders. It is estimated that the rails will be required at the end of 1922, and the cars in the autumn of the same year. The "A/S Akersbanerns" recently applied to the Government for a further concession for a line from Christiania to Ostensjo, a distance of five miles.

The use of radio-telegraphy for commercial purposes appears to be making good progress in Italy. From the "Manchester Guardian" we learn that regular radio-telegraphic communication has been established with Germany, the United Kingdom, Spain, Switzerland, Rumania, Bulgaria and Serbia, and arrangements are in progress to link up with Hungary, Greece, Portugal, Czecho-Slovakia and Russia. The traffic between ships and coastal stations, which prior to the war was about 80,000 words yearly, exceeded 500,000 words last year. The radio-telegraphic stations on board have risen from 50 to more than 300. In order to obviate the inconvenience of possible interruptions of the cables between Sardinia and the Continent, two radio-telegraph stations will shortly be established. Senator Marconi has expressed his intention to form an Italian company to secure a concession for a group of stations to be used solely in the interest of the public service and of the national and international Press. The Marconi Company has already filed a petition for a concession, which will be examined by the permanent Board for Radio-Telegraphic Service.

Miscellaneous.

The death occurred on Jan. 26 of Mr. S. Trevor Smith, gas and electrical engineer to Malvern Urban Council since 1914. Formerly he was at Leek.

A financial statement on the Hull Municipal Telephones has been prepared by Mr. T. Holme, manager and engineer of the department. The total amount of royalties paid to the Post Office during the past five years was £30,550, or 10 per cent. on the gross income. The net profit was £3,645 in 1916, £5,355 in 1917 and £850 in 1918. In 1919 there was a loss of £1,105 and in 1920 of £611. The tariff has been increased in order to meet the deficit.

Though not in agreement with the principle involved, the National Joint Industrial Council for the Electric Supply Industry has agreed to put in operation the award for No. 10 Area Council, which was recently accepted by a ballot vote of the workpeople. The award will give increases ranging from 3s. to 12s. 6d. per week, and is to be retrospective from Sept. 1 last. Application has now been made to No. 9 Area Council for similar rates.

At the regular meeting of the Kelvin Lodge, which was held at the Mark Masons' Hall, London, on the 28th ult., the reigning Master, Mr. H. Porter-Cox, presided over a gathering of 98 members and visitors, including three Grand Lodge officers, namely, Messrs. Charles F. Quicke, E. J. Reid and P. P. Kipping, as well as others of provincial and London rank, and all present enjoyed the speeches and the musical entertainment which was provided after dinner. Applications to join the Lodge are coming in steadily, and each year the support given to the great Masonic charities seems to exceed that of the previous year.

As the grounds for the control of the distribution of coal and the regulation of pithead prices have ceased to operate, the Government has decided to cancel on March 1st the directions of the Board of Trade as to pithead prices. All directions to collieries to supply specified districts or consumers will also be abolished. From the date mentioned all questions as to price, quality and delivery of coal will be matters for arrangement between buyers and sellers. Most people, and particularly station engineers and managers, will welcome this announcement.

The first issue of "Space," the House Journal of Messrs. Benn Brothers, Ltd., is an artistic production, which possesses a literary merit much above the average house magazine. There is a good reproduction of Sir W. Orpen's portrait of the chairman of the company, Sir John Benn, Bart., who contributes an interesting article entitled "The House that Benn Built." There are various items of trade and domestic news and a striking diagrammatic representation of the great progress made by Messrs. Benn Brothers' technical journals during the war and since the Armistice.

At Birmingham Police Court on Friday last, Frances Clifford Johnson, aged 20, was fined £20 (or 51 days' imprisonment) for stealing £225 from her employers, Messrs. Harpin & Company, Ltd., electrical engineers. Mr. John Harpin, managing director, said Johnson, who had been with the firm for about five years, cashed an open cheque for £225 on Jan. 7 and later disappeared with the money. She was arrested at Wolverhampton, where she had entered domestic service, with £182 in notes in her possession, having spent the remainder on a servant's outfit and other articles. She went to Wolverhampton Police Station to telephone to Mr. Harpin that she was returning, when she was arrested.

The report of Callender's Hospital and Distress Fund for 1920 states that eleven donations were received, varying from £50 (from the Company) to £2 2s., and the weekly subscriptions amounted to £761 19s. 7d., compared with £362 2s. 7d. in the previous year, the difference being due to the increase from 1d. to 2d. per week. Awards varying from £210 to £5 5s. were given to hospitals and other institutions, the aggregate being £640 10s., against £375 18s. Hospital letters issued were 321 (increase 118), besides 16 (increase 8) for home nursing; 124 surgical appliances were supplied and various sums were paid for spectacles, special surgical requirements, &c.

This month will witness the opening of two important trade exhibitions, each of which has been designed to draw attention to the value of British products. As already announced, Messrs. Benn Brothers will be represented at each of these shows. A special feature of our exhibit at the Business Efficiency Exhibition at Olympia (Feb. 10 to 26) is the unique and striking decorative arrangement of the stand, and we extend a cordial invitation to our readers to come and see it. The number is 161. At the British Industries Fair, White City (Feb. 21 to March 4) stand G. 8 has been secured, where all the Benn journals, annuals and scientific books will be on view. Arrangements have been made to enable visitors to examine the exhibits in comfort.

The first Report of the Royal Commission on Awards to Inventors has been issued. Over 1,000 cases, mainly relating to inventions connected with the war, were submitted for consideration. Among the awards made are the following:—Capt. W. S. Tucker (Hot Wire Microphone), £4,000; Mr. A. G. Cooke (Photometric Method of Screw Gauging), £2,500; Executors of Dr. E. Russell Clarke (improvements in wireless telegraphy and aircraft devices), £8,000; Dr. Hele-Shaw (Pneumatic clutch), £3,000; Mr. H. H. R. Green (electrically-controlled switches), £7,500; Major A. C. Fuller (Fullerphone, in addition to £1,250 already received from the Ministry of Munitions), £3,500; and Commander F. R. S. Bircham (indicator nets, in addition to £150 already received from the Admiralty), £1,500.

The recent Welsh railway disaster has brought into prominence the question of using wireless telegraphy as an auxiliary means of communication for railway purposes. The Marconi Company has been carrying out some experiments and it is constructing special sets for the work. Provided the Post Office grant the necessary licences, sets will be submitted to the L. & N.W. Railway Company for an extended trial. During the railway strike the Government asked the company to help in the problem of goods transport by the installation of a network of wireless stations to link up the big railway centres. The company established seven stations on the Midland Railway, but owing to difficulty in constructing the sets, they were not ready until the end of the strike. The scheme, however, created interest in the subject and the company recently undertook an exhaustive series of tests between Euston and Crewe.

Institution Notes.

The next Dynamicables dinner is to be held at the Trocadero Restaurant, on Tuesday, Feb. 8, at 7.30 p.m., when Sir James Devonshire, R.N.E., will be in the chair.

The Institution of Electrical Engineers will hold their annual dinner and reunion at the Hotel Cecil on Thursday, March 3, under the presidency of Mr. Ll. B. Atkinson. Early application for tickets should be made to the secretary of the Institution, at 1, Albemarle-street, London, W. 1.

An address on "The Position of Cost and Works Accountants in Co-ordinating the Aims of Capital and Labour," will be delivered by Mr. H. W. Allingham before the Institute of Cost and Works Accountants. Tickets of admission may be obtained from the Secretary at 38, Grosvenor Gardens, London, S.W. 1.

A branch of the Women's Engineering Society has been founded at Loughborough. The activities of the section include debates and discussions on technical subjects, tours over various engineering works, and lectures by prominent engineers. Sub-centres are to be formed at Bedford and Birmingham. The secretary of the branch is Miss E. J. Linford, The College, Loughborough.

In the lecture on "The Advantages of Electric Traction on Railways," delivered by Sir Vincent Raven before the York Railway Lecture and Debating Society on the 25th ult., tables were submitted relating to the working of the North Eastern Company's Newport and Shildon line (the only electrified mineral line in this country). Particulars were given for nine months in 1914 (steam) and 1920 (electric), showing (1) that the train-miles per train-hour had increased from 6 and a fraction in 1914 to 7, 8 and even 9 and a fraction in 1920; (2) that the wagon miles per train mile had increased from figures like 43, 44 and 45 to as much as 54 and 55; and that the wagon miles per train engine-hour, which had ranged from 202 to 214 in 1914, had risen to 378-390 in 1920.

On Friday, Feb. 11, the Physical Society of London will hold a discussion on "Absolute Measurements of Electrical Resistance and Instruments Based on the Temperature-variation of Resistance." The programme includes Papers on "Absolute Measurements of Electrical Resistance," by Sir Richard Glazebrook, K.C.B., F.R.S., and Mr. F. E. Smith, O.B.E., F.R.S.; "Resistance Thermometry" will be dealt with by Prof. H. L. Callendar, LL.D., F.R.S., who will contribute an article on "The Compensated Resistance Bridge, and Instrument for the Measurement of Radiation"; by Prof. C. R. Darling on "The Early Work of Siemens on the Resistance Pyrometer"; and also by Mr. C. Jakeman on "The Measurement of Steam Temperatures." Major W. S. Tucker, R.E., D.Sc., will read a Paper on "The Function of the Convection Current in the Hot-Wire Microphone," and Capt. E. J. Paris on "Theory of the Tucker Microphone." Papers on Anemometry and Heat Convection will be contributed by Prof. J. T. McGregor Morris on "A Hot-Wire Anemometer," Dr. J. S. G. Thomas on "A Directional Hot-Wire Anemometer," and Mr. A. H. Davis on "An Instrument for Measuring Convected Heat." Miscellaneous Applications will also be given by Dr. G. A. Shakspear on "A Gas Permeameter"; Prof. Leonard Hill on "The Caleometer"; Mr. E. A. Griffiths on "Liquid Depth Gauge (Distant Reading Type)"; Dr. Daynes on "A CO_2 Recorder"; and Dr. Ezer Griffiths, "Electrical Hydrometers."

Catalogues, Price Lists, &c.

Stock lists of two and three-phase induction motors have been issued by Messrs. Rayner & Heald, Ltd., Duke-street, Derby. Both squirrel cage and slip-ring types are listed, and particulars of voltages, with prices, &c., are given.

The Hart Accumulator Company, Ltd., have issued a leaflet illustrating their "PL" battery for high voltage work. It is designed mainly for use with thermionic valve amplifiers, but it is equally suitable for all kinds of electrical testing where small currents are required at a high-constant pressure. A special feature of the construction is high insulation resistance, due to the design of the cell containers.

In descriptive list No. 2,420 B the British Thomson-Houston Company, Ltd., give a general description of their Rotary Converters, with particulars of their design and construction, methods of starting, &c. The list is well illustrated, and machines of various capacities are shown. Rotaries have been built, or are under construction, of practically all capacities up to 4,500 kw., and the company is prepared to build machines for any voltage up to 2,000 for 25-cycle systems and up to 1,000 volts for 50-cycle systems.

Bankruptcies.

Albert Lord, electrical contractor, 33, Westgate, Burnley, has been adjudicated bankrupt.

David Suchostawer, engineer, First-avenue, Acton, has been adjudicated bankrupt.

Personal and Appointments.

Mr. A. J. Giffin is leaving the Western Electric Company, Ltd., at the end of January, to take up an appointment with the Bradford Dyers' Association.

Sir Robert Robertson, K.B.E., F.R.S., Director of Explosives Branch, Research Department, Woolwich, has been appointed Government Chemist, in succession to Sir J. J. Dobbie, who has retired.

Mr. W. J. Morrison, works manager at Messrs. Bruce, Peebles and Company, at Edinburgh, who has become general manager of Eglinton Foundries (Limited), Glasgow, has been presented with gifts from the members of his staff. A presentation was also made on behalf of the workers at East Pilton.

At the conclusion of a lecture on "Cloudland Studies" at the Royal Institution on Monday, Sir James Dewar said the present year was for him and his wife an annus mirabilis, for he would be celebrating therein his golden wedding, and, if he lived till that celebration, his 80th birthday. The announcement was received with sympathetic applause by the company present.

Mr. Wm. Morries, B.Sc., who has been chief electrician at the Blackley works of the British Dyestuffs Corporation for the past three years, is resigning in order to enter business as an electrical engineer and wiring contractor, at 35, Cheapside, Middleton, Manchester. On the 27th ult. the electrical staff presented their departing chief with a beautiful rose bowl, suitably inscribed. The presentation was made by Mr. C. E. S. Place, chief engineer of the works engineering department. Mr. Morries replied, and thanked the staff for their beautiful present, bespeaking their close co-operation for his successor, Mr. J. H. Davies. Mr. Morries will be pleased to receive price lists and catalogues from makers of electrical equipment for both power and lighting.

The following appointments have been made by the directors of the group of companies which includes the Underground Electric Railways Company of London, the Metropolitan, District, London Electric, City and South London, and Central London Railways, and London General Omnibus Company: Assistant managing director, Mr. H. E. Blain and Mr. F. Pick; director for construction (railways), Mr. Z. E. Knapp; chief engineer (omnibuses), Mr. G. J. Shave; chief engineer (railways), Mr. A. E. Cooper; secretary and treasurer, Mr. J. C. Mitchell. The management of the London and suburban traction group (the Metropolitan Electric, London United and South Metropolitan Electric Tramways) has been brought into direct connection with the Underground management, and the following appointments have been made:—Mr. C. J. Spencer, general manager; Mr. E. Boys, secretary and treasurer.

Business Items, &c.

Edward John Tripp and Ralph Ives Herbert Carryatt, motor, electrical and general engineers, 59a, Alma-road, Clifton, Bristol, have dissolved partnership. Debts by Mr. Tripp, who continues the business.

Chas. Wm. Johnson and John Cecil Ridsdale, electrical engineers, 27, Upper North -street, Leeds, have dissolved partnership. Debts by Mr. Johnson, who will carry on the business in his own name.

Frank Sinclair Ormonde & Nathan Silverstone, trading as the Soho Electrical Works, 125, Islington, Liverpool, have dissolved partnership. Debts by Mr. Ormonde.

Walter Wm. Fennell and Geo. Clinton Forrester, electrical engineers, 48, Queen's-road, Nuneaton, have dissolved partnership. Debts by Mr. Fennell, who continues the business under the style of Fennell & Forrester.

Messrs. W. H. Smith & Co. (1920), Ltd., have appointed Mr. Ashley P. Pope as sales manager, with headquarters at their London Office, Central House, Kingsway, W.C. 2, where he will be delighted to see old friends. Telegrams: "Virwires Westcent London"; telephone: "Regent 2368."

An important scheme for the amalgamation of a group of British lead manufacturers has been arranged. A new company, with the title of Associated Lead Manufacturers, Ltd., will be formed to acquire the control of Messrs. H. J. Enthoven & Sons, Walkers, Parker & Company, Locke, Lancaster and W. W. & R. Johnson & Sons, James & Company, Foster, Blackett & Wilson, and Alex. Fergusson. The combination will include some of the oldest firms in the lead manufacturing business and will be closely associated with the Burma Corporation, which owns the largest known lead property in the world.

The Edison Swan Electric Company, Ltd., announce that, owing to the greatly increased sales of the Royal Ediswan lamps, coupled with the use of the most perfect machinery and methods at present known in the production of lamps, they are in a position to reduce the prices as from the 1st inst., and a schedule of the reductions has been issued. The reduced prices apply to their gasfilled, vacuum and motor car types. New price lists will be obtainable in a few days.

The General Electric Company, Ltd., have also made a material reduction in the price of Osram lamps. Though not generally known, British electric lamp factories were engaged in war work of the most vital importance and progress was thus retarded. Since the armistice great efforts have been made in extending the Osram-G.E.C. lamp works, in replacing machinery by the latest and most efficient types, &c. As a result of these combined circumstances, together with the increasing efficiency of the workpeople, who have rapidly become expert in the new methods, the company are able to record a reduction in the cost of production and an improvement in the quality of the Osram lamp. Outstanding orders will be executed at the reduced prices.

Tenders Invited.

Manchester Electricity Committee require tenders by February 14 for supply and laying of 33,000 volt trunk feeder, pilot and telephone cables. Specification from Mr. F. E. Hughes, Town Hall, Manchester.

Croydon Corporation want tenders by Feb. 11 for a gas engine and pump, or electric motor and pump for Beddington sewage farm. Specification from the Borough Engineer.

Middlesbrough Corporation require tenders by Feb. 9 for laying a double line of tramways in Grange-road West. Specification from the Borough Engineer and Surveyor.

Tenders are required by Feb. 3 for electrical installation work at the Chepstow and District Hospital. Particulars from Mr. J. N. Jefferies, Wansbeck House, Bridge-street, Chepstow.

Tenders are wanted by March 1 for additional electric fittings for the County Sanatorium, Almeley, Herts. Specification can be seen at the office of the County Surveyor, High Town, Hereford.

Great Yarmouth Corporation invite tenders for the supply and erection of h.t. switchgear. Copies of specification from the engineer, Mr. Gordon Bryant. Tenders to the Town Clerk by Feb. 11.

Belfast Tramways Committee want tenders by Feb. 26 for stores, including electrical accessories, copper strip, cable, lamps, insulating tapes, carbon brushes, wire and ears, g.i. wires, &c. Forms of tender from the General Manager.

The New Zealand Government Railways Dept. require tenders by March 5 for two overhead electric cranes for goods shed at Christchurch. Specification can be seen at Dept. of Overseas Trade, 35, Old Queen-street, Westminster, S.W. 1.

Aberdeen Corporation invite tenders for supply and erection of electric pumping machinery capable of delivering 6½ million gals. per 24 hours, including transformers, motors, pumps, &c. Specifications from the Water Engineer, 41½, Union-street, and tenders by Feb. 21.

Pretoria (Transvaal) municipality require tenders by March 10 for one 20 ton overhead crane, six boilers to evaporate 18,000 lb. an hour each at 350 lb. pressure; three 3,000 kw. steam turbo-generators, condensing plants, five 750 kw. converters. Specification from Town Clerk.

The Tramways Committee of Manchester Corporation invite tenders for various stores, including permanent way points, tongues and hardened steel centres, welding portions, &c., also motor controller parts, resistances, commutator segments, armature and field coils, &c Schedules from the general manager, Mr. J. M. McElroy, 55, Piccadilly, Manchester, and tenders to the Chairman of the Committee by Feb. 15.

Tenders are invited up to March 2 for the supply and delivery to the Australian Postmaster-General's Department, State of South Australia, of (a) telephone parts (Schedules 558 and 559); and (b) telegraph and telephone materials (Schedule 560). Forms from High Commissioner for Australia, 406, Australia House, Strand, W.C.2.

The City of Auckland (N.Z.) invite tenders for the supply and erection of one 3,000 kw. and one 5,000 kw. turbo-alternator, rotary converters (1,500 kw. and 500 kw.) switchgear and transformers, also water tube boilers, conveyor pumps, pipework and h.t. and l.t. cables. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew & Rider, 8, Queen Anne's-gate, S.W. 1, and tenders by noon, February 22, 1921, to Mr. Alex. Wyllie, C/o. Messrs. Preece, Cardew & Rider.

Tenders are invited up to Feb. 23 for the supply and delivery to the Postmaster-General's Dept., State of South Australia, of electric lamps (Schedule 561); up to March 21 for the supply and delivery to the Postmaster-General's Dept., State of New South Wales, of telephone and telegraph apparatus, testing instruments and switchgear parts (Schedule 814); up to March 29 for the supply to the Postmaster-General's Dept., State of Western Australia, of telegraph materials (Schedule 333), up to April 5 for the supply and erection of accumulators, &c., at the Telegraphic Office, Eucla (Schedule W. A., 647), for the Postmaster-General's Dept., Western Australia, and up to March 30 for supply of switchboard apparatus and parts (Schedule 515), to the Postmaster-General's Dept., State of Queensland. Tender forms, &c., from the High Commissioner for Australia, 406, Australia House, Strand, London, W.C.2.

Sydney (N.S.W.) Council has let a contract to the English Electric Company of Australia for the supply of a 25,000-kw. turbo-alternator, which, it is said, will be the largest erected in Australia. The machine is to be paid for at cost, plus 15 per cent. up to a maximum of £200,000.

London County Council has accepted the tender of Crompton & Company for the supply of electric motors required in connection with the electrical work at the new County Hall. The amount of tender is £14,231 1s. 6d., which is the lowest of the four tenders submitted, the highest being £14,285 6s. 0d.

Salford Gas Committee has placed an order with Mather & Platt, Ltd., for two 20 b.h.p. electric motors for £921. The Electricity Committee has accepted the following tenders:—Metropolitan-Vickers Electrical Company, supply and delivery of one 100-k.v.a. transformer (£300), one 6,600-volt switch cubicle (£266), one 600-k.v.a. transformer (£1,182), and spare and rotor parts for turbo-alternator (£4,400).

Messrs. Johnson & Phillips, Ltd., Charlton, S.E.7, have just received an order from the G.P.O. Engineering Department for a Duplication of the London to Brighton Trunk Telephone Cable laid by them in 1914. This cable consists of approximately 55 miles of 104 pair 70 lb. dry core lead-covered cable, and is in addition to considerable mileage of trunk telephone cable which the firm have in hand for other sections of the G.P.O. telephone system.

Patent Record.

SPECIFICATIONS PUBLISHED

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & CO., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

COMPLETE SPECIFICATIONS.

127,255 CATANI. Process and apparatus for the electrolytic decomposition of chlorides. (20 5/18.)
147,141 KRUPP AKT.-GES. Electro-magnetic chucking device. (18/6/19.)
148,280 SIEMENS & HALSKE AKT.-GES. Starting of electric arcs in lamps, rectifiers, and the like. (21 7/19.)
148,457 KRUPP AKT.-GES. Electro-magnetic chucking device. (23/7/19.)
149,921 MEYFARTH. Electric vehicle controllers. (18/8/19.)
151,231 HAEFELY ET CIE. Electric insulators. (13/9/19.)
154,166 JOHANSSON. Electrical connectors. (7/11/19.)
154,386 GOLDSTONE & BRYDON. Electric condensers. (19/9/19.)
154,390 ROSS. Electric fuses. (25/9/19.) (Patent of Addition not granted.)
154,429 STONE & CO. Brush-gear for dynamo-electric machines. (16/2 17.)
154,432 THOMPSON. (Chollet.) Electrically-operated diaphragm horns. (12/11/19.)
154,444 ERICHSEN. Electric furnaces. (25/11 19.)
154,454 FOSTER. Thermo-electric couples. (5 12/19.)
154,471 HEBERLEIN. Method for electrolysing a solution of nickel salt. (8/8 19.) (Divided application, on 141766.)
154,492 TURNER. Magneto-electric machines. (19 2 20.)
154,499 AMES. Means in connection with carburettors for electrically heating the induction charge for internal-combustion engines (3/3/20.)
154,503 PUDUMJEE. Electric controlling switches. (12/3/20.)
154,518 WHITEHEAD & WHITFIELD. Means for connecting together sets of electrical conductors. (5 7 20.)
154,635 ADAM, STEVENSON, MABBITT & FIELDHOUSE. Electrolysis. (27/2/19.)
154,637 OLIVER. Hand-cart for transporting and operating wireless telegraph station in forward battle areas. (13 5/19.)
154,650 SNELL. Work feeding attachment for electro-plating apparatus. (28/8/19.)
154,65[illegible] MCCONNELL. Process of manufacturing electric steels. (30/7/19.)
154,682 SMITH & POWELL. Method of and means for electrically controlling the throttle valve in internal-combustion engines for propelling vehicles. (28/8/19.)
154,691 REED-COOPER. Dynamo-electric machinery. (30 8/19.)
154,692 GRAFTON & GRAFTON DYNAMOS, LTD. Moving brush-gear for dynamo-electric machines. (30/8/19.)
154,698 AUTOMATIC TELEPHONE MFG. CO. (Automatic Electric Co.) Automatic switching mechanism for use more particularly in telephone and/or like systems. (2 9 19.)
154,711 WICKETT. Electrical treatment of ferrous metals during casting. (3/9/19.)
154,717 FRANKLING. Arrangement of electric welding apparatus. (4/9/19, addition to 134,393.)
154,720 TRICHARD. Electric frequency multipliers. (5/9/19.)
154,723 WHITE. (Wisconsin Electric Co.) Universal grinders, particularly of the electric type. (6/9/19.)
154,726 O'DELL. (Western Union Telegraph Co.) Method of and apparatus for operating synchronous telegraph systems. (8/9/19.)
154,729 THOMAS. Microphones. (11/9/19.)
154,735 HIATT & CO. & MELSON. Electric lamps for police and like uses. (16/9/19.)
154,737 OLDHAM, OLDHAM & OLDHAM. Galvanic batteries. (16/9 19.)
154,752 JAMES. Variable limit switch for breaking the circuit of an electric motor operating printing machinery. (25/9/19.)
154,763 B.T.-H. CO. (G.E. Co.) Pneumatically-operated controllers for electric motors. (14/10/19.)
154,767 DEAN & REDMAYNE. Electrical fuses and distribution boards. (21/10/19.)
154,779 HADDAN. (Regan.) Centrifugally-operated electric switches. (7/11/19.)
154,785 CARTER & BRENDELL. Machine tools provided with electro-magnetic chucks or work holders. (13/11/19.)
154,809 JEAL. Means for starting internal-combustion engines, adapted also to be used for generating electric current. (2/1/20. Addition to 144,509.)
154,814 NEGROMANTI. Electrically-heated garments. (9/1/20.)
154,833 COWPER-COLES. Process and apparatus for the manufacture of wire by electro-deposition. (18/3/20.)
154,849 POLLAK. (Maschinenbau Akt.-Ges. Seebach.) Electric welding. (1/5/20.)

APPLICATIONS FOR PATENTS

July 10, 1920.

20,574 CONSTRUCTIONS ELECTRIQUES DE BELGIQUE SOC. ANON. Contact fingers for rheostats, &c. (2/4/19, Belgium.)
20,580 MEYER. Driving systems for a.c meters. (12/6/19, Germany.)
20,583 GRUNDHOFER. Induction furnaces. (21/1/18, Germany.)
20,597 APEX ELECTRICAL MFG. CO. Washing Machines. (10/6/18, U.S.)
20,613 GOLDSCHMIDT. Ground connections for wireless stations. (8/11/17, Germany.)
20,617 GOLDSCHMIDT. Ground connections for wireless stations, (22/3/17, Germany.)
20,632 HUTH. Apparatus for rhythmically influencing electric waves produced by cathode tubes. (3/4/19, Germany.)
20,634 HUTH. Method of connection for producing oscillations with vacuum tubes (27/9/17, Germany.)
20,635 HUTH. Service arrangement for transmitting stations. (8/9/16, Germany.)
20,636 ALGEMEINE ELEKTRICITATS GES. Coin-freed meter for electricity, &c. (13/7/17, Germany.)
20,655 NEUE INDUSTRIE WERKE. Multiple electric fuses. (23/12/14, Germany.)
20,662 HUTH. Arrangements for reception of electrical waves. (26/4/19, Germany.)
20,666 AEGIR ELEKTRISCHE BORD APPARATE U. MOTOREN GES. SCHWARZ & CO. Distance signal device for indicating levels of liquids. (31/1/17, Germany.)
20,667 WESTFALISCHE GASGLUDLICHTFABRIK F. W. & C. Killing distribution of light of electric lamps. (4/12/15, Germany.)
20,671 AEGIR ELEKTRISCHE BORD APPARATE U. MOTOREN GES. SCHWARZ & CO. Distance signal device for indicating levels of liquids. (5/12/18, Germany.)
20,688 DYNAMOBURSTEN FABRIK NURNBERG, REICHELSDORF SCHMIDTHAMMER & MAGNUS. Electric carbons. (20/3/18, Germany.)
20,738 AUFRANC. Switches. (11/7/19, France.)
20,755 AYMARD. Continuously renewable anode or cathode surface.
20,756 AYMARD. Electrolytic cell.
20,782 MACRORIE, MULLARD & SHEARING. Thermionic valves.
20,784 MORRIS-AIREY, MACRORIE, MULLARD & SHEARING. Insulation and support of valve electrodes.
20,807 LATOUR. Electro-magnetic wave-signalling systems. (16/12/18, France.)
20,808 LATOUR. Electro-magnetic direction-finding systems. (7/12 18, France.)
20,809 LATOUR. Receiving arrangement for reception of electro-magnetic waves. 27/10/16, France.)
20,810 LATOUR. Inductances. (12/12/18, France.)
20,811 LATOUR. Telegraphic systems.
20,814 SOC.-RADIO ELECTRIQUE. Electro-magnetic wave receiving systems. (31/11/16, France.)
20,815 SOC.-RADIO ELECTRIQUE. Wireless telegraphy. (26/10/16, France.)
20,817 HANSA-LLOYD-WERKE A. G. Electrically-driven vehicles. (3/7/19, Germany.)
20,824 GES. FUR NAUTISCHE INSTRUMENTS. Electric contact device. (11/5/16, Germany.)
20,829 NEUFELD & KUHNKE. Electric connecting device for vessels. (21/7/16, Germany.)
20,831 GES. FUR ELEKTROMECHANISCHE TELEPHONAPPARATE. Circuit arrangements of automatic exchanges. (10/1/14 Germany.)
20,832 SIGNAL GES. Sending device for subaqueous sound signals. (6/2/15, Germany.)

Companies' Reports, &c.

An interim dividend at rate of 1 per cent. (tax free) has been declared by the UNDERFEED STOKER COMPANY, LTD., for year ended Dec. 31.

A dividend at the rate of eight per cent. has been declared on the ordinary shares of the MONTREAL LIGHT, HEAT and POWER COMPANY for the quarter ending Jan. 31, payable Feb. 15.

THE LIMA LIGHT, POWER AND TRAMWAYS COMPANY has declared a dividend of 2 per cent., payable in London as to 1 per cent. in cash and as to 1 per cent. in ordinary shares, against Coupon No. 27.

The directors of the WESTMINSTER ELECTRIC SUPPLY CORPORATION LTD., have declared a final dividend for the half-year ended Dec. 31 at the rate of 12 per cent. per annum (less tax), making 10 per cent. for the year, the same as in 1919.

The directors of the CITY OF BUENOS AYRES TRAMWAYS COMPANY (1904), LTD., recommend payment of a balance dividend of 1s. 3d. per share (making 5 per cent. per annum) for 1920. The sum of £3,000 has been transferred to general amortization fund and £3,940 15s. carried forward.

The directors of the ST. JAMES' and PALL MALL ELECTRIC LIGHT COMPANY, LTD., have declared a dividend of 8s. 6d. per share on the ordinary shares, making a total distribution of 12 per cent. for the year 1920, the same as in the previous year.

The estimated gross profits of the EAST LONDON RAILWAY for 1920 were £101,343, and 56 per cent. of this amount would give the company £56,752 instead of the minimum rental of £30,000 per annum. The Directors state that in spite of repeated applications for some modification of the terms agreed upon between the railway companies and the Government, which so adversely affect the East London stockholders as the result of the electrification of its line, the Government has declined to make any concession. Warrants for the six months' interest on £2½ per cent. (Whitechapel extension), first 3½ per cent. and second charge 4 per cent. class "A" debenture stocks, also for 10s. per cent. for one year on the second charge 4 per cent. debenture stock class "B" have been posted.

The directors' report of the DUBLIN UNITED TRAMWAYS COMPANY, LTD. (1896), for 1920, states that the amount available for division is £95,941. Interim dividends amounting to £21,840 were paid on the 31st July last, and it is recommended that a dividend at the rate of six per cent. per annum be paid on the preference stock for the half-year ended December, and that a final dividend at the rate of seven per cent. per annum (making five and a half per cent. for the year), be paid on the ordinary stock for the same half-year; that £30,000 be set aside towards deferred renewal of rails, and £2,000 be written off price of investments, leaving £13,331 to be carried forward.

The net profit of the YORKSHIRE ELECTRIC POWER COMPANY for the year 1920 after payment of interest, &c., is £64,740, against £54,134 in 1919 and £46,536 in 1918. With £17,596 brought forward the total is £82,336. The directors recommend payment of a dividend at the rate of 6 per cent. on the cumulative preference shares, and at the rate of 5 per cent. on the ordinary shares for the six months ended 31st December, 1920 (making with the interim dividend) 8 per cent. for the year, and also to transfer £15,000 to general reserve fund, carrying forward of £20,939.

The directors report that during the year the costs of coal, wages, and materials showed further increases which were met to come extent by economies arising from the increased output. The extensions of the power stations which are now proceeding, and which include a 12,000 kw. turbo-alternator, would produce still further economies when they come into use in the present year. A large number of new connections have been made, the full revenue from which will not be secured until the present year. Further agreements for supply have been made, which will also produce a substantial increase of revenue. The unification of the supply of electricity in the West Riding, which has been made possible by the existence of the Company's system, continues to grow. Out of a total of 62 undertakings of authorised distributors in the area 40 are taking or have agreed to take a supply of electricity in bulk from the Company, and negotiations are proceeding with others which should lead to a complete co-ordination of the supply of electricity in the area. The Electricity Commissioners have given notice of their intention to hold inquiries into the present and future position of electricity supply in certain districts, which together include the company's area of supply, and it is hoped that the Commissioners' action may lead to the removal of the legislative obstacles which have retarded the development of the company's undertaking. The company has recently purchased premises in Leeds to be used as head offices, and these will shortly be ready for occupation. The directors regret to report the resignation, through ill-health, of Mr. H. A. Earle, a director of the company since its formation.

For the year ended Aug. 31 last the gross profit of the MELBOURNE ELECTRIC SUPPLY COMPANY, LTD., from the Melbourne and Geelong undertakings was £221,388, compared with £180,161 for the previous year, an increase of 23 per cent. After payment of management and general expenses at the London head office, and after providing for debenture and gold bond interest and for the sinking and service funds the directors have written £10,149 off sundry items of capital expenditure, placed £30,000 to reserve for income tax, corporation tax and excess profits duty, £10,000 to gold bonds redemption account, and £35,000 to general reserve, leaving a balance of £81,600 Deducting from this balance the dividend on the 7 per cent. first cumulative preference shares for the half-year ended Feb. 29, 1920, and the interim dividend of 5 per cent. on the consolidated ordinary stock, the available balance is £44,350, which has been applied in paying the dividend on the 7 per cent. first cumulative preference shares for the half-year ended Aug. 31, and a final dividend of 5 per cent. on the consolidated ordinary stock (making 10 per cent. for the year), and also paying interest at 10 per cent. per annum on the 96,365 partly paid ordinary shares for the half-year ended August, 1920, leaving a balance of £4,691, which (with £50,050 15s. from the previous year) has been carried forward.

The total capital expenditure is £1,970,406, compared with £1,770,581 in 1919. In order to facilitate the provision of the further capital necessary to cope with the continued expansion of the business, the directors have decided to submit resolutions to increase the rate of dividend on the whole of the authorised issue of 100,000 first cumulative preference shares of £5 from 7 to 8 per cent. per annum as from March 1 next. At Melbourne there are 51,675 consumers (against 42,430), and the total connections (including 34,478 H.P. in motors) are equal to 78,485 kw. The total units sold were 44,444,000, against 35,069,000 in the previous year. At Geelong there are 3,862 consumers (3,374) and the connections (including 2,509 H.P. of motors) 5,894 kw. (5,497 kw.), the units sold being 1,627,276 (1,551,042). The area of the suburban districts in Melbourne covered by the company's statutory powers is 92 square miles, with an estimated population of 416,000; and supply is now available in 721 miles of streets, an increase of 62 miles. These figures are exclusive of the bulk supply to local authorities of several outlying districts. New consumers connected during the year showed an increase of 22 per cent., the power supply by 14 per cent., and the total connections (including lamps, motors, heating, cooking and other apparatus) 18 per cent.; the total units sold increased by 26 and the gross revenue by 24 per cent.

New Companies.

The following list has been compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, 116-117, Chancery-lane, London, W.C. 2:—

ALADDIN LAMPS (MIDLANDS), LTD. (172,644)—Private company. Reg. Jan. 18, capital £35,000 in £1 shares (25,000 preference), to take over the business of electric lamp manufacturers and agents, &c. Directors are S. Coxon, W. A. Williams and J. T. Jones. Reg. office: Sherborne-street, Birmingham.

ELECTRIC LAMP AND BULB COMPANY, LTD. (172,518)—Private company. Regd. Jan 10. Capital, £100 in £1 shares. To carry on the business of electric manufacturers, agents and factors, &c. First directors are F. Kitchener and A. H. Greening. Reg. office: 15, Clifford's Inn, E.C.

HARRISON, BUDD & COMPANY, LTD. (172,699).—Reg. Jan. 20, capital £250 in £1 shares, to carry on business of mechanical engineers, manufacturers of machinery, &c. Directors to be appointed by subscribers, J. Harrison and D. J. Budd.

RAIL WELDING COMPANY, LTD. (172,636)—Private company. Reg. Jan. 17, capital £30,000 in £1 shares, to carry on the business of rail welders, &c. First directors are E. Jacob, F. S.A. Lowndes and A. P. Strohmenger. Reg. office: 119, Victoria-street, Westminster, S.W.1.

SANTON, LTD, (172,731)—Private company. Reg. Jan. 21, capital £4,000 in £1 shares, to carry on the business of electrical engineers. First directors are H. C. Sanders, J. F. Fulton, R. C. Taylor (and Secretary) and C. W. Buckley. Reg. office: 34, Bridge-street, Newport, Mon.

TULLY GAS PLANTS, LTD. (172,691).—Reg. Jan. 19, capital £150,000 in 100,000 £1 preference and 50,000 £1 ordinary shares, to acquire and carry on business of contractors, electricians, gas engineers, &c. Directors: C. B. Tully, P. P. Sandford, J. W. Tully and T. Thorpe.

PETER PILKINGTON (1921), LTD. (172,667).—Reg. Jan. 18, capital £50,000 in £1 shares, to acquire and carry on business of manufacturers of power and steam hammers. Directors: D. Denton, J. Parker, P. Hutchinson and E. J. Latham. Qualification of directors, £500. Reg. office: Dowry Bridge Ironworks, Bamber Bridge, Lancs.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics" (Specal French edition).—"Accident to R 34", Mr. Georges Aveline's "Automatic Pilot"; "Some Problems in Aeronautical Research," by Air Commodore A. R. M. Brooke-Popham.

"Chemical Age."—"Ammonia Oxidation Limits for Sulphuric-acid Plants," by Wilfrid Wyld, F.C.S.

"Cabinet Maker" (Children's Furniture Number).—"Nursery Furniture and Toys"; "Review of New Designs in Perambulators and Cots"; and "A Furniture Trade Convention."

"Farm and Home."—"The Pig as I saw him at Smithfield," by Prof. Long; "The Farmer and his Work"; and "Wheat Decontrolled."

"Fruit-Grower."—"Horticultural Research"; "Worshipful Company of Fruiterers' Banquet"; and "Spraying Operations."

"Gardening Illustrated."—"Perpetual-flowering Carnations"; "Annuals for the Coming Season"; and "R.H.S. Exhibition."

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Forty Years Ago.

(The Electrician, February 5, 1881.)

Electric Light at Bristol.—The experiments were continued every evening last week; the light is spoken of as being brilliant and steady.

Erratum.—Mr. Heaviside's Paper at the last meeting of the Society of Telegraph Engineers was on "Induction." A typical (*sic*) error in our report described the subject as "Education." We regret that we cannot find room for the Paper.

The Society of Telegraph Engineers and of Electricians.—The next meeting will be held at the Institution of Civil Engineers on Thursday, February 10, 1881, when a paper on "Earth Currents—Electric Tides," by Alex. J. S. Adams, Associate, will be read.

Professor Helmholtz in London.—The Faraday Lecture will be delivered by Professor Helmholtz in the theatre of the Royal Institution on Tuesday, April 5. The subject will be "The Modern Development of Faraday's Conception of Electricity."

Arrangements for the Week.

FRIDAY, February 4th (to-day).

Junior Institution of Engineers.

8 p.m. At Caxton Hall, Westminster, London, S.W. Lecturette on "Surface Tension and some of its Industrial Applications," by Mr. W. H. Ballantyne.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "The Electrical Expression of Human Emotion," by Dr. A. D. Waller, F.R.S.

MONDAY, February 7th.

Institution of Electrical Engineers.—Liverpool Sub-Centre of the North-Western Centre.

7 p.m. At the University, Brownlow-street, Liverpool. Discussion of "Report on Research on the Heating of Buried Cables," the report to be presented by Mr. E. B. Wedmore.

Institution of Electrical Engineers.—Western Centre.

7 p.m. At the Merchant Venturers' Technical College, Bristol. Paper on "The Application of Electric Locomotive to Main Line Traction on Railways," by Lieut.-Col. H. E. O'Brien.

TUESDAY, February 8th.

Institution of Electrical Engineers.—North Midland Centre.

7 p.m. At the Metropole Hotel, King-street, Leeds. Paper on "Temperature Limits of Large Alternators," by Mr. G. A Juhlin.

Institution of Electrical Engineers.—North-Western Centre.

7 p.m. At the Engineers' Club, 17, Albert-square, Manchester. Address by Mr. Ll. B. Atkinson, President.

Institution of Electrical Engineers.—Scottish Centre.

7.30 p.m. At 207, Bath-street, Glasgow. Paper on "Automatic Protective Devices for A.C. Systems," by Mr. A. E. McColl.

Institute of Metals.—Scottish Centre.

8 p.m. At the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper on "Aluminium, Production and Uses," by Dr. G. H. Bailey.

WEDNESDAY, February 9th.

Institution of Civil Engineers.—Students' Meeting.

6 p.m. At Great George-street, London, S.W. Lecture on "Machinery applied to Mass Production," by Mr. J. H. Barker.

Institute of Cost and Works Accountants.

7 p.m. At the Institute of Patent Agents, Staple Inn Buildings, Holborn, London, W.C. Address on "The Position of Cost and Works Accountants in Co-ordinating the Aims of Capital and Labour," by Mr. H. W. Allingham.

Association of Engineers-in-Charge.

7.30 p.m. At St. Bride's Institute, Bride-lane, London, E.C. Paper on "The Super-Diesel Internal-Combustion Engine," by Capt. W. P. Durtnall.

Industrial League and Council.

7.30 p.m. At Caxton Hall, Caxton-street, London, S.W. Lecture on "Payment by Results," by Mr. E. J. P. Benn, C.B.E.

THURSDAY, February 10th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Discussion on "Electric Appliances for Domestic Purposes," to be introduced by a Paper by Dr. E. Griffiths and Mr. F. H. Schofield on "Some Thermal Characteristics of Electric Ovens and Hot Plates."

FRIDAY, February 11th.

Physical Society.

5.15 p.m. At Imperial College of Science, South Kensington, London, S.W. Discussion on "Absolute Measurements of Electrical Resistance, and Instruments based on the Temperature-variation of Resistance." For further details see Institution Notes.

Institution of Electrical Engineers.—Students' Section, Scottish Centre.

7.30 p.m. At the Royal Technical College, Glasgow. Paper on "Mercury Arc Rectifiers," by Mr. Morrison.

Electro-Harmonic Society.

8 p.m. At Cannon Street Hotel, E.C. Concert (Ladies' Night).

THE ELECTRICIAN

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Notes.

The Passing of the E.P.D.

THE Excess Profits Duty is to go, unregretted if not unsung. The CHANCELLOR OF THE EXCHEQUER in departing from tradition by making a forecast of this year's Budget in a speech delivered outside the Houses of Parliament has taken a wise course, though the actual abandonment of this unpopular duty has not been achieved without a good deal of persuasion. We are now being told, implicitly, if not explicitly, that this desirable result is due to the irresistible force of the arguments against the continuance of the tax that have been put forward in the Press and by the various trade associations. Without, however, wishing to appear sceptical we have no hesitation in advancing the opinion that the real reason for the disappearance of the Excess Profits Duty is that it has ceased to pay. For while there is nothing that the Treasury official likes better than to collect money from the unwilling taxpayer there is nothing he likes less than paying it out. And as far as this impost is concerned he has for some time been gradually ceasing to do the one and been forced to do the other with greater and greater regularity. While, therefore, we are willing to admit all that has been said by many speakers and writers on the subject from Mr. CHAMBERLAIN downwards about the shortcomings of the tax, we feel certain that its death blow is due to its failure as a means of producing revenue.

The Effect on Industry.

BUT far more important in our view than the actual abandonment of this tax is the result that its disappearance is likely to have on the industry of the country. It marks, in fact, one more step towards complete relaxation by Government officials of interference with trade and traders. This in itself is a matter for congratulation, and of its value there can be no doubt. But we hope that those optimists who expect other beneficial results to flow immediately will not be disappointed. For the abandonment of the Excess Profits Duty is only a step towards freedom and not freedom itself. The financial policy of the Government, whether we consider that part of it which is concerned with the repayment of debt or that part which deals with expenditure on the administration of the country, makes that certain. Direct or indirect taxation, both of which are at present far too high for national prosperity, must remain high, for even now the revenue they produce is hardly sufficient to finance the schemes which our governors think necessary for the inauguration of a better and brighter world. Mr. AUSTEN CHAMBERLAIN in announcing the non-renewal of the Excess Profits Duty added that he did not propose to impose any new tax in its place. This is good as far as it goes, but we are not surprised to see an agitation crystallising in favour of a reduction of the income tax. For that form of direct taxation now stands at a figure which is not only punitive but deprives the country of too large a proportion of its purchasing power, while the Corporation Tax about whose removal or reduction nothing is said has the same effect. Present conditions therefore mean a reduction in the supply of capital and generally a detrimental effect on industry, employment and national welfare. Apart from questions of economy and expenditure it is therefore a point for consideration whether the present policy of dealing with our war debt will not result in permanent overstrain of our national resources.

Coal Decontrol.

THE announcement that the Government has decided to remove the control over the inland coal supply will probably be received with mixed feelings by those whose business it is to manage electricity supply undertakings. On the one hand with the passing of control they will be given greater freedom to buy where they please, and what they please, unhampered by rules, regulations, forms, permits, inspectors, sub-inspectors *et hoc genus omne*. On the other hand, there is a prospect that owing to the fall in export prices, their coal costs may rise to a greater height than even the present inflated figure. We do not, however, take this prospect very seriously. Experience has shown that the removal of control is very like what happens on the opening of an inductive circuit. The price rises sharply, but falls to a figure below controlled level in quite a short time, owing to the fact that more money can be made by selling large quantities with a relatively small return than by disposing of small quantities with a larger return per article. Were this all there was to be said on the matter, therefore, there would be a large balance in favour of decontrol; but unfortunately in the coal industry the shadow of labour trouble still hovers in the background, and the attitude of the miners' organisations towards this question will not improbably be an important factor in determining the future price of this commodity.

The Labour Attitude.

This attitude is probably correctly defined by Mr. Frank Hodges, who, interviewed on this subject the other day, said: "We do not think the proposals are in the interests either of the country or of the trade." In other words, as the pressure that can be brought to bear by labour interests on an uncontrolled industry would be much less than on a controlled industry we shall do our best to prevent decontrol coming about, or if it does come about to do our best to ensure that the home consumer shall suffer as much as possible from high fuel prices, and so force on the dawn of that happy day when all the coal mines shall be nationalised. As it seems impossible to convince Mr. Hodges and those whom he represents that such a policy is not in the best interests of the British trade, or indeed in the long run of the miners themselves, the fainthearted may well presume that, as controlled coal is better than no coal at all, it will be better to continue as we are. While admitting the force of these arguments we still vote for decontrol, as we consider that once freed from that "deadhand" the coal industry, even without the help of labour, will gradually right itself to the benefit of all concerned.

The Electrical Expression of Human Emotion.

Electrical engineers' connection with psychological science has become more and more evident during the past few years, for they have been forced, willingly or unwillingly, to study all those emotions which make their impress upon the human frame, to note the idiosyncrasies of character both in the mass and in detail, and to deduce more or less useful conclusions as to their own and others' conduct from them. It would now seem that they can do something to repay this debt by assisting psychologists on the more biological side of their studies. As is already well known the brain responds instantaneously to various emotional indications, the responses set up being transmitted to certain parts of the body, where corresponding changes in the blood pressure, which can be measured by various simple means, occur. In a discourse delivered last Friday at the Royal Institution by Prof. A. D. Waller it was explained how these measurements can be made electrically, using the subject for study as one arm of a Wheatstone bridge, through which a constant current is passing, so that any response to psychological effects, that is any change in the blood pressure, is indicated on a galvanometer. Prof. Waller did not attempt on Friday to do more than show the results of measuring the human emotions by electrical means. He even went so far as to say that he was not yet prepared with any explanatory theory of the phenomena that take place. He did, however, suggest that his methods might form yet another way of dealing with various forms of malingering and might also be used for distinguishing between genuine and pretended spiritualistic mediums. Such uses are, however, relatively unimportant, compared with the determination of how bodily health and welfare depends on emotional stress. Such a determination should be possible, with a greater knowledge of the delicate methods now outlined, and in this way a little more might be done towards improving human existence.

The Tramways Inquiry.

Though the Committee which was appointed by the Ministry of Labour to make an investigation into the employees' claim for an increase of 12s. a week in wages has adjourned until Tuesday next in order that certain returns may be prepared by the municipal tramway undertakings, we believe that sufficient has already been disclosed to show that the tramway industry is in a serious financial position. Mr. Beckett, for instance, was able to show that the present average total cost of operating the tramways of this country, including renewals, is 26·72d. per car-mile, and as the earnings are only 23·17d. there is already a deficit of 3·55d. per car-mile, which will be increased to 5·14d. if the present demands be conceded. There is also evidence that the existing fares, especially in the industrial towns in the north, are too high for many workers who formerly used the tramways now prefer to walk, so that it is pretty evident that any further increase in the tariff would mean a further reduction of revenue. On other scores the sorry financial plight of the industry is sufficiently clear. Several of them are on the rates and the remainder are within whispering distance of the bankruptcy court.

Trolley Omnibus *v.* Tramcar.

But hope is not altogether submerged and there does seem at least one way of overcoming this section of their difficulties. At Chester, for instance, where £70,000 is required to put the track in order, the Tramways Committee are considering whether the money would not be better spent by inaugurating a motor omnibus service. At Birmingham, Bradford and Glasgow, where the municipal tramways have hitherto been very successful and where large sums have been paid in relief of rates, the trolley omnibus is the favoured solution to avoid the heavy expenditure now necessary on track renewals. At Bradford, Mr. R. H. Wilkinson, as already noted in The Electrician, is going a step further and is making trial of a double deck trolley omnibus of new design, capable of carrying 55 or 60 passengers. So far this vehicle has proved very successful; so much so that managers of other tramway systems have already visited Bradford to inspect the vehicle in operation, and to decide whether it should be flattered by imitation in their own districts. If Mr. Wilkinson's experiment proves a financial and technical success it is probable therefore that we shall soon witness an extended use of this type of locomotion on established and new tramway routes, especially in suburban areas.

A Joint Authority for Greater London.

The suggestions of the Conference of those local authorities who own electricity undertakings in Greater London for the constitution of a Joint Electricity Authority seem, as far as we can judge from the brief outline that has been made public, to be more complicated and more elaborate than those for any of the other electricity districts. This in itself is not a good thing, but is perhaps only to be expected seeing that there are 160 local authorities and eight County Councils involved, apart from electricity supply companies, railways and other interests whose views and opinions must be taken into account. It is therefore not unnatural to find that the Joint Authority is a little ill-balanced, the supply companies only obtaining the inequitable representation of four out of 27 members. Of the remaining 23 members, 12 are to be elected by authorised undertakers, 8 by the purchasing authorities, County Councils and local authorities not undertakers, and three by the Minister of Transport. This inequity would probably have been averted by a little sinking of interests to the advantage of the scheme generally.

Out-of-Date Election Methods.

The twelve representatives of the local authority undertakers are, it is said, to be elected by the authorities, each of whom is to have one vote and one additional vote for each complete million units sold in excess of one million. These votes are to be exercised by representatives of the individual local authorities sent by such authorities to an electoral college. This may sound simple enough, but in practice we believe it will lead to friction between the various authorities, who will each want representation on the authority. It would be better to have a larger number of members with committees for administrative and technical functions. To those with a knowledge of European history the term "electoral college" will give rise to somewhat painful memories and, while we have no wish to see Roman Empire procedure introduced into electricity supply, we further consider it unwise to increase the complications of an already complicated matter. While sympathising with the Committee in their desire to provide a small and live controlling body, some simpler method of doing this must be found, or else the remedy will be worse than the disease. The remainder of the projected scheme gives the usual administrative and financial powers, but as the details given are very meagre, we do not feel inclined to press any criticism upon them.

◆

The Reorganisation of Electricity Supply.

When on Tuesday next the Electricity Commissioners commence an inquiry into the reorganisation of electricity supply in the North Wales and Chester area they will find two official schemes awaiting investigation, and several local authorities opposed to both. Only one of the schemes, that proposed by Chester Corporation, contemplates the formation of a Joint Electricity Authority, as the other would practically confer upon the North Wales Power & Traction Company the right to supply electricity in bulk throughout the whole of the districts, leaving the local authorities to carry out the duties of retail distributors of electricity in their respective areas. Practically the whole of the municipal corporations and urban councils in North Wales favour the Company's proposals, this unusual policy being the result of a strong desire to conserve Welsh resources and to utilise them to the best advantage for local industrial and agricultural purposes. Up to a certain point this may be laudable, but it ignores the national interests and the claims of the part of the electricity district not in North Wales. However, we inagine that the Commissioners will not look upon excessive parochialism, even when tinged with Celtic patriotism, with a kindly eye, especially as there will be more hydro-electric power available in the area than can be used locally for many years to come.

◆

A Plethora of Schemes.

Somewhat similar conditions prevail in other electricity districts; two or more schemes are in preparation in several of them. At least two are projected for the Greater London area and two for the West Riding district. Though it is well to have alternative proposals to fall back upon, and we hope that both sides of the case will always be carefully considered, it is unfortunate that the rival schemes in the West Riding should emanate from local authorities, thus indicating, if not discord, at least that lack of local co-operation which is essential for the success of any joint electricity authority. In the meantime the Yorkshire Electric Power Company has taken advantage of the complications of the situation to issue a carefully prepared statement in which the financial and other difficulties of a joint authority are emphasised. Some of the points made by the Company are perfectly legitimate, and we are not sure that any authority could have made more progress in recent years than the Company which is now supplying electricity in bulk to about 40 local authorities in that part of the country. The Company's view is that the present tendency to co-operation should be encouraged, that the restrictions which have hampered the Company's development should be removed, and that the present time is most unsuitable for considering any change of ownership which will result in dearer electricity. The principal, if not the only, justification of a joint authority would be to give a cheaper and better supply of electricity, and, if it cannot do this, then its *raison d'être* ceases. A properly organised authority ought to be able to do this as well as a company, but the jealousy of local authorities may militate against efficiency, and the expectations of the authors of the Electricity (Supply) Act may not be realised. However, we hope that, whatever happens, the pioneering work of the Yorkshire Electric Power Company will be recognised, as it is only now beginning to reap the reward of its enterprise and courage. Though it has again paid 8 per cent. on its ordinary capital for the past year, it must be remembered that the average yield since the formation of the company is only about 1½ per cent., which is not much of an encouragement to private enterprise.

◆

Electric Traction on a Suburban Line.

The advantages of electric traction on a suburban railway are illustrated in a striking manner by the recent report of the East London Railway Company. It appears that during the past year 14,667,000 passengers were carried, compared with 4,224,000 in 1912, the last year of steam working. In the same period the gross receipts increased to £101,300 from £38,000. Unfortunately, Government control has deprived the company of the benefit of the increased traffic and receipts, and the chairman, Lord Claud Hamilton, complains that, not only have the shareholders obtained no advantage from electrification, but, on the contrary, they are being penalised, having regard to the interest that is being piled up against them in respect of the capital cost of electrification, whilst the Government, under their system of control exercised over the lessee companies, gained the whole advantage of the conversion to electric traction. This is highly inequitable and we hope that the chairman will succeed in convincing the responsible department of the justice of his claim.

◆

The Continuance of Finsbury Technical College.

After a great deal of agitation, which seems on the surface to have done little except to have made the attitude taken up by the Council of the City and Guilds Institute even more uncompromising than it was to start with, there now seems some hope that the decision to close Finsbury Technical College may, after all, be revoked. We gather this from a report recently presented by the Education Committee to the London County Council, wherein it is recommended that, in view of the importance of not depleting the existing provision for technical training in London, the Council should assist in the maintenance of the College for a period of five years (during which time its ultimate future can be fully considered) by neutralising the existing annual deficit of some £10,000, provided that not more than 16 free places are reserved to the holders of the Council's scholarships and exhibitions. In the past it has always been the proud boast of "Finsbury" that they were beholden to nobody for financial assistance and that, in consequence, they were able to carry out engineering training of a high class, untrammelled by rules and regulations and free from the ties of bureaucratic syllabuses. This freedom has allowed it to do work of a character done by no other training Institution. Nevertheless, we sincerely hope that when this proposal has been approved by the Council, as we have no doubt it will be, the governors of the College will on their side accept the recommendation and so prevent this historic building from closing its doors.

Electrical Breakdowns

It is unfortunate in many ways that we have had to chronicle during the past few weeks so many breakdowns of electrical generating plant. Such breakdowns mean to the station engineer an added difficulty in dealing with the winter load and to the consumer a check to the development of an already depressed trade. Worst of all, they make the general public, and we are afraid to many electrical engineers as well, suppose that the hand of the British engineer is losing its cunning, and that neither in design nor workmanship do we stand where we once did. This idea, which is in our opinion quite erroneous, must, nevertheless, be counteracted by every means in our power, especially as the industrial conditions which we shall have to endure during at least the next few months will tend to increase the number of recruits to the ranks of those who demand cheapness, even when attended by poor design and bad workmanship. It will, therefore, need great steadfastness of purpose to withstand the very real temptation to sacrifice long life and good operation to the saving of a few pounds on the capital account. To attempt to save money in this way is, as everyone knows in theory, at best a most short-sighted policy; but it is also one of those cases where theory too often fails to be translated into practice.

War Strain and Machinery.

In our opinion, many of the breakdowns to which we have just called attention are due, not to bad design or workmanship, but to overstrain, both human and mechanical. In the former it has led to a reduction in vitality and a slackening of interest, following on mental and physical overwork. In the latter, the overloading for long periods made necessary by war conditions has resulted in shocks and strain to every part of the machine, the effects of which are now becoming evident, but whose history is not too clearly understood. But embarrassing though these breakdowns are, they nevertheless place those concerned in the position to learn useful lessons, and they should, therefore, be welcomed as an opportunity for discovering new facts, rather than as an excuse for depression. Among these facts is the fairly evident one that no human being or machine can be consistently overloaded, and it is, therefore, the best form of insurance to see that both human being and machine, if constantly employed, are employed on work that is well within their powers. If in addition these breakdowns emphasise the fact that there is no substitute for good design and workmanship, they will be a blessing rather than a curse.

Economy in Education.

We are glad to see that influential and well-informed objections are being made against the proposal to postpone on the score of economy the operation of that part of the Education Act, 1918, which deals with continued education. These objections come not only from employers of labour, who in a letter to the daily Press protest that economy consists in wise expenditure not in unintelligent parsimony, but from a specially convened Labour Conference who through Mr. C. G. Ammon urged that if there was to be economy it must not be effected by robbing the children of their educational equipment. At the same meeting a resolution was carried declaring that the reduction of expenditure on education is not economy but waste. We are not surprised, however, that the economy axe should first have been laid at the roots of one of the most useful trees this Government have planted. That is the way of politicians. They can see no good in education at the present time, and that is sufficient reason why they should take steps to ensure that it never will be any good. The trouble with the educational facilities of this country at the moment is that they have withdrawn a large number of the population from a blissful state of ignorance and have given them sufficient learning to imbue them with a discontent, divine or otherwise, but not enough to show them what the real benefits of knowledge are. But that is no argument for the diminution of expenditure on education. Rather is it an argument for more and better facilities. Even for the material reason that it would improve the industry of the country an increase and not a decrease in expenditure would be an advantage, as improved education would develop our productive capacity, help to increase our wealth, and discharge our debts. We sincerely hope these protests will have their effect.

Kilowatts or Horse Power.

It may have occurred to some engineer of a speculative nature to inquire why dynamos are rated in kilowatts and motors in horse-power. After a little consideration of the subject, however, the inquirer soon learns that he has been led into thinking about a question similar to that discussed on an historic occasion by those two well-known dialecticians, the walrus and the carpenter. At first sight, indeed, it would seem that if the ratings must be different they should be the other way about. The dynamo is coupled to a prime mover which is invariably rated in horse-power, with the result that to make relative calculations of their two performances a conversion of units has to take place. Similarly, a comparison of the performances of the dynamo and the motor which it supplies necessitates another conversion. Interest in this subject is increased by the perusal of a catalogue of Teutonic origin in which all the motors dealt with are rated in kilowatts, and we may well inquire for what reason this change is made. Do present industrial conditions demand it, or is something more occult behind it? What are the objections to either one or other unit, but not both, being used?

Electric Drive and Paper Making.

The question of the cheaper and, what is the same thing, the more abundant production of paper, while being of prime importance to publishers and printers, is one which should not be without interest to manufacturers and factors of all sorts and conditions, as well as to so-called non-producers and to the public generally, whether they help to add to the wit and wisdom of the world or whether they simply derive what benefit they can from it without giving much in exchange. A philosophical treatise on the influence of paper on the development of our civilisation might well be written, and without wishing to do anything of the sort in the columns of The Electrician, it may be said without fear of contradiction that most of our progress, using a very much over-ridden term, is directly dependent on the wide use which is made of this commodity.

A Doubly Interesting Question.

To electrical engineers the question of the manufacture of paper should be of double interest, for not only are they intimately concerned in its use and abuse in the ways that we have just outlined, that is they employ paper for correspondence, the production of catalogues and leaflets and the collection and dissemination of instructions, but they also use it in the manufacture of much electrical apparatus, and especially in the production of cables. They will, therefore, continue to require it in ever increasing quantities in order to supply the electrical needs of the public in the near future. Indirectly, the part which the electric drive can play in the actual manufacture of this commodity is an important one, and offers problems whose solution is at once of commercial and technical interest.

Speed Maintenance, Drive and Design.

In a general way, the problems that have to be solved in applying the electric drive to paper manufacture are not unlike those which are met with when the operation of other textile machinery by electrical means is considered. Paper is in fact a textile, and we have, for that reason, included interesting matter relating to its manufacture in our annual Textile Issues. The problems of speed maintenance and regulation, of methods of driving and of design of the motors and other electrical equipment permit in most cases of a similar solution to those which have been found successful when the electric drive is employed for the operation of machines producing cotton and woollen fabrics and other similar products. In the same way the necessity for the use of large quantities of steam in the production of paper has provided an obstacle to the introduction of the electric drive, while the conservatism of the paper manufacturer has often blinded him to the advantages which are to be derived from the use of the electric drive until these advantages have been brought home to him by hard financial facts. Apart from these similarities, however, there are some special problems which must receive attention in considering the application of electricity to paper making

The Processes of Manufacture.

In an article by Mr. E. E. Fuller, the second part of which we publish in this issue, the various processes followed in the manufacture of paper are described. These processes consist in the production of a continuous web from a material which, at first, is practically entirely water. In passing through its various stages this material gradually loses its moisture until it appears as a finished product, of which 95 per cent. is solid matter and only 5 per cent. water. Consideration of the problem involved will show that very close speed control over the various parts of the paper-making machine must be maintained. Moreover, the drive must be so designed as to permit of the individual speed adjustment of each section at all times to counteract the stretching in the web, which occurs in the process of manufacture as the paper passes from section to section of the machine. The amount of this stretching varies from time to time, and is in itself an added complication to the problem. All this speed variation has to be effected without shock, in order to avoid breakage of the product, which does not make matters easier.

One Motor Drive Uneconomical.

In replacing the steam engine by the electric motor for the operation of paper-making machines the usual course of directly substituting one system of drive for the other was at first followed. As Mr. Fuller shows, driving machines for the production of "news" by a single motor in this way does not present any great engineering or productive difficulties, though the only method of obtaining the necessary speed of variation does not make for the best economy and may under certain conditions lead to a large percentage of wastage. The system of driving each section of the machine by an individual motor therefore possesses from this point of view very much greater advantages. In its simplest form, however, it introduces the necessity of placing each section of the machine under the control of a machine man, of fitting power and speed indicators alongside the regulating gear of the motor, so that the exact speed of each section may be instantly determined and adjusted, and of so designing the motor equipment that the speed of each section shall be kept within 0·15 per cent. of that of the next section either by voltage or field control or by a more or less complicated system of driving pulleys. Electrically, these conditions are somewhat difficult to fulfil with the usual design of motors and systems of control, and therefore some method of interlocking is necessary between the motors driving each section of machine, which sections may amount to as many as eight in number. This is the more necessary from the fact that although each part of the machine is separately driven they are virtually belted together by sheets of paper in the process of manufacture, the connection thus provided having very little tensile strength, so that it easily breaks, while undue strain also detracts from the quality of the product. The advantages obtained by this interlocking are the elimination of a considerable amount of shafting and gearing, a reduction in the power required by as much as 22 to 25 per cent., easier regulation and greater economy.

Some Further Solutions.

It is fairly obvious, however, that the matter cannot be left there, and several ingenious devices have been suggested for obtaining more advantages from this system of driving. One of these is the Harland system, which was described by Messrs. E. Tanner and C. F. Papworth in The Electrician of March 26, 1920. This system employes a master shaft running the entire length of the paper-making machine and driven by a small motor. From this shaft a second shaft, upon which is mounted a small cone pulley for each section, is driven through gearing. These cone pulleys are belt connected to each of the motors driving a section of the machine. The speed of this differential shaft is electrically controlled in such a way that synchronism is maintained between the various parts of the machine, but it is obvious that, though the desired result is obtained, it is only achieved at the expense of a good deal of complication.

An Electrical Synchronous Drive.

Another and better method is that described by Messrs. W. W. Cronkheit, W. L. Merril and H. W. Rogers in the current issue of the "General Electric Review." This system, which has been specially designed for high-speed work, has been applied to a machine producing paper 164 in. wide at the rate of 1,000 ft. per minute. The machine is divided into eight sections, each of which is driven by 100 h.p. shunt-wound motor running at 136 revs. per min., while the roller is driven by a similar motor of 30 h.p. The whole of these motors are supplied from a turbo-generator on the Ward-Leonard system, the speed of the machines as a whole being controlled by altering the generator voltage. Further regulation is obtained in a somewhat similar manner to that employed in the Harland system, synchronous motors being substituted for mechanical gearing. A 20 h.p. motor of this type is mounted on the base of each of the direct-current motors, to which it is connected through gearing and belts. These motors have the effect of rigidly interconnecting the various sections of the machines and of maintaining an unvarying speed relation between them. This they do by absorbing any change in load which may occur on one section of the machine and distributing it over the entire equipment.

This system, though apparently a great advance on anything that has been used up to the present, is not altogether free from complications, and we have no doubt that with greater experience still further improvements will be effected. In fact, we may say that without a doubt the same result will follow in the paper as in the textile industry proper, and that given proper design and manufacture the electric drive will be more and more employed, not only for directly economic reasons, but because of its greater automatic action, the high production that its use permits, the elimination of unnecessary labour, and above all the freeing of the paper maker himself from the responsibilities of problems connected with the generation and supply of power.

The Application of Electricity to Paper Mills.

By E. E. FULLER, A.M.I.E.E.

(*Concluded from page* 174.)

The Paper-making Machine.

In considering the question of driving the machine itself, it is necessary to understand the function of each section. The first section to be dealt with is the wire. This is made in the form of an endless belt of very fine metal gauze of about 60 to 70 mesh to the inch. The supply of stuff from the strainer passes on to the travelling wire in an even flow from the weir box, spreading over the entire working surface. The surplus water passes through the wire into the machine pit, leaving the fibre on the surface. At the end of the wire, and before the pulp or paper in formation passes off the wire to the couch or wire-driving roll, there are a number of vacuum boxes; these are connected by a suction pipe to the vacuum pump with the object of drawing a portion of the water remaining in the stuff. This terminates the first section of the drive.

The paper passes from the couch roll to the presses. There are generally three presses, each having a separate drive. Each press roll is provided with suitable means whereby the pressure between the rolls may be adjusted. From the third press the paper passes on to the drying cylinders; these consist of a large number of steam-heated cylinders, receiving the steam for drying purposes from the exhaust of the machine-driving engine or from a reducing or extraction turbine. The cylinders are divided into two sections, each having a separate drive.

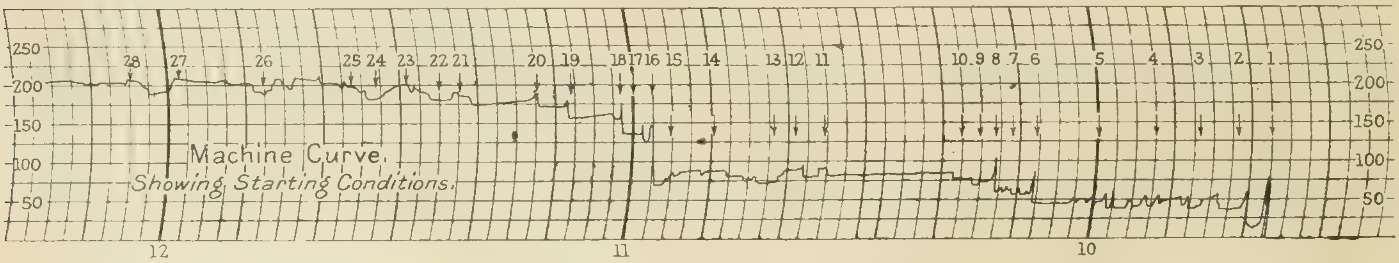


Fig. 8.—Power Curve of Large Size News Machine when Starting Up.

From the drying cylinders the paper next passes on to the calenders for finishing. For fine printing papers two calenders are generally required. In the case of a "news" machine, one calender is sufficient for all ordinary purposes. The last drive is the reel drum on which the finished paper is reeled and ready for re-reeling and cutting. This is carried out on a separate machine not forming part of the machine drive.

Details of the Drive.

We have now eight sections of the machine each having a separate drive from the line shaft, or, in the case of an individual drive, from a separate motor. With a single motor driving on to a line shaft, each section's speed can be adjusted by means of a belt cone, so that the exact difference in speed between the section can be maintained. When the machine is running at the normal speed the approximate difference between the wire speed and that taken on the reel drum is 1½ per cent. This may be taken as a reasonable figure. There are, however, cases where 2½ per cent. may be found to be quite satisfactory. In designing an individual drive the author recommends the former figure be adhered to, so that there may be a safe margin; any increase above 1½ per cent. may be obtained by regulation. The application of a single motor does not present any great difficulties when dealing with a "news" machine. It is necessary to allow the machineman to speed up his wire to about half-speed when a new wire is required and when starting up. From half-speed he will speed up by small increments of not more than 3 ft. per min. to the normal speed. This operation may take only a few hours, or it may be prolonged for a considerable time. Under the circumstances it is necessary to provide that the electrical equipment is suitable for a continuous variation of a speed above half-speed. Any adjustment below half-speed may be carried out by means of the starting rheostat, which should be liberally rated to allow for frequent inching. Owing to the fact that inching on sections can be done by fast and loose pulleys, the main motor is rarely called upon to do this work; however, it is as well to allow for inching in the design. In common with all types of mechanical drives and line shafting, there is considerable loss of power and possibility of slip in the ropes and belts. The slip on the belt is not so noticeable on slow-running machines. It is when we have to deal with machines having a speed of 550 ft. or more per minute that it is likely to cause a serious loss in the form of "broke." It is for this reason that some electrical manufacturers have developed a system of individual drives which will eliminate all the shafting and belts. The motor in these cases would be geared or coupled direct to the section shaft.

The Individual System.

This arrangement forms an ideal system. The motor equipment may be placed in the machine-room or situated in an alley, which should be clean and free from the machine-room vapours. Each section would be under the control of the machineman. Speed and power indicators for each motor can be mounted on a panel together with the regulating gear, so that he may know the exact speed of each section and be able to adjust the speed between them. In order to keep within the range of speed between the wire and reel drum, the motor equipment must be designed so that each motor or section will keep within 0·15 per cent. of the next section speed. In order to take care of any possible variation in load due to paper breaks it is necessary to maintain a constant speed on each section, with a sudden variation of load equal to 15 per cent. of the actual working power when the speed is set at any point between one-half speed and full speed.

These conditions are somewhat difficult to obtain with the usual design of motors and rheostatic control. Means must be provided to interlock the system electrically or mechanically, so that it is practically impossible for the speed to alter between sections unless desired by the machineman. It should be possible for him to control the complete system or each section from a remote control board. Safety push buttons should be located on various points of the machine to enable any section to be shut down in case of emergency. The control board should also include a recording wattmeter and a recording speed indicator to enable the management to obtain the power cost per ton of paper, the operating speed and number of breaks. By eliminating the mechanical drive with its shafting, numerous belts and gears, a considerable saving in power may be obtained. The author has taken numerous tests and considers that a gain of 20 per cent. of the total power of the machine may be obtained by the use of individual drives. Added to this gain there is a saving on the renewal of ropes, belts, &c., which at the present high prices amounts to a considerable item.

Fig. 8 is a curve taken on a 175 inch "news" machine during the starting up period: it was taken with the object of securing information regarding the variation in power caused by the starting of the various sections of the machine. This curve may be taken as a fairly representative case. Larger variations have been obtained on some machines due to inefficient oiling or wear in the bearings and to an attempt to accelerate too rapidly. To make the curve more clear, numbers have been added to each alteration made by the machineman. These have been tabulated together with the corresponding speed. The speed during the whole period was frequently adjusted to suit the operating conditions.

Table I.

Operation.	Revs. per min.
1. Machine motor started	210
2. Second press started	210
3. Second press shut down and started	210
4. Inching second press	216
5. Second cylinders started	216
6. Calenders started	215
7. Inching wire	215
8. First cylinders started	215
9. Inching second press	206
10. Inching third press	205
11. Inching wire	203
12. Inching wire	203
13. Second press shut down	205
14. Inching wire	206
15. Third press shut down	206
16. Speeding up	360
17. Third press started	355
18. Wire started	350
19. First press started	340
20. Speed up paper on	360
21. Running paper on cylinders	360
22. Paper break to first press	365
23. Paper on	360
24. Paper break to third press	364
25. Paper on	360
26. Paper break	
27. Paper break to first press	365
28. Paper on	360

Table II. gives the brake-horse-power on each section of a 175 in. "news" machine operating at a constant speed of 550 ft. per minute. They will serve as a guide when studying the power required for an individual drive. Ample margin must be provided to meet the varying conditions and for rapid acceleration of each section after a shut down.

Table II.

	B.H.P.
Paper roll machine	24
Calenders	25
Second cylinder	27
First cylinder	26
Third press	20
Second press	19
First press	17
Couch roll and wire	18
Bottom shaft and belt, light loaded	52
Total power of machine accounted for by meter	228
Actual power of motor driving machine	236

The difference between the power accounted for and the actual power may be due to the increase friction losses on the shafting when the machine was operating under full-load conditions.

Re-reelers.

From the calender reel drum, the paper rolls are taken to the re-reelers for cutting up to the size required. Variable speed motors are required for this purpose. They can be geared or a suitable chain drive may be used. Although the load is somewhat intermittent a continuous-rated motor should be used for this purpose. There are a large number of sizes made requiring power from 9 B.H.P. to 35 B.H.P. A re-reeler of the usual pattern to take, say, 170 in. roll of paper and a speed equal to 1,000 ft. per min. would require 25 B.H.P. to 35 B.H.P.

Conclusion.

There are numerous pumps and auxiliary plant in a paper mill which can be electrically driven. They do not require any special consideration in this article. The author has refrained from dealing with advantages and disadvantages of either alternating current or direct current system. But now that it is possible to obtain an alternating current variable speed motor which will satisfy all the requirements of paper-mill work, there ought to be a great field for this system.

The Institution of Electrical Engineers.

Judging from the general course of the proceedings at the meeting of the Institution of Electrical Engineers on January 27, members turned with relief from the discussion of more or less hypothetical distribution problems to a consideration of the more practical question of the temperature limits of large alternators. But while the greater liveliness of the discussion was very apparent, there is still a pleasing, but rather unnecessary, diffidence on the part of the audience to taking their places in the front seats. When, as on this occasion, the author requires the "blacking out" of all the illumination for the exhibition of slides at the very beginning of the me ting, the similarity of the "Civils" theatre to a theatre of a lighter kind, with the occupants of the stalls coming in late and people standing at the back of the pit, is evident.

A Long Balloting List.

In performing the familiar business of appointing scrutineers for the ballot of candidates for election and transfer th PRESIDENT pointed out that the list before the meeting that evening contained no less than 550 names. The Institution of Electrical Engineers, as we all know, is already the largest of the technical societies, but this figure makes it evident that its growth has not yet ceased. It is further clear that in spite of all the criticisms which have been levelled at it during the last few weeks it at least has a certain usefulness for members of the electrical engineering profession, or why should they trouble to join?

In opening the discussion on Mr. G. A. JUHLIN's Paper on "The Temperature Limits of Large Alternators," an abstract of which appeared in our issue of January 28, the PRESIDENT said that with the present cost of generating plant it was of the utmost importance to obtain the highest loading possible without running unnecessary risks. We are glad to find he was in agreement with the suggestion that has already been made in THE ELECTRICIAN that all concerned should make a point of obtaining more knowledge on this important question by thoroughly testing some machines on a practical scale. He went a step further and hinted that Mr. Merz, who had already given the greatest assistance to the cable industry by taking certain risks with pressure and heat loadings, was the person to do this.

The Effect of Temperature on Cost.

Mr. C. H. MERZ, who we should like to see a more frequent attendant and speaker at the I.E.E. meetings, followed the President in calling attention to the decrease in cost and increase in output which could be obtained by adopting Mr. Juhlin's suggestions, and added that few machine users would hesitate, after the author's Paper, to adopt a definite total temperature as a basis rather than a more or less artificial temperature rise. There should also, he thought, be little hesitation in placing temperature detectors in alternators, for such a step would mark a great advance in the manufacture of these machines. He then speculated on the possible effect on other parts of the machines of working at a higher copper temperature. Would the iron and insulation thereby come within the danger one? Although there might not have been a great reduction in the number of failures during the last five years, there had certainly been a great reduction in the number of failures that could be ascribed to excessive temperature. If there had not been a reduction in the total number of failures, that might be attributed to the harder conditions under which the machines had been working. (Mr. Mer was hypothetical about all this.) In the past, manufacturers had been allowed to fill in the figures for the steam consumption that they guaranteed and he did not see why, for a given size of machine, they should not also be allowed to state the temperature at which it could be worked. This is a hint which might be followed up.

Expansion, Vibration and Dirt.

From the compliments of Mr. C. H. Merz we passed abruptly to the criticism of Mr. R. **Orsettich**, who, speaking fast and in a rather low tone of voice, did his best to pierce several joints in Mr. Juhlin's armour. He objected that the results given by the author from tests on specimen windings would not be obtained under actually working conditions in the machine. He pointed out that tests of bending stresses alone had been made, but expansion, which with a machine running at 100°C. might be as much as 3 mm. on the copper, could not be thus cavalierly dismissed. As the copper, the insulation and the core all expanded at different rates, there must be a certain amount of relative movement between them leading to depreciation. Moisture, which occurred in great quantities especially with artificial cooling, had also been ignored, although laboratory experiments showed that the insulation of a coil could absorb about 10 per cent. of its own weight of moisture when immersed in a perfectly saturated atmosphere. Dirt was another factor which had not been taken into account, though the presence of metallic dust might have a great effect on life. Dirt in itself increased the temperature of various parts of the machine by filling the ducts and covering the cooling fins, and it would be found that after three or four years the machine was operating at a much higher temperature than it had been on test. Mr. Orsettich showed himself one of the conservatives in this matter of temperature rise and warned the meeting against the adoption of a new policy on which there was little available experience. The author's idea, he said, seemed to be to employ higher temperatures so that larger machines could be made, but if the table in the Paper were correct, the average size of machines was decreasing.

The Duty of the Operating Engineer.

A supporter of the author was to be found in the next speaker, Mr. F. H. **Clough**, who said that, in the past, machines had often been worked at higher temperatures than was generally realised. At the same time, he did not go all the way with Mr. Juhlin in thinking that it was advisable to employ such high temperatures in the stator windings at once. The stator would always be cooler than the rotor, and he would, therefore, be inclined to apply the limits given by the author to rotors rather than to stators. Mechanically, the stator was not limited in the same way as the rotor, as there was more room, its deep slots gave it a considerable advantage and its greater reactance also made it safer. Mr. Clough was one of those who looked to the operating engineer to provide from his experience information which would determine the performance of alternators, and so allow reliable guarantees to be given.

The Drawback of Laboratory Experiments.

The next speaker, Mr. J. **Shepherd**, remarked that the Paper was vital rather than academic, thus enunciating the genesis of a thought which the Papers Committee might consider in its various bearings. The thermo-couple did not wholly find favour in his sight, as it did not necessarily indicate the highest temperature that the copper reached, as would be seen by reference to a Paper read by Mr. Newbury before the American Institute of Electrical Engineers, in which doubts had been cast on this apparatus when used for measuring the temperature at the bottom of the slot or at the top of the slot between the winding and the wedge. Economically higher temperatures might mean a saving, but at the same time, as he very justly pointed out, we could not afford to sacrifice the running safety of a machine by suddenly forcing up its working temperature. Mr. Shepherd agreed with Mr. Orsettich that the author's experiments did not really show what was happening to the insulation. Treating the winding as a bar excluded all risks due to failure at the joints, which increased with temperature and vibration. If the insulation was restricted to its legitimate use, that is to insulate and transmit heat, then something would have to be used to bind the insulation tightly against the metal. Higher temperatures than at present employed could then be used, as the insulation proper would be relieved of vibration stresses. He saw no reason why, if some method for holding the insulated bars together in a more efficient fashion, as in a commutator, could be devised, temperatures of 200°C. should not be employed with safety.

It was interesting to note how the speakers warmed up to their subject as they went along, and how the real practical value of the points at issue produced an eloquence which has been singularly absent from many of the meetings heretofore.

The Impeachment of Standards.

Dr. S. P. **Smith** opened his remarks with the good point that the standards recommended by the British Engineering Standards Association were not those used by consulting engineers and other buyers of electrical machinery, thus impeaching the value of a standard which nobody employs. He did not attempt to apportion the blame for this, but said that agreement ought to be reached and rules to which they could all work laid down and kept well up to date. At present the thermo-couple was the best equipment they could use for measuring alternator temperatures, though it had grave objections from the manufacturers' point of view. The increased losses in the copper for any suggested arrangement of ventilation could be pretty closely calculated from Field's curves; but unless the temperature along the core was known it was impossible to say whether the insulation between the stampings was being run at too high a temperature, and until the existing temperatures were known it would not be safe to increase the present limits. The point about expansion made by Mr. Orsettich, Dr. Smith considered, was really an argument in favour of using temperature detectors, while the present problem of the designer to reduce losses to get the largest possible output would be solved by the use of the same sort of equipment. Altogether, Dr. Smith, while considering in some things the Paper went too far, also seemed to think that in some others it did not go far enough, therefore achieving a nice balance of opinion. And he added that it would be unwise to increase the temperature limits until we knew more about what was happening in the machine, thus subscribing to what was a pretty general view.

Mica Insulation and Higher Temperatures.

Mr. A. R. **Everest** said that the question of higher temperatures required consideration from two points of view. The first was associated with the adoption of new methods of measurement, and the second had reference to the introduction of new materials. The use of mica insulation naturally meant higher temperatures, but neither of these two considerations really predicated any suggestion of a departure from existing practices. There was a third, however, that did make for this change. Embedded temperature detectors could only be used commercially on stators, and not on revolving parts, without a good deal of trouble and special apparatus. Mr. Juhlin seemed to have fallen between two stools with regard to his figures for temperature limits. The International Electrotechnical Commission decided not to establish temperature limits for materials themselves. The British standardisation rules, which followed International practice, give a temperature limit of 115 deg. for a certain section of mica. In the American Institute rules the figure was 125 deg. By subtracting 10 deg. for the method of measurement practical agreement was obtained, though for another method of measurement some other figure would have to be subtracted. He thought that the conclusions which had been drawn about the machines at Niagara were misleading. There was sufficient mica in those machines which operated at 2,000 volts to withstand 8 to 10,000 volts during constant running. But even with them there had been frequent breakdowns, while in an adjacent power house where there were some low voltage machines with no mica in them there had only been one failure, and that due to an operator's mistake. Mr. Philip Torchio, discussing Mr. Newbury's Paper before the American Institute of Electrical Engineers in 1915, put the final temperature limit for mica at 125 deg., but later on he accepted 150 deg. on condition that a 6,600-volt machine in question was tested up to 30,000 volts. The heavy shock this meant might easily lead to other trouble.

Temperature Limits and Reliability.

Mr. A. B. **Field** ranged himself on Mr. Juhlin's side. Our ideas on the subject of temperature limits should be, he said, brought up to date, as a result not only of the author's experiments but of his own experience in the States. He made, what at first sight seems a paradoxical point, that in limiting the manufacturer too closely in the matter of temperature the purchaser would be getting a machine which would be less reliable and frequently less efficient than would otherwise be the case. In this country turbo-generators running at 3,000 revs. per min. with a capacity of 10,000 kw. to 12,000 kw. and insulated in a modern way (that is almost entirely with mica and asbestos) would supply practically all the electrical demands that were required. In such cases the structure of the machines would be much more reliable if reasonable temperature rise were allowed, and the designer would be discouraged from using all sorts of schemes of freak ventilation. Rotors should be as little ventilated as possible, while to limit the rotor temperature too much simply meant the distortion of design. A great deal had been said about the usefulness of the American Institute rules, but a little footnote indicated that they did not always represent the basis on which the machines were sold.

Mr. H. W. **Taylor** rather gave away secrets by saying that operating engineers were probably running their machines at higher temperatures than they thought. Five or seven years ago manufacturers had been rather surprised to find what temperatures were reached by their machines, and when the question came up of constructing larger machines they revised the details of their designs so that the temperatures should be less. Modern large machines, therefore, were cooler than the old machines, so that he felt that though it was not altogether necessary to go all the way with Mr. Juhlin, operating engineers might well take the risk of using higher temperatures than the present Engineering Standards rules allowed.

The author then read a letter from Prof. **Miles Walker** which dealt with the calculation of temperature distribution within a conductor when heat was being conducted along both the conductor itself and through the walls of the containing tube. A curve was shown of a stator 70 in. wide, having micarta tubes 3 mm. thick, enclosing 6 sq. mm. of copper with a periphery of 13·8 cm. This curve showed that at the centre of the machine the temperature rise of the conductor was 125 C., or only 2 deg. lower than the temperature which would actually be obtained if there were no conduction of heat along the copper at all. In a machine 32 in. long and having a micarta tube 4 mm. thick, with a current density of 500 amperes per square centimetre, the drop in temperature at the centre of the machine due to conduction along the copper would be found to be 35 C.

A Good Argument for Temperature Detectors.

The **Author**, in reply to the discussion, showed himself quite unwrung by the many criticisms which had been levelled at the details of his Paper. He reiterated that we were already operating machines at temperatures quite as high as those he had suggested without any bad effect on the iron, while the insulation would not be damaged by considerably higher values than those common to-day. On the failures question he pointed out that although the number of failures might not be falling, the machines were becoming much larger, and therefore the failures per kilowatt were considerably less. He did not share Mr. Orsettich's forebodings as regards expansion troubles and thought that the same speaker in dealing with dirt, filtration, &c., had put forward the best arguments of the evening for measuring temperatures by embedded detectors. He emphasised the fact that mica would withstand the temperatures he had given in the Paper and, that without wishing to rush up the maximum now employed, advantage should be taken of this fact. The effects due to vibration were not going to be very different, whether the temperature was 125 deg., 150 deg. or 160 deg., though the higher the percentage of mica employed the better the bar would withstand mechanical stresses. He agreed with Mr. Everest that our standards should be revised, and with Mr. Field that in many cases mechanical considerations were more important than temperature limits.

DISCUSSION AT MANCHESTER.

Mr. **Juhlin**'s Paper was also discussed in Manchester on January 25th. We give an account of the remarks of the various speakers below.

Prof. **Miles Walker** said that the Paper was important as defining more precisely the operating limits of mica insulation and illustrating the enormous value of a well-organised experimental department in a large works. The curves of temperature drop along conductors of different lengths assumed that all the heat travelled along the copper, but an analysis could readily be made to cover the heat flow through the insulation. The influence of the cooler ends in a short conductor was very marked. (*See* also above.) Everything was gained by working with a hot rotor, but this was not the case with the stator. Eddy currents in the copper increased with the temperature, and under existing conditions the reduction in losses by the use of extra copper amply covered its annual cost. The problem should be considered not only from the point of view of manufacturing cost, but of ultimate cost and efficiency, which did not receive from purchasers the consideration it deserved. The Paper would reassure many operating engineers.

Dr. S. F. **Barclay** suggested that the hottest spot in the rotor winding would be much hotter than the temperature given by the increase in resistance. The expansion of copper at high temperatures had to be considered. He advocated reliability as the main consideration and an increase in the alternator cost to give better reliability would be well worth while if it prevented breakdowns.

Limitation by Specification.

Mr. A. B. **Field** said that the manufacturer was unduly limited by specifications drawn up by clients, and in specifying a low temperature rise the manufacturer was compelled to give a less reliable machine than would otherwise be the case. The temperature limits introduced by insulation and by the consideration of ultimate cost raised by Prof. Walker were two different things. It did not pay to run a rotor to more than 110 to 120°C. rise, which meant an increase of 40 to 50 per cent. in resistance. The insulation presented no difficulty under these conditions. With reference to standardisation rules, it was not sufficiently realised in this country that the rules adopted by American manufacturers were not adhered to in practice.

Mr. J. A. **Kuyser** said that the new B.E.S.A. rules meant larger machines than the old rules, and this was confirmed by the relative prices. The adoption of higher temperatures would result in better designs, higher efficiencies and lower costs.

Mr. A. E. **Clayton** said that the Paper would convince purchasers of machines that thermometer readings were hopeless, and asked why the author preferred thermo-couples to the resistance thermometer, which was more robust.

Increase in the Size of Filters Necessary.

Mr. G. F. **Sills** asked what was the influence of high temperatures on Paper insulation in laminations, and on core belt expansion. Air filters would have to be larger if higher temperatures were adopted. Machines with the proposed rating might be sold in foreign markets, but were not likely to be adopted in this country.

Mr. B. G. **Churcher** said that the thermo-couples were more robust than resistance thermometers, which required finer wire. Temperature determinations by thermometer even for flat surfaces were liable to errors, especially if the thermometer was shielded from the hot surface by a pad. In such cases thermo-couples should be sweated to the surface.

Mr. T. **Baxendale** thought the effect of a wet filter at high temperatures would be more marked and the influence of the heat would open joints in end-connectors and damage end-connector insulation.

Running Efficiency v. Capital Cost.

Mr. F. **Walker** said that under certain conditions efficiency in running might more than offset capital cost from the point of view of cost per unit of output.

Mr. R. **Johnson** said that the adoption of higher temperatures would force manufacturers to use mica and increased reliability would follow automatically.

The **Author**, in reply, said that high temperatures had been obtained and would continue to be obtained in alternators. A 40 deg. rise on the outside meant a big rise in the winding. He claimed that a high-temperature machine would be more efficient than a low-temperature machine. The slight swelling of the insulation in the slots gave the conductor a little elasticity to accommodate copper expansion. In the core, the core expanded with the bolt. One American company was varnishing its laminations. A more efficient machine would require a smaller and not a larger air filter. It was not practicable to differentiate between machines for home and foreign markets.

Railway Telephone and Telegraph Systems.

By M. G. TWEEDIE, A.M.I.E.E.

The communications provided on a railway, while not occupying an outstanding position in the working of it, do play an important but unassuming part in its eternal economy. It has been said that "evil communications corrupt good manners." This could be paraphrased to read, "evil communications corrupt good train working."

During the past 15 years the development of the use of the telephone for purely traffic movements has increased enormously throughout the world, by the institution of Control systems. At the same time, the telephonic communications between the chief officers of a railway and the districts and departments have been greatly improved and developed. In addition, the use of the single needle telegraph instrument for communication between signal boxes and their stations is being gradually dispensed with and box-to-box telephones and omnibus circuits installed.

The essence of good railway telephonic and telegraphic communication is that the two points must be able to get into touch without delay and that speech or messages can be clearly understood. Delay in getting into touch with the right man or station may easily result in delay to trains.

General Features.

A general feature of a railway telephone circuit is that there are a number of stations on the same line wires. As many as 32 stations have been so arranged, but this is exceptional. In its simplest form the calling signal is by bell and code ringing. With more than six stations, the ringing becomes a nuisance and some form of selective ringing has to be adopted. The different systems of selective ringing are ingenious, and in most cases complicated, and, in consequence, the workmanship in the telephones is required to be of a high order to ensure faults being few and far between. Selective ringing can be obtained by the introduction of double polarised relays in the telephones, each relay being so connected that it only responds to a current in a certain direction and correct strength. Again, relays to respond only to alternating vibratory or direct currents can also be adopted. Step by step selecting relays are also in use. Generally speaking, the selective system consists of turning a rotary segmental switch or "commutator" to such a position that the required battery connections are made, and then by closing the circuit to energise the particular delay at the "called" station, which in turn rings its bell by a local circuit. A mixture of selective and code ringing can also be adopted.

In many of the above systems it is necessary to listen in on the line before calling up, and to be careful to hang up the receiver after a conversation is finished. Secrecy cannot, of course, be obtained on selective or code ringing circuits.

The Control System.

In the control system the problem is somewhat different. The conditions required are that the controller can call up any station direct and that any station can call up his controller direct, but stations cannot call each other. The different control lines, 6 to 12 or more, with up to 32 stations on each, are led direct on to a switchboard on the controller's desk. Where more than one desk is in use the connections are arranged in multiple, so that another controller can deal with a call when another is already engaged. Lamp signalling is adopted on the control board, but bell ringing at the stations. Red and white lamps are employed to indicate a call and "engaged line" signal respectively. In some control offices the controllers have their duties divided, and in order to get on to the right man direct, a selective device for the controllers' desks is also provided. Two push-buttons on the station telephone allow this to be done.

The latest control systems are worked on the central battery system at 24 volts for the lamps. Separate batteries are required for working the vibratory ringers and for providing the high voltage, up to 40 volts to earth on either polarity, for the selecting stations.

For general communication purposes all types of telephones will be found. At important stations on the big railways C.B. telephone exchanges are provided with adequate trunk lines to other important points and junction lines to the local P.O. exchange. Magneto boards, cordless and with cords, and many other types, generally obsolete, will be found working well and doing what is required of them satisfactorily.

Telegraph Developments.

While the telegraph is not developing, it still plays an important part. Trunk telegraph lines between big towns exist, with sounders working simplex, duplex and quadruplex, as the case may be. Railways accept public telegraph traffic for the Post Office, which messages are transmitted by sounder or telephone to the local postal telegraph office. There still exist many local single needle telegraph circuits working between wayside stations with up to 20 instruments. Superimposing of telephones on block wires, electric train staff wires, telegraph and telephone circuits is largely resorted to, to effect economy in line construction. For successful working this requires a high standard of maintenance, which is generally obtained.

Administration Arrangements.

The administration of railway telegraph and telephone systems is not carried out in a uniform manner on all railways. On some railways the telegraph department deals with the operating staff and their work as well as construction and maintenance work, and the telegraph superintendent is responsible direct to the general manager. On other railways this work comes under the company's electrical engineer, but the operating staff and their work under an officer in the traffic department. Yet again, the signal department is responsible for communications as far as construction and maintenance is concerned, the operators being under the traffic department. Where there is a telegraph section in the traffic department the preparation of new schemes and alteration to existing schemes, together with the preliminary negotiations, is carried out by them. The technical side of the work is, however, left entirely to the construction and maintenance department, who act as advisers to the General Manager on matters of this nature. On small lines the work is sometimes in the hands of contractors.

The Physical and Optical Societies' Annual Exhibition.

(Continued from p. 133.)

FOSTER INSTRUMENT COMPANY.

The Foster Instrument Company showed a selection of their well-known pyrometers and mechanical testing apparatus

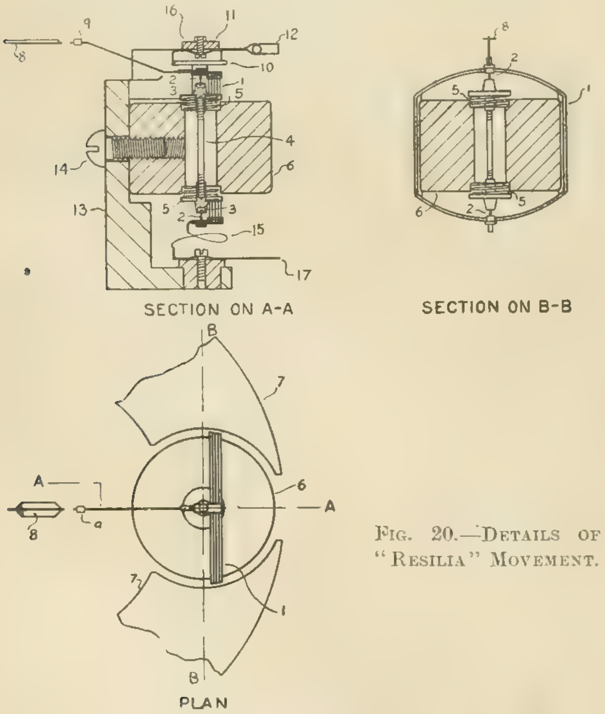


Fig. 20.—Details of "Resilia" Movement.

The construction adopted in their "Resilia" millivoltmeter is of interest, as it provides a means by which the effects of vibration are avoided. In many delicate instruments the effect of a slight jar may be sufficient to damage the fine pivot point by bringing it it forcibly against the conical jewel, but in the "Resilia" design the pivot and jewel cannot be separated and therefore cannot strike each other.

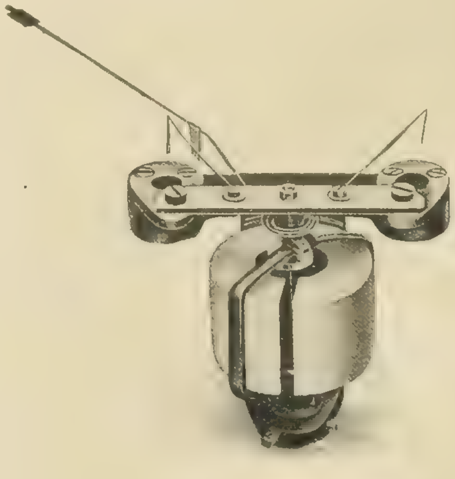


Fig. 21.—Patent "Resilia" Movement.

This construction is indicated diagramatically in Fig. 20. The coil 1 carries inturned pivots 2, having their bearings in the conical jewels 3. These jewels are mounted upon a staff 4, which itself is very light and which is held in position relatively to the core 6 by the light springs 5. Any jolt of the instrument, therefore, will move the whole system of coil, pivots, jewel and staff, and it is impossible for the pivots to strike a blow on the jewels. The current to be measured is led into the coil through the control spring 10, and the ligament 15; thereafter the circuit is carried by the frame 11 at the top and by the insulated arm 17 at the bottom. The zero is controlled by the arm 12. Attached rigidly to the coil is a light pointer 8. The coil 1 is mounted slightly eccentric to the axis 4 so that its weight balances the weight of the pointer 8, a final adjustment of balance being made by the position of the small sliding weight 9. This construction avoids the necessity of a counterweight tail and counterweight usually employed, and therefore enables the weight of the whole moving system to be kept to a minimum. Thus the controlling forces may be small and the pivot points very fine, and therefore the internal resistance of the instrument can be high without introducing objectionable mechanical delicacy or friction errors. The core 6 is held by the screw 14 to the rigid frame 13, which, in turn, is attached to the magnet and combines the whole moving system into a unit. Fig. 21 shows the complete movement.

A portable indicating pyrometer with Hoskins' alloy thermocouple, specially arranged for direct momentary insertion into molten non-ferrous metal, was also shown. The thermo-couple may be directly immersed in the molten metals, and a reading is obtained in from 10 to 15 seconds. A special connection head is used in this outfit, allowing renewal wires to be quickly attached. The portable indicator included in this outfit is made specially robust for foundry work, and can safely be placed in the hands of relatively unskilled users.

THE CAMBRIDGE & PAUL INSTRUMENT COMPANY.

As usual, the stand of the Cambridge & Paul Instrument Company was a centre of interest. Some of the apparatus has been well known by report during the war, but has not been generally seen. Thus we may mention the sound-ranging apparatus, which was one of the many devices developed from purely physical principles for war work. The outfit shown on the present occasion included a 6-string Einthoven galvanometer, the deflections of which were recorded on a moving band of photographic paper. The latter is passed through an automatic developing attachment. It is probable that such an equipment will still find a useful application in determining distances at sea to a much greater accuracy than hitherto.

Machine-running Recorder.

The recorders of the Cambridge & Paul Instrument Company are well known to readers of The Electrician, but we do not remember seeing previously a device for recording the stoppage of a number of machines running simultaneously. The particular instrument exhibited was designed for Messrs. J. & A. D. Grimond, Ltd., Dundee, for recording the number of stoppages and their duration on 50 textile machines. It need scarcely be remarked that it is important to minimise both the number and duration of stoppages in plant of this kind. The principle of the device will be understood from the following description

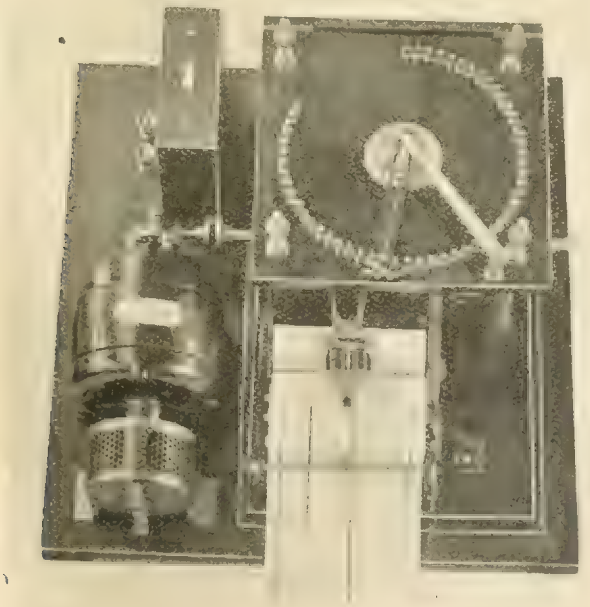


Fig. 22.—Machine-running Recorder, seen from above, with Cover removed.

Each machine is connected up to the instrument in such a way that when the machine stops an electric circuit is completed up to contacts in the instrument, each of the 50 machines being connected to one of the 50 contact studs arranged in a circle as seen in Figs. 22 & 23. A rotating switch runs over these 50 contact studs, being driven from a small electric motor of $\frac{1}{8}$ H.P., and it is so geared that it passes over all the contacts once in 6 seconds. The records are made on a continuous paper chart, passing over a brass cylinder, by means of an inked roller carried at the end of an arm swinging across the surface of the chart. A cam on the main spindle which carries the rotating switch causes the recording arm to swing completely across the paper from right to left as the switch passes across the 50 contacts, and returns the arm to the extreme right-hand position before the switch again starts to travel across the contacts. If none of the contacts is energised, *i.e.*, if all the machines are in operation, the inked roller does not touch the chart, but when the circuit is completed by the stoppage of one of the machines, an electromagnet on the recording arm is energised, causing the inked roller to be momentarily pulled downwards and make a mark on the chart. If this contact is still closed when the switch next passes the corresponding contact stud the roller will be once more pressed on to the chart, which is moved forward a short distance after each revolution of the contact switch. Consequently, a series of marks, forming a straight black line on the chart, is made during the whole time any machine is out of operation. The charts are not graduated, but an engraved celluloid scale, dividing the chart width into 50 equal portions, and also showing the time scale, is supplied with the instrument. By applying this scale to the record on the chart it is possible to see which machine it is that has stopped, and the duration of the stoppage. The complete recording instrument is enclosed in a wooden case with glass panels, as shown in the illustration, and the driving motor may conveniently be mounted on the same base as the recorder.

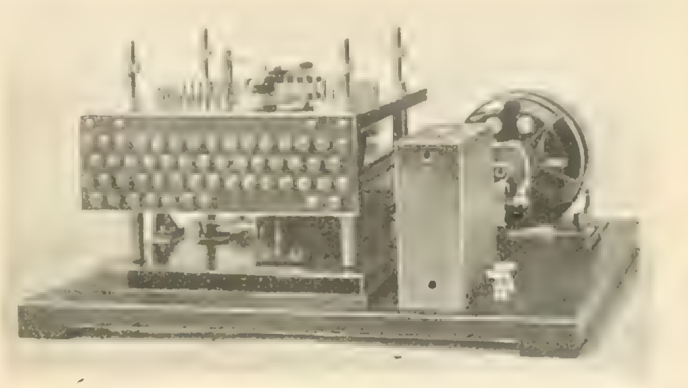


Fig. 23.—Machine-running Recorder, showing Terminal Board for Connections.

Moll's Thermopiles.

These thermopiles, which are due to Dr. Moll, of Utrecht, are constructed on a new system, their outstanding features being very small heat capacity, ensuring great rapidity of action, and high sensitivity. The thermopiles are built up of thin strips, each consisting of two dissimilar metals, the strips being joined at one end and having their other ends soldered to copper bars. The strips can be exposed to radiation over their whole length. On account of the great difference in heat capacity between the junctions which rest on the copper bars and the junction of the two strips, the latter, when radiation is admitted, attain a much higher temperature than the copper-bar junctions. Such elements may be combined to build up either linear or surface thermopiles, and thermopiles of three types were exhibited.

A large surface thermopile was shown for the measurement of total radiation. This is composed of 80 elements arranged in three rows in a circle 2 cm. in diameter. The resistance is about 50 ohms. The pile is mounted within a heavy brass cylinder, closed on one side by an ebonite plate to which the two terminals are attached, and on the other side by a heavy brass lid, into which a glass plate is fixed. Radiation from a candle at 1 metre distance yields about 500 microvolts, when the reflector is used.

The second thermopile was linear, for spectral investigations. This consists of one row of 30 elements, with a resistance of about 20 ohms. The thermopile is mounted in a heavy brass cylinder, which carries a simple slit of 2 cm. length and variable width; at the back it is provided with an ebonite plate through which the two terminals protrude. With a slit 1 mm. wide the radiation of a source of 1 c.p. at 1 metre yields about 10 microvolts.

The third thermopile was a small surface one for school use. It consists of 17 elements, placed in a circle of 1 cm. diameter. The resistance is about 10 ohms. The holder is closed by a lid with a glass plate and arranged to carry a conical reflector. Radiation from a source of 1 c.p. at 1 metre (with reflector and without glass plate) yields about 100 microvolts.

In connection with these thermopiles we noticed a useful galvanometer lamp and scale outfit, a 4-volt gasfilled lamp being used to give a brilliant image. This lamp will be found to replace satisfactorily the Nernst lamp, which is no longer obtainable. The galvanometer spot is of the type designed by Dr. Moll. With this form of spot, which is shown in Fig. 24, the figures can be readily seen, and at the same time readings can be made on the edge of a brightly illuminated line. It appeared to be very effective.

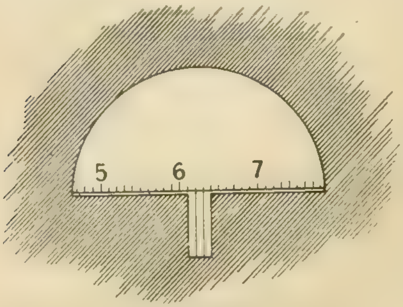


Fig. 24.—Dr. Moll's Form of Galvanometer Spot.

Simple Potentiometer.

This potentiometer has a range from 1·8 volts to 0·00001 volt, and is suitable for students' use and for workshop laboratories. All the moving parts are enclosed, the contacts of the slide wire, rheostats, &c., being operated by means of dial switches. Included in the instrument are the potential coils and slide wire, coarse and fine adjustment rheostats for the battery circuits, checking key (enabling the adjustment to be checked at any instant without interrupting the test), and a switch by means of which any one of three external test circuits can be connected to the instrument. The main potentiometer circuit consists of 17 potential coils, each of 1 ohm resistance, in series with the slide wire and the rheostats for adjusting the current, which is obtained from a 2-volt accumulator. To check the adjustment of the current through the potential coils a tapping-off point is provided at 1·0183 volts (10·183 ohms) and the current is adjusted by the coarse and fine adjustment rheostats (which are arranged in two dials) until a balance is obtained at this point against the E.M.F. of a Weston cell. The potential coils then each correspond to a fall of potential of 0·1 volt. The slide wire is arranged in a circle below the ebonite top of the potentiometer, the contact being adjusted by turning an external handle. The wire is adjusted to 1 ohm resistance, and the scale has 100 divisions, each equal to 0·001 volt, with sub-divisions corresponding to 0·0002 volt.

Ammeter for High-frequency Currents.

This instrument has been designed by Messrs. A. Campbell and D. W. Dye to meet the requirements of current measurements in radio work. The instrument consists of a small iron-core transformer having a ratio of 100 : 1, the primary of which is connected direct in the aerial circuit, whilst the secondary is connected to a small thermo-junction in vacuo, the thermo-couple of which is attached to the millivoltmeter. It has been shown that a transformer of this type is independent of changes in frequency from 150 to 6,000 metres wave length. The millivoltmeter used is a unipivot instrument having an edgewise scale calibrated to read up to 20 amperes in the aerial circuit. The instrument exhibited was designed for marine work.

Instantaneous Photometer.

An instrument known as the instantaneous photometer has been designed for the Admiralty in conjunction with the staff of H.M.S. "Vernon" for measuring the instantaneous candle-power of an electric lamp when it is lighting up or going out. This is of some importance in lamps used for signalling, as it affects the maximum speed at which the operator can use this method. In this instrument the comparison is always made with a similar lamp which has been previously calibrated with various currents in an ordinary photometer. The lamp to be measured is placed in the upper box, and the comparison lamp in the lower box of the instrument. The lower comparison lamp is then run steadily with different currents below and up to its normal current. The interiors of the boxes are painted white and the two lamps illuminate slits covered with opal glass. Disregarding the effect of the shutter for the moment, light from these two slits passes through two cylindrical prisms with vertical axes to a double prism with horizontal axis in the eyepiece, and the light then passes on in two nearly parallel beams to the eye. The latter prism is observed by an ordinary eyepiece so that the observer sees two adjacent rectangular fields, the upper illuminated by the lower comparison lamp and the lower rectangle illuminated by the upper lamp under test. The revolving shutter carries another pair of slits. Light only reaches the eye when the two pairs of slits come into line with the eyepiece, so that the eye only perceives flashes lasting about 0·001 second. The two revolving slits are independently adjustable on both sides so that the two flashes can be made simultaneous and of equal duration. To avoid carrying the obscuring screen completely round, a second shutter obscures the lamps when the revolving slits are far away from their operating position, the secondary shutter being opened by the revolving slits in good time before the slits themselves come into action. The revolving slits or shutter also carry a cam which operates the switch for lighting up the lamp under test, and for switching it off. The contacts themselves are carried on a large wheel under the revolving slit. By rotating this wheel the position of the contacts is moved so that the cam lights up the lamp at a varying interval before the shutters open, or alternatively, switches off the lamp at a varying interval before the shutters open. As the motor revolving the shutter and cam is fitted with a centrifugal governor, the speed of revolution is constant at 30 revs. per min., and the wheel carrying the contacts can be calibrated accurately in units of time. One-half of the wheel with white figures is calibrated in hundredths of seconds, from 0·1 second, representing intervals of time after lighting up, and the other half of the wheel is similarly calibrated in red to represent intervals of time after switching off. An actual test is made by setting the comparison lamp by passing a known current through it, so that it gives a certain known candle-power. The wheel carrying the contacts is then rotated until a match is obtained in the two fields. The time reading of the wheel then gives the interval after switching on or switching off, at which the lamp being measured has this particular candle-power. By taking a series of readings of the different currents through the comparison lamp the complete illumination curve of candle-power against time for lighting up or going out of the lamp under test can be obtained. The general character of the apparatus will be seen from Fig. 25.

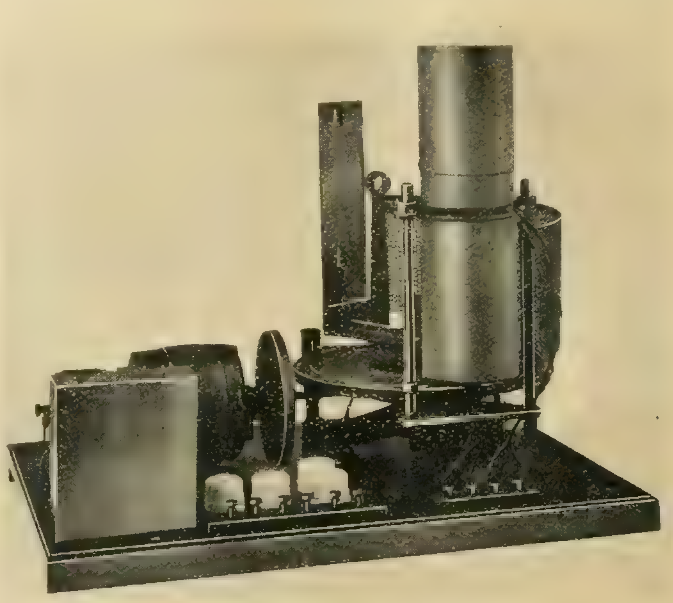


Fig. 25.—Instantaneous Photometer.

The very sensitive electric anemometer due to Prof. MacGregor Morris was shown in a form which has been developed for measuring the velocity of air in coal mines. This instrument was recently described in The Electrician (Aug. 27, 1920.) The special feature which may be noted is the ease with which the fine metal wires that are exposed to the flow of air can now be replaced if by chance they are broken.

The Rosenhain Inverse Rate Recalescence Curve Tracer.

This recorder is designed to allow of the semi-automatic plotting of "inverse rate" heating and cooling curves. In such curves the quantity plotted is the time taken by the specimen to heat or cool through successive equal temperature intervals, and the use of an instrument such as the one exhibited does away with the laborious plotting by hand of the time intervals obtained by the use of an ordinary chronograph. The recorder consists of a revolving drum, carrying a chart, over which the recording pen is made to move at a definite rate. The apparatus is so arranged that at the end of each time interval when the observer taps a key, the pen is caused to make a mark on the chart, indicating its position and is immediately afterwards returned to zero, while the drum is simultaneously advanced one step. After a short period of rest, introduced in order that the times of the forward movements of the pen shall not be altered by the varying times taken by the pen in returning to rest after long or short deflections, the pen once again moves forward at a steady rate until its progress is stopped by the observer again tapping the key at the end of the next temperature interval. The series of points thus marked on the chart gives the curve required showing the varying times taken by the specimen to heat or cool through the successive equal intervals of temperature.

MR. R. W. PAUL & F. TWYMAN.

Mr. R. W. Paul and Mr. F. Twyman showed an interesting personal exhibit. This took the form of an interferometer, which renders it possible to demonstrate the existence of convection currents flowing about an electrically-heated wire. The variations of refractive index so produced in the air cause interference bands

(To be concluded.)

Canal Building by Electricity.

An interesting example of the application of electricity to the handling of material in canal construction is that which is being employed by the Hydro-Electric Power Commission of Ontario in the construction of the Welland River Canal. To make this canal will involve a cut of about 140 ft. at the deepest point, and it is further interesting from the fact that the water flowing along it will be used for supplying power to an electric generating station at Queenstown at the edge of the Niagara River Gorge with a net head of 305 ft. The present power plants at Niagara utilise heads of 150 ft. to 250 ft., and the additional drop which will now be employed is obtainable by using a site beyond the Rapids. The canal is designed to carry sufficient water to generate over 400,000 h.p. and the power house which is to be erected will, as a beginning, contain four units each with a capacity of 40,000 kw.

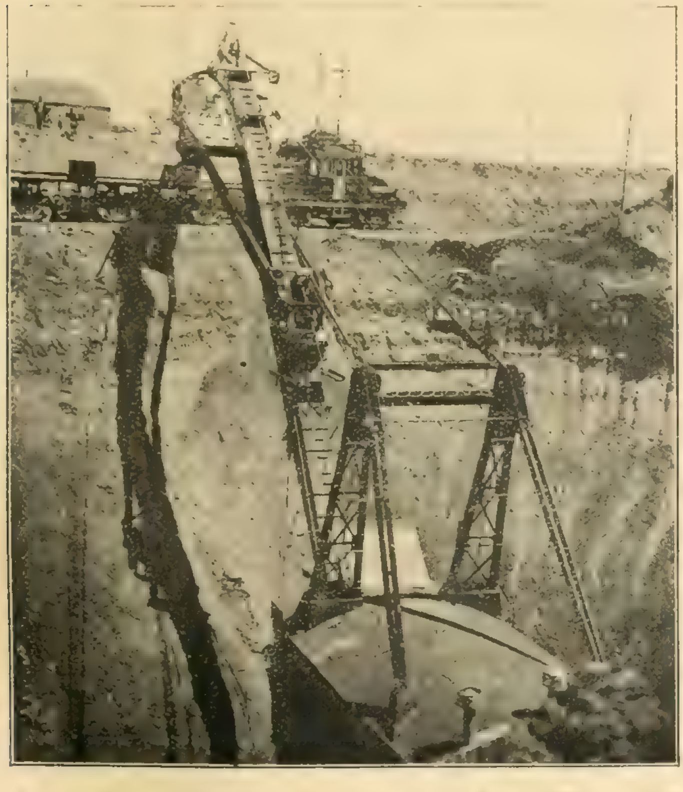


Fig. 1. Dumping Spoil into Trucks between 60 and 70 ft. above Excavator Rail Level.

Electrically-Operated Excavators.

We illustrate and describe in this article the electrically-operated excavators which are being used on this work, but there are also in use on the site electric locomotives and electric-operated air compressors, cranes and shovels, with, of course, electric lighting. The excavators weigh about 300 tons, one of them being equipped with a 90 ft. boom and the other two with 80 ft. booms, and all being fitted with shovels capable of taking 8 cubic yards of earth or 6 cubic yards of rock. Their design was complicated by the high lift, though by making this a feature of the machine, the problem of training the spoil away was greatly simplified, while, of course, the long reach also allows an enormous amount of material to be dealt with without shifting the machine or the track.

Electrical Equipment.

The electrical equipment of these large shovels is mounted on a girder-type frame which rotates on a roller circle 30 ft. in diameter. The three movements of hoisting, racking and swinging are obtained with separate motors, the hoisting motors being also used for propelling. Power is taken to the shovel from a nearby overhead line parallel to the cut, through a three-conductor armoured cable. Current is supplied at 4,000 volts, three-phase, 25 cycles, and passing to the three 150 k.v.a. transformers on the revolving frame through collector rings. The current is transformed to 440 volts for the motors and control equipment.

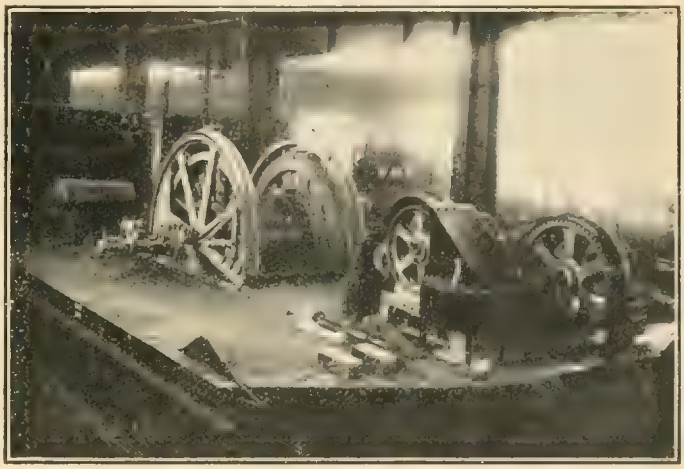


Fig. 2. Revolving Platform, showing Winding Gear and Control Panels.

The hoisting unit consists of two motors of 225 h.p. each, driving the 54-in. winding drum through double helical gears and an intermediate shaft. By means of a band clutch operated by compressed air from a motor-driven compressor, the motors, intermediate shaft and main hoist gear can be disconnected from the drum. An air-operated band brake on the drum shaft is used for holding the shovel at the desired height while swinging. Two hoist motors are used, as the particular type suitable for rough shovel work has not been developed in the larger sizes, and also for the reason that the flywheel effect of two small motors is less than it would be for one large one of this character.

The swinging motor has a capacity of 140 h.p., and is geared through reduction gearing to a pinion meshing with the rack on the stationary base. A slipping clutch on one of the intermediate shafts relieves overstrains due to rough handling, as in the steam shovel. The thrust or racking motor is also of 140 h.p. capacity, and its gear is also fitted with a slipping clutch to protect it. An air-operated band brake automatically controlled relieves the racking motor when it is desired to hold the shovel at a certain radius. The whole machine is moved by the hoisting motors through shafts and gears passing to the lower frame through the centre, and geared to all the 16 wheels of the machine.

Control Arrangements.

The control equipment is of the magnetic type, equipped with automatic gear to limit the accelerating peak load, and also on the hoist motor to limit overload while digging, by the automatic insertion of resistance in the motor circuit. This is effected without interrupting the pull on the bucket. The bucket is arranged for regenerative lowering, that is to say, after dumping the load the motor is reversed and the falling shovel overhauls the motors, driving them above the synchronous speed so that energy is returned to the line. Not only does this reduce the total current consumption, but it also results in a reduction of brake wear, and a considerable simplification of control and operation.

Speed of Operation.

In regard to the speed of operation these large machines will make a complete working cycle in from 30 to 50 seconds, depending on the nature of the digging, the height of lift and the angle of swing.

The maximum yardage loaded into cars in one 10-hour shift, on this project, has been 4,930 cubic yards bank measurement, obtained when the shovel was served with trains on either side. The best monthly run, consisting of two 10-hour shifts for a total of 26 days has been 175,800 cubic yards band measurement, or a daily average per 10-hour shift of 3,380 cubic yards. These records were made when the machines were digging stiff clay against a bank about 30 ft. to 40 ft. high. On this job the exceptionally good figure of 75 per cent. of the total working time has been spent by these electric excavators in actual digging.

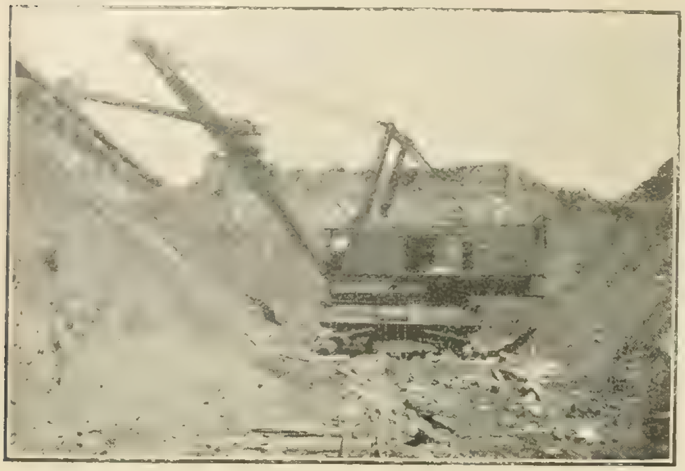


Fig. 3. —Excavator at Work on a 70 ft. Face.

The power consumption varies on this work from about 4 kw. to 10 kw. per cubic yard for the small machines mentioned above, to 8 kw. to 10 kw. per cubic yard for the large excavators, hoisting the material 60 ft. to 70 ft. to the cars being loaded.

The Electrical Expression of Human Emotion.

In a discourse delivered on Friday, February 4th, before the Royal Institution, Dr. A. D. Waller, F.R.S., director of the Physiological Laboratory, University of London, dealt with the invisible and insensible manifestations of emotion which accompany visible responses such as muscular movements and secretory discharges. Dr. Waller at once proceeded to demonstrate the phenomena which he has been investigating during recent years and which were first described as psycho-galvanic reflex phenomena, by Veraguth (Berlin) in 1909. Dr. Waller's first subject was a "normal person," a medical man. Electrodes (zinc discs covered with chamois leather impregnated with salt solution) were strapped to his hand and coupled in series with a battery of a few cells and a galvanometer, so as to form one arm of a Wheatstone bridge. Another pair of electrodes in circuit with another galvanometer was attached to the forearm. The two light spots were marked *H* and *A* respectively. Bridge balance having been established, Dr. Waller threatened to prick the subject with a pin; *H* was deflected, marking a decrease in resistance, and was again deflected, but rather less strongly, when the pin was really applied after a while. The *A* galvanometer took part in these movements, but the deflection was merely a slow creeping movement. Similar observations were made when the lecturer lighted a match to burn the subject, and when he spoke of blowing a motor horn. The suggestion of the pain or noise had a more marked effect than the actual application of the test. The response was thus not under our control—though this statement had to be qualified—and that made these tests valuable for discovering cases of malingering. People were not all equally sensitive in these respects, however. The four spiritualistic mediums whom Dr. Waller had been able to examine had proved remarkably sensitive; in their case both the *H* and *A* would respond almost equally and at the same moment. Dr. Waller exemplified this at a later stage with another subject whom he would class with the highly sensitive or imaginative people. Most men and women were normal and gave the palmar response *H*, but hardly any forearm *A* response; in them the response to fiction was greater than the response to the fact. He had also found insensitive people giving neither response, among psychiatric and shell-shock cases. Dr. Waller remarked that he thought he could distinguish a true medium from a false medium by his tests.

Some Striking Experiments.

Confirmatory evidence was adduced by a great many photographic slides which also showed by their time scale, what the demonstrations had made quite striking, that the electric response is not instantaneous with the emotion, but follows it after a distinct lag of one, two or more seconds. The slides further gave the myograph, the curve of muscular activity. When the subject had raised the finger, the muscular contraction was at once recorded by an increase in electric resistance, whilst the emotional decrease in resistance lagged behind. In general the hand (palmar) response was more rapid than that of the foot, and the foot more responsive than the leg, but the latter did not hold for very sensitive people. Most of the curves were very jagged, the galvanometer coming to rest after rapid oscillations. As the measurements were resistance determinations, and as the palm of the hand proved the most responsive part of the body, Dr. Waller had taken continuous observations of his palmar resistance. He then observed fairly regular diurnal variations of the resistance, the resistance being greater at night than during the active hours of the day, and that variation seemed to run parallel with the emotional activity. In order to decide whether the diminution of the resistance following and marking emotion was a real decrease of resistance or due to some electro-motive force (a diminution of the e.m.f. of polarisation) he also placed a potentiometer in series with the bridge arm. These experiments indicated a real diminution of the resistance.

The Effect of Nerve Impulses.

Dr. Waller hence came to the conclusion, a few years ago, that the emotional response depended upon the dilatation of the membranes through which the ions pass in general vital activity. When the nerve impulse reached the membrane, the protoplasm contracted, and the pores became dilated (somewhat as the pupil dilated), so that more ions could pass and more carriers of the current entered into action. By watching a galvanometer in the palmar circuit one could see oneself live, in a sense. During the active hours of the day the pores were more dilated; at night, and when we were fatigued, the pores contracted. Any discharge in the nerve system, whether emotional or not, thus gave rise to galvanic phenomena. That was in accord with the palmar resistance measurements mentioned and with other observations. The response of the right hand was more intense than that of the left hand, but the curves were parallel. Hand and foot mostly went parallel as well, but when the hand response lagged two seconds behind the emotion, the foot response might lag by four seconds. The dilatation of the pores itself was not instantaneous, requiring about two seconds to become effective. Various observations made during the air-raids of the war brought out some curious facts. In one case the maroon signal and the anti-aircraft guns had not produced any effect, but the hum of the Gotha was marked by a strong deflection, corresponding to a resistance-decrease of about 4,000 ohms, much greater than in the laboratory experiments. A certain control seemed therefore possible. We should add that Dr. Waller offered his explanation of the phenomena as a working hypothesis, not yet as a theory.

The End of the E.P.D.

By **ERNEST J. P. BENN.**

At long last, after two and a half years of the most authoritative agitation, the Government has decided that the E.P.D. must go. From the day when the Armistice was signed, right down to last Friday, everyone with any claim to speak as an authority on industrial matters has demanded the immediate abolition of this completely bad tax. All these expressions of opinion have been disregarded, and the authorities have only now been willing to take the right line in view of the accumulating evidence, through unemployment and slump, of the damaging effect of this impost.

Mr. Chamberlain deserves the unstinted thanks of the business community for the courage which he has displayed in setting a new precedent. Never before in the history of the Chancellors of the Exchequer has there been a case where a holder of that office was willing to divulge in advance the secrets of a forthcoming Budget. This one act lifts Mr. Chamberlain into the front rank of statesmanship, and will make him famous as the creator of a new constitutional practice long after the E.P.D. and all that it means has been forgotten. Mr. Chamberlain will, of course, be severely criticised for the step which he has taken. The House of Commons is sure to call him over the coals; and from many points of view the House of Commons will be right. In recent years the undesirable practice whereby Ministers make important announcements to trade union conferences, deputations, and even to their constituents, before addressing the House of Commons, has grown. The Chancellor's speech in Birmingham will, therefore, be regarded as a further attack upon the prestige of Parliament, and many will agree with criticism on those lines.

Possible Opposition in Parliament.

The business man will be wise to note that the E.P.D. is now definitely doomed, but to wait patiently before basing any very high hopes upon the details of the final death bed scenes. There will, of course, be very violent opposition in Parliament from the Labour benches. The Labour Party is committed to a policy of taxing profits out of existence, and it has not the courage or the ability to see that E.P.D. not only damages profits, but absolutely destroys industry. Parliamentary discussion will, of course, bring out a lot of details, and Ministers are sure to make concessions to opposition, and qualify in various ways the simple and straightforward utterance of the Chancellor at Birmingham. Even when the House of Commons has finished with E.P.D., and the Budget is finally passed, the matter will then pass into the hands of the bureaucrats. Tax-payers know from bitter experience that Ministerial utterances have a way of finding unexpected interpretations when they ultimately reach the hands of the collectors of taxes. For these reasons the prudent business man will merely experience a sense of thankfulness that a time limit has been set to his troubles and will "wait and see."

The Financial Side of the Duty.

The E.P.D. is stated to have produced for the Exchequer something like £1,100,000,000, but whether this figure refers to money actually collected or to claims lodged is not made clear. It has been shown to be the most powerful price-raiser ever invented, and there are those who hold that it has really cost the Exchequer a great deal more than ever it brought into the National Funds. The War cost roughly £12,000,000,000, so that the E.P.D. will account for about 2s. 6d. in the pound of the total expenditure of the Treasury while it has been in force. If the E.P.D. has had the effect of raising prices by 2s. 6d. in the pound, or 12½ per cent., it will be seen that the national balance-sheet is no better for this tax, while the individual taxpayers and consumers of the country have all had to suffer from high prices. If the E.P.D. raised prices by less than 2s. 6d. in the pound, then Mr. Chamberlain has benefited to some small extent from it ; if, on the other hand, as is quite possible, the effect of the tax was to push up prices, say, 15 per cent., then the Treasury has had years of trouble and is definitely worse off owing to the blunder of this much discussed form of taxation. However that may be, it is evident that the Treasury, the nation and the taxpayers generally, have all been put to enormous trouble during the last seven years for a final result which cannot amount to more than an odd few millions one way or the other.

In making this belated concession to authoritative pressure, Mr. Chamberlain has done the handsome thing. The only pity is that all this wisdom comes so late. Had the Government had a little foresight, and had Mr. Chamberlain made his speech a year ago, we should not now be faced with unemployment or with slump so acute as is apparent to-day. However, if we cannot get foresight, we must be thankful for hindsight in high places, and rejoice to know that this E.P.D. madness is at last at an end, and that with it are going most forms of Government control. It will now be up to the business men who have so vigorously demanded these alterations to justify their complaints by demonstrating that the new conditions do give room for enterprise and expansion. We may expect to see developments in all directions which have been delayed pending this announcement, and the result should be a gradual diminution in the number of unemployed and a gradual improvement in the volume of our trade.

Specialised Switchgear Manufacture.

A recent inspection which we made of the works of the **Electrical Apparatus Company** and of the associated firm of Bray, Markham & Reiss, enabled us not only to see the details of some interesting designs of starter and control equipment, but allowed us to draw some equally interesting comparisons between ancient and modern works layout, or rather between the shifts and devices which have to be adopted when a works are established in an already existing building, and the more direct course which can be employed when a building is erected for the specific purpose of manufacturing specialised electrical apparatus. These points will, perhaps, be made clearer if we shortly describe the genesis and development of the firms concerned.

A Lord Chancellor and an Actor.

The Electrical Apparatus Company was established in 1906, primarily with the object of acting as selling agents, but also to sell apparatus under their own patents but made by other firms. Very soon, however, it was found advisable to establish works at Battersea for the manufacture of motor control gear and electricity meters. Further extensions to these works were necessary within a few years and land was acquired on which the present Vauxhall works of the Company were built. The site is interesting for the fact that it was originally covered by a house which for several years was inhabited by the late Mr. Lionel Brough, the actor. These Vauxhall

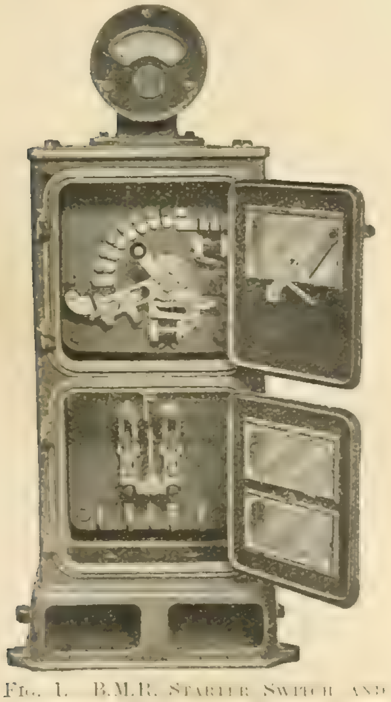


Fig. 1. B.M.R. Starter Switch and Ammeter Combination for Floor Mounting.

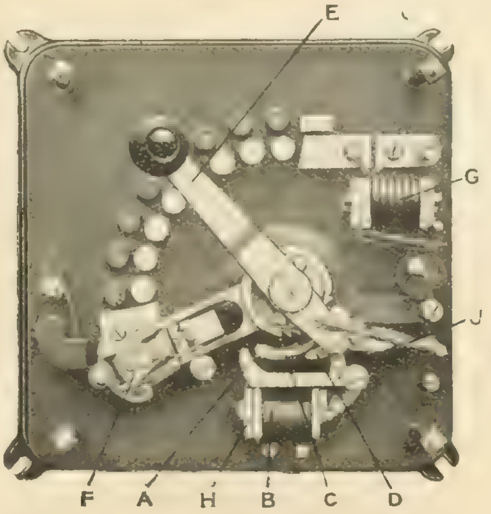


Fig. 2.—B.M.R. Ratchet Starter.

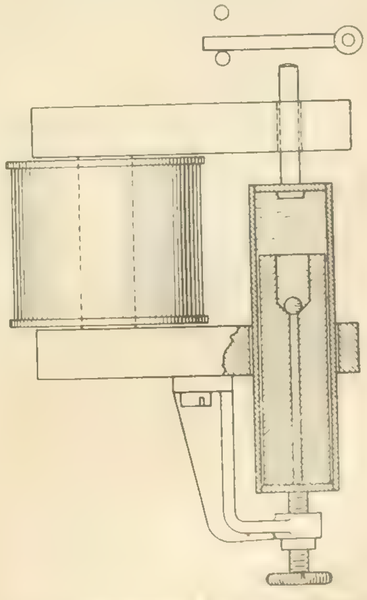


Fig. 3. Diagram of an Ingenious Time Lag Device. (Electrical Apparatus Co.)

works have been extended from time to time as business exigencies required, but last year the limit in this direction was reached, and it was therefore decided to acquire a plot of ten acres at St. Albans, onwhich an entirely new works could be built. Unfortunately, so pressing were the demands on the Vauxhall works that new premises had immediately to be acquired, at least temporarily, and a building, which had once been the residence of Lord Eldon, at one time Lord Chancellor, in Wandsworth, was therefore taken over. This house, though hardly ideal as a modern factory, is interesting for the relics of ancient glory which it still contains in the form of marble pillars and ornamental plaster, while the conjunction of a celebrated lawyer and a still more celebrated actor with the manufacture of such mundane articles as controllers and starters should not be without interest for the philosophical among whom, we feel sure, many readers of The Electrician may be numbered.

Early in 1920, a further development in the history of the firm occurred by the conclusion of an arrangement whereby the interests of the Electrical Apparatus Company and of Messrs. Bray, Markham & Reiss, of Walthamstow, were conjoined. This arrangement allowed the establishment of a common sales organisation and for a joint financial control. Except for this, however, the two enterprises are conducted separately, and, as regards the Walthamstow works, are still superintended by Mr. E. N. Bray, one of the original founders of the firm.

The Output of the Various Works.

At the Vauxhall works direct-current control gear, including motor starters, shunt and starter regulators and inching starters, together with modifications of these, such as automatic starters, contactor panels and testing rheostats are manufactured, as well as alternating-current control gear of the face plate and drum types and control panels fitted with switches and starting gear for various purposes both air-break and oil-immersed apparatus. The Wandsworth Road Works, that is Lord Eldon's whilom residence, is used as a sort of annexe to the Vauxhall works for the manufacture of detailed parts of automatic machines of various ingenious designs.

At the St. Albans Works the principal product turned out is the oil-immersed draw-out switch in its numerous combinations with other control gear to form complete power units and distribution switchboards for industrial use. Here also is established the meter department where the manufacture of house service meters for both alternating-current and direct-current circuits is carried out in large quantities. The sales organisation of the Company is controlled from the Vauxhall works with ramifications at Manchester, Birmingham, Newcastle, Glasgow, Cardiff, Nottingham, Leeds, and at Bergen in Norway.

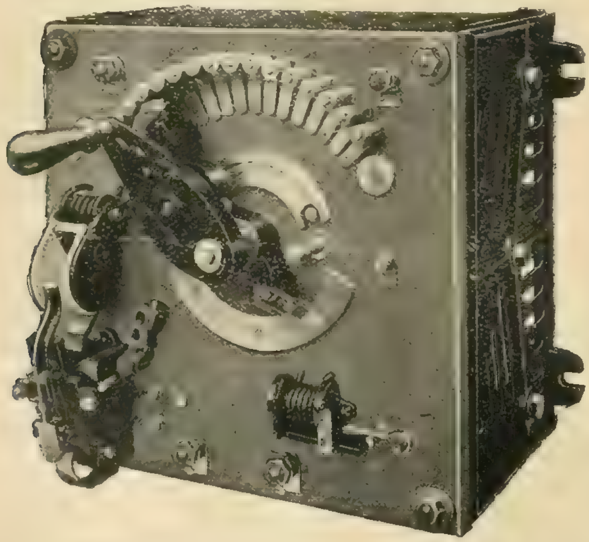


Fig. 4.—Electrical Apparatus Co. Heavy Duty Inching Starter for D.C. Circuits.

The Walthamstow Works.

Messrs. Bray, Markham & Reiss, the amalgamation of whose interests with those of the Electrical Apparatus Company we have just mentioned, was established in 1902, in buildings occupied by Messrs. Peter Hooker, Ltd., for the manufacture of starters with automatic releases, apparatus which, at that time, was mainly imported from America and was chiefly distinguished for the flimsiness of its construction and the consequent trouble which it gave to anyone with temerity enough to use it. To improve this state of affairs Mr. Bray and his colleagues first turned their attention to the question of resistance design and succeeded in producing a unit which has proved so successful in meeting the conditions imposed upon it that it has been in use without alteration ever since. It, in fact, possesses qualities of uniqueness and reliability that have largely established the success that has been achieved by the Company, and is by this time well known to electrical engineers.

Shortly after their establishment the Company also brought out a design of starting panel, which was accepted as a standard in connection with the electrification of the Admiralty dockyards and a motor starter which was adopted by Mr. Wordingham for use on battleships. From that period to the time that war broke out the firm were practically entirely engaged on the production of switchgear for Admiralty work and for the mercantile marine.

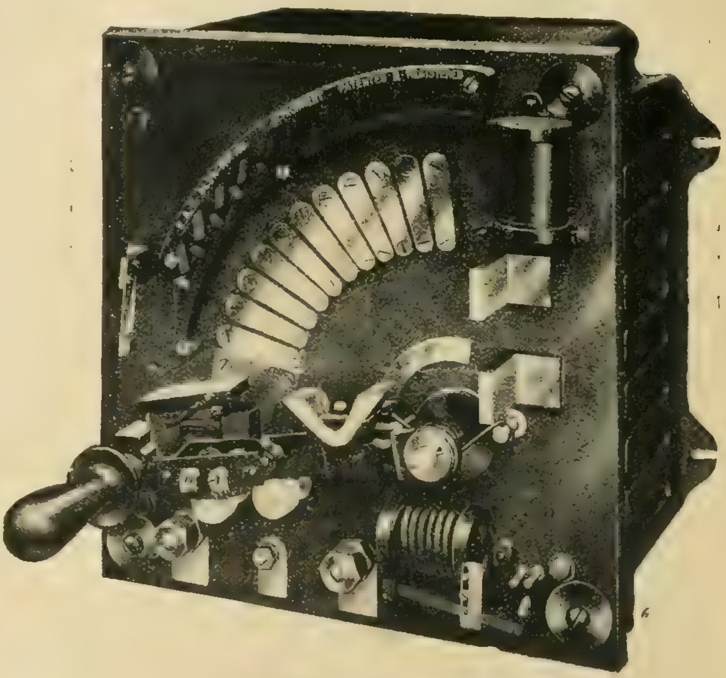


Fig. 5.—One Minute Type Motor Starter.

During the war it became necessary to establish works of their own, apart from Messrs. Peter Hooker's premises, and since the armistice, when the Admiralty work dropped to a minimum, they have been largely engaged on the manufacture of remote control and automatic starters for direct-current work and have also developed a motor operated type of starter with considerable success. A new departure is a starter of mica and iron construction which is a combination of the face-plate and drum types. This type was originally designed for use on H.M. submarines where the drum type was found too bulky. A very large number of these starters were manufactured during the war and a modification was also developed for use on land in the form of pillar-type panels.

Illustrations of typical products made by this firm are given in Figs. 1 and 2. The apparatus turned out may be summarised as including direct-current starters of the ordinary lever type and of the slow-motion ratchet type in every combination of pillar panel with fuses, breakers, and shunt regulators; navy type starters of the mica iron construction already mentioned, double pole switches of the laminated brush type in cast-iron cases and fitted with magnetic blow-outs; motor-operated remote-control starters of the face-plate type and of the motor-operated master switch and contactor pattern, together with every possible combination of field regulators both for shunt and main alternator fields. To a large extent the productions of the firm are standardised. The operations in the works, which are of the most modern type, are carried out on principles which make for large production and cheap manufacture. Factors in bringing about these two desirable conditions are the personal supervision which is given to the whole of the work by Mr. Bray and the contentment which has been engendered among the workers generally.

An Ingenious Time Lag Device.

Returning to the products of the Electrical Apparatus Company in more detail, we may first mention the ingenious form of time lag device which has just been designed and is now being tested out by the firm. This device, which is shown diagrammatically in

Fig. 3, is intended for operating any gear in which it is necessary to delay the electrical action of circuit breakers, master controllers, or other automatic apparatus. The moving part of the device consists of a hermetically sealed tube of non-magnetic material. This tube is almost filled with a soft iron cylinder, the remaining space being occupied with oil. This combination of tube, oil and core forms in its turn the core of a solenoid or the pole piece of an electromagnet. In either case, the inner core is in a comparatively weak field when the circuit is first closed, so that it is drawn up slowly inside the tube, the movement being further checked by the braking action of the oil. As the core rises into the region in which the field is stronger, the magnetic force increases and finally becomes sufficiently strong to enable the iron core to draw the brass tube up until the contact at the upper end is closed and the effect desired produced. When the current is cut off, on the other hand, the iron core falls more rapidly than it rose, owing to the oil being able to escape through a hole drilled in the axis of the cylinder. The ball valve shown prevents this escape when the circuit is closed. A very large range of time adjustment is, we understand, possible with this apparatus by using oil of varying viscosity or by altering the clearance round the cylinder. In addition, each device can be regulated within considerable limits by raising or lowering the initial position of the tube by means of the set-screw shown.

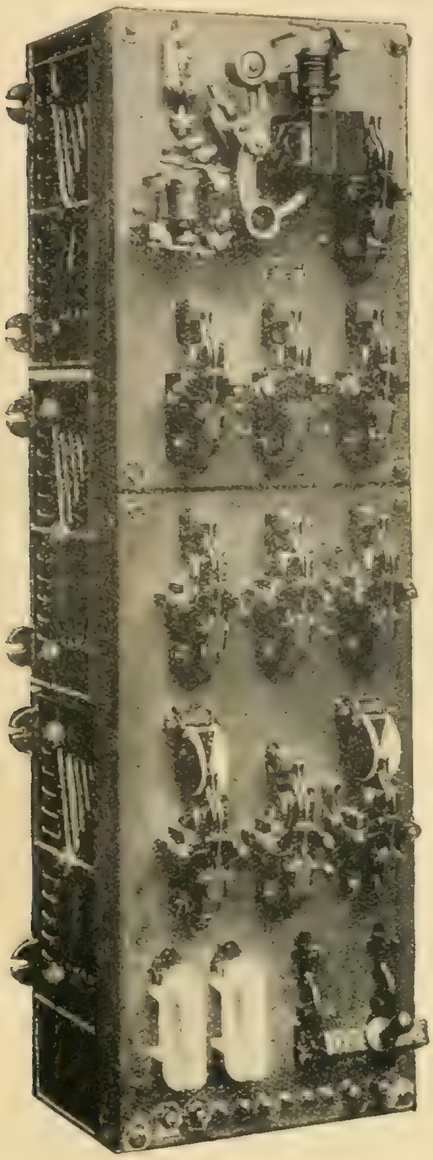


Fig. 6. AUTOMATIC MOTOR STARTER FOR D.C. CIRCUITS.

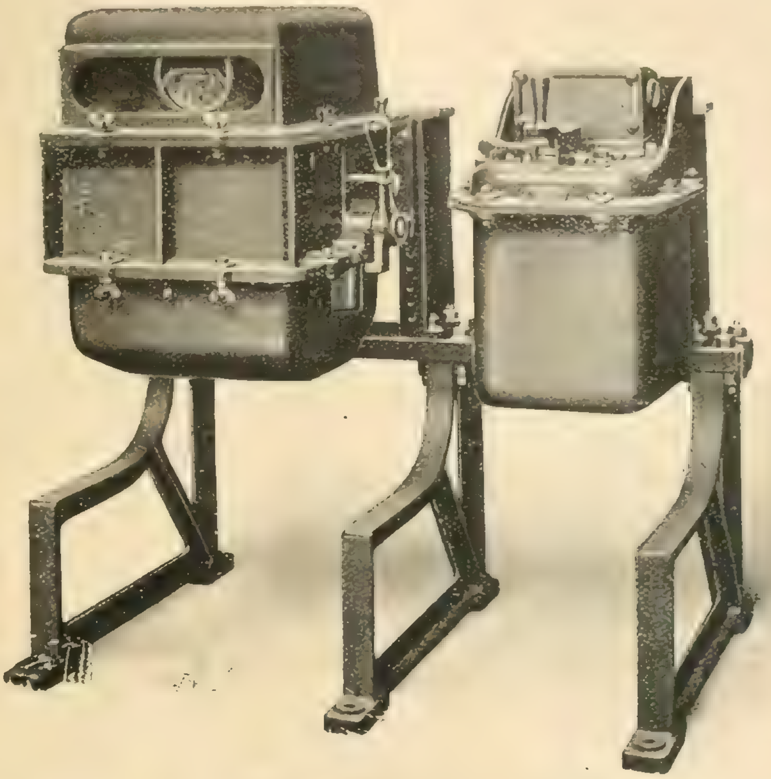


Fig. 7.—IRON CLAD MOTOR PANEL FOR A.C. CIRCUITS.

A HEAVY DUTY STARTER.

Turning to the heavier productions of the Company, Fig. 4 shows a heavy-duty direct-current inching starter, the main part of which consists of a plain rheostat lever moving over a series of contacts. This lever carries a copper post at the lower end of which is a plunger making contact with a sector on the slate, but completely insulated from the lever. Superimposed on the main lever and pivoted on the same spindle is a cradle which carries the operating handle. A plunger contact is fitted on the inside of this cradle facing the insulated post on the main lever, the post and plunger being normally kept apart by a small spring. At staring the first movement of the handle brings the plunger into contact with the insulated post, thus allowing the current to flow through the control sector to the coil of the contactor, which thereupon closes automatically and completes the main circuit to the motor. As long as a forward pressure or motion is continued the plunger and post remain in contact and the contactor stays closed. If, however, the handle is released or reversed, the energising current is broken, the contactor flies open and the motor stops. When the handle reaches the end of its travel a circuit is closed which holds it in its full-on position. A further feature of the apparatus is that each contactor opens a circuit before the main lever is moved, so that it is quite impossible to get an arc breaking on the starting segments. Independent no-volt and ove load releases are provided, and these are operative in any running or starting position, so that the starter makes motor operation as fool proof as can be desired.

Fig. 5 shows a type of motor starter for direct-current circuits known as the 1-minute type, the resistance being rated for a starting period of 60 seconds. Slow motion is obtained by a pawl carried on the lever. This pawl moves in a guideway provided with alternate camming and arresting shoulders. This arrangement does not affect the backward movement of the lever.

An example of the automatic motor starters made by the firm is shown in Fig. 6. In this apparatus a master solenoid control switch nergises a number of contactors in succession which, in turn, short-circuit the starting resistance. The first and last contactors of the series are fitted with powerful magnetic blow-outs.

A type of ironclad motor panel made by the firm is shown in Fig. 7, and any desired combination of switches, starters, fuses, instruments, &c., can be built up to form a self-contained motor control unit or switchboard to comply with the latest factory and mining regulations.

The late Mr. THEO. N. VAIL, president of the American Telegraph & Telephone Company and of several other telephone and electrical organisations, who died on April 16 last, left estate in the United Kingdom of the gross value of £46,456, with net personalty £36,096. The total value of the property will exceed £1,000,000. He made generous bequests to Dartmouth College, Princetown University, Harvard University, the Massachusetts Institute of Technology and other institutions.

Correspondence.

TELEGRAPH RELAYS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : In your issue of January 21st. a description is given of the so-called "Carpenter" relay, as used in connection with Creed receivers. I would like to point out that the title used is open to question in view of the fact that, some time ago, I invented a relay identical with that described, both as regards its magnetic circuits and the position of the exciting coil.

To overcome certain constructional and maintenance difficulties, I subsequently developed this relay beyond the parent type as exemplified in the relay described in your article, but still retain a magnetic circuit operating on the same lines, which relay, in its final form, is being put on the market under the name of the "A.T.M. High Speed Relay," this name being chosen, as, owing to its small inductance and light moving parts, it is particularly suitable for high speed circuits where its low current requirements and short transit time make it especially valuable.

Suitably wound, this relay will work reliably with less than 1 microampere, and with its usual winding will work reliably with 2·5 milliamperes at over 400 words per minute.

It would be interesting to know why Messrs. Creed found it necessary to use an ordinary P.O. relay in cascade with their new relay, as I have found that both the transit time and the contact pressure on my new type have been greatly superior to the P.O. standard B relay.—I am, &c.,

Liverpool, Jan. 31st. S. R. Smith.

HEATING OF BURIED CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : On page 130 of your issue of January 28th, I am made to say that it seems desirable to proceed slowly with the use of 33,000-volt three-core cables. This is so much at variance with my views and with what I did actually say, that I trust you will allow me this opportunity of saying that I have every confidence in paper-insulated cables for this pressure as a thoroughly sound engineering proposition.

What I did say was as follows, and I would ask you to give equal publicity to it :—

> Mr. Woodhouse gives a word of warning about the danger of going beyond 33,000 volts with underground cables at present, because experience, even of that pressure, is limited. Possibly a word of caution on that question is needed, in view of the discussion which has taken place regarding that question of cable pressures. The position seems to me to be this, that there is something like 15 years' very satisfactory experience of 20,000-volt cables, and entirely satisfactory experience of 20,000-volt joints for about eight years. The total operating experience of the world with 33,000 volts is, I believe, limited to some 50 miles of cable, but I am confident that three-core cables for that pressure are a sound engineering proposition. It seems to me rather unwise and opposed to British conservative methods to talk of changing everything from 33,000 to 66,000 volts without having a great deal more experience, and that can only come from extended knowledge of the behaviour of compound dielectrics under continued stress over a period of years under operating conditions.

I am, &c.,

Prescot, Feb. 2. B. Welbourn.

THE ELECTRICAL ENGINEERS' BALL.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : It is to be hoped that if another dance is arranged by the Electrical Engineers the Committee will see it is conducted on somewhat quieter lines. The behaviour at supper last Friday night left a great deal to be desired, and the writer would certainly not risk taking a party again if they are to be subjected to the noisy demonstrations that went on in the Oak Room.

The writer hopes that the Committee will take steps to see that such conduct is not repeated, otherwise he is afraid they will find they will lose the support of a good many people.—I am, &c., "Disgusted."

Electric Lighting of Woodworks.

Good artificial lighting is necessary in any workshop or factory, and especially so in places such as saw-mills which employ fast-moving, and potentially dangerous machinery. In a wood-working plant it is not possible to provide absolute mechanical safeguards ; and it is, therefore, all the more important that the artificial illumination should give no excuse for those errors of hand or eye which lead to spoilage and personal injury. Adequacy, comparative uniformity and absence of glare are essential qualities in any scheme of industrial lighting.

These characteristics are abundantly evident in the lighting system recently installed in the Bute Saw Mills, Luton. It was decided that 6 ft.-candles represented a desirable standard of average intensity: and the installation was planned to secure this result. The accuracy with which such values may be predetermined by the use of scientific methods is well demonstrated by the fact that subsequent tests showed an average illumination intensity precisely equal to the value planned. Incidentally, it may be said that, on account of the light-coloured walls and ceiling and wood work, coupled with the high efficiency of the Mazdalux reflectors and Mazda gasfilled lamps, it was possible to achieve this relatively high intensity at the low energy expenditure of about 0.7 watts per square foot.

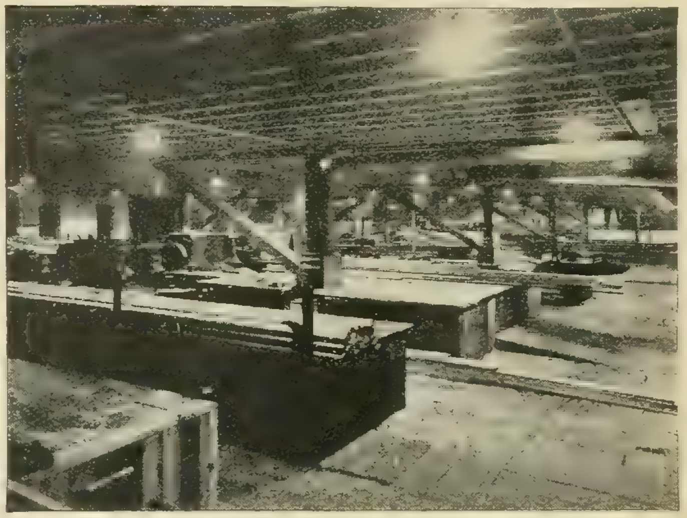


Fig. 1.—Lighting of Shop at Woodworks.

In the main shop, where many circular saws, band saws and planing machines are in operation, the lighting equipment consists of fifty-eight intensive Mazdalux reflectors, and a similar number of 100-watt Mazda gasfilled lamps. This shop measures 125 ft. by 66 ft., and the lighting units are spaced uniformly over this area. The ceiling is 10 ft. high, and the reflectors are fixed between the beams in such a manner that the mouths of the former are level with lower surface of the latter. This not only permits of the reflectors being mounted at the proper height, but has the further advantage of preserving the units, to some extent, from the mechanical damage to which they would otherwise be

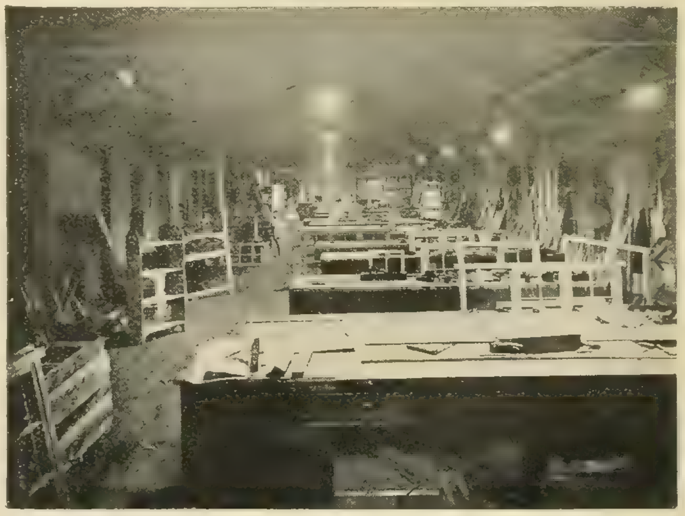


Fig. 2. Another View of the Same Works.

especially liable in a place where long planks and beams, &c., have to be manœuvred. There is a rectangular opening down the middle of the ceiling in the main shop. The first floor is, in effect, a balcony to the ground floor. A somewhat unusual, although essentially reasonable, arrangement has been adopted in the placing of the light units over this opening. As a rule in such cases the units would be suspended at the same height as those on the balcony or upper floor. Of course, it is easier to do this, but from the lighting point of view such a procedure is illogical, since the area which needs to be illuminated is at the bottom of the well. At the Bute Saw Mills, the lights in the opening are fixed on a level with the ground floor ceiling, with the result that the illumination in the middle of the main shop is equal to that at the sides.

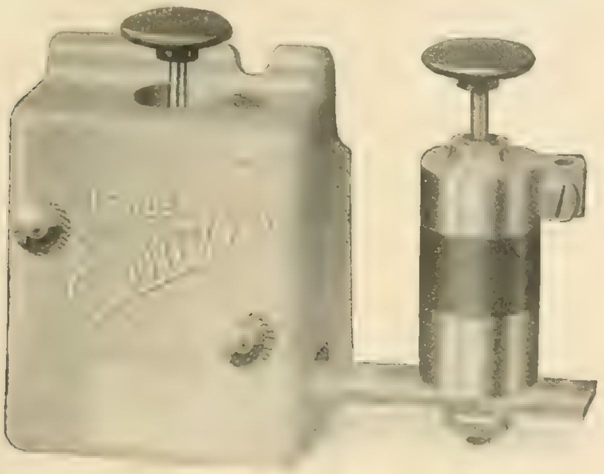
In the carpenters' shop, which measures 141 ft. by 26 ft. 6 in., there are 24 intensive Mazdalux reflectors and Mazda gasfilled lamps. The same illumination intensity was aimed at here as in the main shop, and this degree of illumination was secured with an even lower expenditure of energy, only 0.65 watts per square foot being required.

The illustrations, which are reproduced from untouched photographs taken entirely by the light of the Mazdalux units, indicate an unusually high standard of artificial illumination. Not only is the lighting amply sufficient for the most delicate and minute operations, but it is also free from glare and harsh shadows. The Mazdalux reflectors are deep and completely conceal the lamps from normal view. As a matter of fact they can only be seen by looking vertically upwards at them.

It is impossible to make any sort of comparison between the new lighting and the old at the Bute Saw Mills, because bats' wing gas burners were used before and until the Mazdalux units were installed. Needless to say, the change of equipment effected a complete transformation in the lighting, which has already exerted a beneficial influence on the productivity and comfort of the workers. Further particulars of this remarkable installation may be obtained from the illuminating engineers' department of the British Thomson-Houston Company.

"Emcos" Cut-outs.

Messrs. Sagar-Richards, Ltd., of Luddendenfoot, S.O., Yorks, have placed on the market the "Emcos" (Electrical Mercurial Cut-Out Series) Cut-Outs, and they have issued a booklet giving particulars of their design and construction. The "Emcos" Series include cut-outs of the small service type, ranging from 2 to 10 amperes, medium and large capacity cut-outs designed to replace "fuses" and circuit breakers, distribution boards in both wood and iron cases, combination switch and cut-outs, circuit breakers in either single, double, or triple pole types and iron-clad, air-break or oil-immersed; also current limiters, and all types of switchgear combining perfect and reliable cut-out features.


Two Emcos Units.

The small service type consists of an inner core having a chamber containing a mercury conductor, and owing to the peculiar construction of this chamber the break in the circuit takes place on "overload" or "short circuit" in a predetermined restricted area, thus ensuring that the severing of the column of mercury occurs under a head of mercury, in a really air-tight chamber, without flash, noise or the emission of molten metal. The displaced mercury is caught in a special chamber in the inner core, again returning to complete the column on depressing a vulcanite button, which is the only projecting part in the complete unit. This inner core is contained in an outer case, and is usually mounted between two porcelain blocks, which form an insulating container, and affords complete electrical protection to the user, at the same time rendering it impossible for any unauthorised person to tamper with the cut-out proper. The column cannot be re-established if the "over-load" or "short" still exists in the circuit.

Among the claims made are: perfect and reliable operation without flash or noise; instantaneous replacement by simply depressing a button in the small service type, and a "snap out" and "push in" movement in the larger types, without danger of shock or burns; no further expense of cartridges or wire and the attendant worry of keeping up stocks of these unnecessary parts; the overfusing of a circuit is entirely prevented; the mercury conductor will not oxidise or age; it is absolutely fool- and fire-proof; there is no porcelain fuse carrier to break under a severe strain; and the overstraining of plant and accessories is entirely prevented. The Company are sole licencees for Great Britain and Ireland and the Isle of Man for all the "Emcos" Series. The illustration shows two "Emcos" units, one with porcelain completely removed.

E.H.T. Distribution.

Mr. R. O. Kapp's Paper on "E.H.T. Distribution," an abstract of which appeared in The Electrician of December 3, 1920, was discussed in Birmingham on January 12. We give an account of the proceedings below.

Major A. M. Taylor questioned the author's diagram, which showed that at a distance of five miles from the generating station the cost of a 6,000 volt system would be the same as that of a 33,000-volt system, and in this connection he proceeded to give particulars of a case which had been worked out in Birmingham. A sub station with a present demand of 6,000 k.v.a. was fed by three 0·15 sq. in. trunk feeders working at 1,500 amperes per square inch. It was desired to double the voltage on these trunks on account of voltage drop. The question to be considered was as to whether it was best to put in three additional cables, or to introduce step-up and step-down transformers and transmit the whole 12,000 kw. over the three existing mains. The result of the investigation was that on a 2 mile transmission there would be an annual loss of £0·16 per kilovoltampere, on a 3 mile transmission a gain of £0·16 per kilovoltampere, and on a 5-mile transmission a gain of £0·80 per kilovoltampere. Some mains were as long as this latter, and in such a case the gain per annum would be about £30,000 on the total quantity of power which it was contemplated to transmit.

Mr. W. Brew said the problems discussed in the Paper were not confined merely to electrical questions, but included the laws of probability and sometimes the human element. Useful guiding principles had, however been demonstrated by the author. Some of the author's diagrams appeared to assume that the total cost of cable per unit of length was proportional to the sectional area of the copper. This assumption would only be approximately correct in the case of the largest cables, and took no account of the cost of trenching and reinstatement. When it was remembered that for medium and small extra-high-tension cables laid singly the cost of trenching and reinstatement approached a figure nearly double that of the cable itself, it would be evident that the form of the diagrams referred to would require to be modified.

Mr. W. E. Groves observed that it was not possible to foresee the conditions that would arise during the development of a large supply scheme, and unfortunately networks had to be planned a long time before the anticipated demand was realised. In the interval unexpected loads might turn up, and it was necessary, therefore, to adopt a step-by-step policy of planning. At the same time, the design had to be based with some ultimate layout in view, and the present Paper was therefore of great interest, though limited in its application. The speaker agreed with the author's comments on the reliability of cables, and also that heavy outlays on pilot-protection systems for distribution networks on a large scale was difficult to justify.

Mr. W. Wilson mentioned that his own experience in extra-high-tension transmission had been solely with overhead systems. In these there was a well-defined relation between length of transmission and voltage, resulting in the rate of about 1,000 volts per mile.

Health and Housing in South Wales.

Electricity was well to the fore at the South Wales Health & Housing exhibition which took place at Cardiff between January 26 and February 5. In spite of the fact that such an exhibition is somewhat of a rarity in South Wales, it was well patronised and is no doubt likely to be repeated. Electrical firms anxious to push domestic and other apparatus might therefore note and act accordingly.

Among the prominent electrical exhibits present was the stand of the Western Electric Company, Ltd., who showed their well-known washing machines, vacuum cleaners, electric irons and other domestic appliances. Domestic electrical apparatus of various sorts was also to be found on the stand of Messrs. Friend, Wintle & Company. These included a "Trieity" apparatus, demonstrated daily by a lady expert, Plexsim irons and modern electric lighting apparatus. Scholey and Company showed their fractional h.p. motors and suction cleaners, while the Electrical Appliances Company also gave a successful demonstration of their Eureka vacuum cleaner.

The Electrical Wholesalers' Federation.

At the lunch which took place at the Hotel Russell, London, on February 2, in connection with the annual meeting of the Electrical Wholesalers' Federation, Mr. J. Albrecht, proposing the toast of "Kindred Associations," said that this was the first occasion on which visitors had been present. The Association had been formed in 1914 to safeguard the interests of wholesalers. Its rules only allowed the admission of genuine wholesalers of financial and social stability, and this restriction should help to make the Federation a really living force. It was obvious that any problem which affected one section of the electrical trade must eventually affect the whole trade, so that a spirit of co-operation and good fellowship was a first step towards a satisfactory solution. In the past there had been many amalgamations tending to closer control, and cheaper production, but few tending to cheaper distribution. Many knotty points with regard to this and other problems, such as discounts, would have to be discussed by those concerned, but the endeavours of the Association would be towards assisting trade generally.

Mr. Llewelyn B. Atkinson, in reply, said that the Institution of Electrical Engineers, had developed from being merely a scientific body into an organisation which fulfilled the needs of the whole industry. British industry had been saved from collapse by associations, and the further development of the association spirit was therefore for the good of the electrical industry generally.

Mr. J. E. Edgcombe, who also replied to the toast, said that the reduction in the price of incandescent lamps would mean a great increase in business. The interests of the Electric Lamp Manufacturers' Association and the Electrical Wholesalers' Federation in this matter were identical, and a joint discussion of matters outstanding between them could only result in a satisfactory compromise.

Mr. F. Collinson also endorsed the expressions in favour of greater co-operation which had been made. There was a real necessity for the Electrical Wholesalers' Federation, and for the Electrical Contractors' Association to get together. As far as the Electrical Contractors' Association was concerned, they were ready to be wooed, and it was up to the Federation to woo them. The great reduction in the price of rubber, cotton, copper and other raw materials which had recently been made, suggested that the time was ripe for passing on the benefits of these reductions to the buyer. If the price of material could be lowered and wages reduced there were great possibilities of trade stimulation.

At the conclusion of the meeting a cheque for 100 guineas was presented to Mr. A. G. Beaver as a recognition of his services to the Association in capacity of secretary.

Scottish Motor Exhibition.

The 19th annual Scottish Motor Exhibition, promoted by the Scottish Motor Trade Association, was opened at the Kelvin Hall, Glasgow, on the 25th ult., by the Marquess of Linlithgow. Large numbers of visitors are being attracted to the show and the general opinion in the trade is that the Exhibition has been more successful than was anticipated.

The Exhibition is divided into three sections, viz., (1) private cars, (2) commercial vehicles, and (3) accessories, tyres and components, &c. It is to be regretted, however, that electrically propelled battery vehicles were not more in evidence among the 137 different types of cars shown. The present high cost of petrol provides a unique opportunity to the enterprising manufacturer of electrics to develop his business, and there is a great future in Scottish cities for vehicles of this type. As an indication of the hold which electrics have obtained in Glasgow, it may be mentioned that the Electricity Department is making arrangements to provide, at different points in the city, garaging accommodation and charging facilities for such machines. In the section devoted to private cars it is interesting to note that most models are fitted with electric starting devices and lighting equipments of one or other of the various makes now on the market, and in one at least of the more luxuriously fitted cars an electric cigar-lighter is to be seen.

An example of the electric-battery vehicle is to be seen in the commercial vehicle section. It is a $2\frac{1}{2}$-ton "Garret," with platform body and equipped with iron Exide battery, capable of running 30 miles on one charge. The Tilling-Stevens petrol-electric machines are well represented, this firm exhibiting four typical examples of their products, comprising: (1) A single-deck saloon omnibus; (2) a fire engine with dismountable pump; (3) a 3/4-ton commercial chassis (internal instead of external dynamo and motor cooling fans have been introduced in this model, which allows commutator end-covers to be removed without interfering with the fan); and (4) a $2\frac{1}{2}$-ton gear-driven chassis. A "C.A.V." self-starter, in conjunction with "C.A.V." electric lighting, has been fitted to the engine, which is also provided with a mechanical governor.

In the accessories section there is a varied range of electric-lighting and starting equipments for cars, including dynamos, starters, batteries, lamps, switchboards, &c., exhibited by several of the firms dealing in these lines. Motor-car manufacturers seem in the past to have looked upon electric lighting and other devices as something which was quite unimportant and could be fitted at the last moment after all the mechanical details of the car were completed, and this would seem to be responsible for some of the trouble for which the electrical devices have been blamed. Manufacturers, however, are now more inclined to modify their chassis, and seem to have grasped the importance of the electrical equipments.

Legal Intelligence.

Re Electrical Industries Ltd.

In the Companies' Winding-up Court recently Mr. Justice Astbury made an order for the compulsory winding up of Electrical Industries, Ltd., electrical engineers, on the petition of R. Johnston & Company, creditors for £375.

Lee & Berlin v. E. Levy

At Shoreditch (London) County Court last week, his Honour Judge Cluer non-suited plaintiffs, who sought to recover £19 7s. 6d. for electrical fitting work done on defendant's premises, as the action was premature.

After plaintiffs' case had closed,

Mr. Fordham, consumers' engineer, and improver in the electricity department of Shoreditch Borough Council, said that when he saw the work in June he gave no order for connecting, as the testing was below the standard, and the tubing was unsatisfactory. Again, in September the work was too bad for him to connect provisionally, but he understood it was to be put right as soon as possible. He had never met plaintiff there. He had not certified the installation fit for use, as the work was still unsatisfactory.

Dispute over Electric Cooking Set.

At Marylebone County Court last week, before Judge Sir Walworth H. Roberts, Messrs. Watson, Marsh & Company, electrical engineers, sued Victor Cope for £17 11s., work done and materials supplied in connection with alterations to an electric cooking set. There was a counter-claim for the return of £15, money paid on the purchase of the set.

The evidence showed that plaintiffs had organised a demonstration of the cooking sets at their premises and defendant was one of the purchasers. After a time defendant complained that the stove would not cook quickly enough, and plaintiffs undertook to have some work carried out which would improve it. The set consisted of an oven, boiling plate and grill: the price paid was £25, and defendant's contention was that the £17 10s. sued for was included in the £25 originally paid for the articles.

Evidence was given for the defence, but the Judge held that the repairs to the set were not included in the £25 which was given for it, and gave judgment for plaintiffs on the claim and counter-claim, with costs.

Re Bristol Tramways.

In the King's Bench Division on Friday Mr. Justice Sankey had before him a special case stated on an arbitrator's award in a dispute between the Bristol Tramways & Carriage Company and the Bristol Corporation. The question was what amount of compensation should be paid by the Corporation to the company for certain tramway buildings on land in the parish of St. Michaels, Bristol, lately taken over by the Corporation.

Mr. Jeeves, K.C., for the tramways company, said the question was, what was the basis of value of certain buildings erected on land leased to the company by the Corporation, to be paid by the Corporation to the company under the provisions of the lease. The lease was dated July, 1875, and was for 21 years. The period expired in 1896 and the tenancy was continued till 1918, when the Corporation gave notice to terminate it. The question was what was the meaning of a covenant in the lease by the Corporation that at the expiration of the term of occupation the Corporation should pay to the lessees "the then value" for all buildings which should have been erected on the land by the lessees with the approval of the lessors. Before the arbitrator the tramway company contended that the proper value of the buildings was the cost of their construction less depreciation. The Corporation contended that the value should be what anyone would pay for them in the open market. The arbitrator found that if the company's contention was right the amount should be £6,499, and if the Corporation were right, £4,000. Counsel contended that the "then value" must be the cost of construction of the buildings less depreciation, and therefore the company were entitled to £6,499.

After hearing Mr. Inskip, K.C., for the Corporation, who contended that the market value was the true value, Mr. Justice Sankey, in giving judgment, said he did not agree with Mr. Jeeves that the matter came under sec. 43 of the Tramways Act, and he did not take the view that the lease was a lease of a tramway undertaking. The way to assess the value was contended for by the Corporation. Therefore, he must answer the question contained in the award in the sense that the Corporation must pay £4,000.

Commercial Topics.

Index of Foreign Trade Catalogue.

The Department of Overseas Trade, 35, Old Queen-street, S.W. 1, has recently published an index of the foreign trade catalogues available in the department. The collection contains 15,000 trade catalogues of German, Austrian, American, Italian, Belgium, Canadian, Swiss, Danish, French, Japanese, Dutch, Polish, Swedish, Norwegian, Portuguese, Spanish and Finnish firms. There appear to be many catalogues and price lists relating to various branches of the electrical industry, and an examination of them may be useful in order to see what competitors are doing, and to keep in touch with the requirements of overseas markets. The catalogues may be examined by British manufacturers in the library of the Foreign Samples Section, at 7-11, Old Bailey, E.C. 4.

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Supply Companies' Dividends.

The Westminster Electric Supply Corporation and the St. James' & Pall Mall Electric Light Company are usually the first of the supply companies to declare their dividends for the past year. In view of the high price of fuel and of the increases in salaries and wages the results must be looked upon as very satisfactory, for both have maintained the previous year's dividend, the Westminster at 10 and the St. James's Company at 12 per cent. for the year 1920.

Gratifying progress is also reported by the Yorkshire Electric Power Company, which reports an increase in the net profit of £10,606. The dividend on the ordinary shares is maintained at 8 per cent., and after again placing £15,000 to general reserve, the amount carried forward is increased by £3,343, to £20,939. The company reports that to some extent the higher costs of coal, materials and wages were met by economies arising from the increased output. Extensions of the company's generating stations, including a new 12,000 kw. turbo-alternator, are in progress and further economies are anticipated during the current year as well as a substantial increase of revenue from the large number of new power connections which have been and still are being made.

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Foreign Tramway Rails.

During the past few months several municipal contracts for the supply of steel tramway rails have been given to foreign firms, the latest instance being the Warrington Corporation, which has accepted the tender of the Anglo-Belgian Steel Company for the supply of 200 tons of rails at £4,000. The explanation given is that the accepted tender is lower by £400 than the lowest British tender and there is also a guarantee of immediate delivery. British firms, it is said, "could not give delivery at any stated time, while they would not supply the sections which were necessary to comply with the rails and points of the tramway system."

If the Warrington case were an isolated one we should not be alarmed, but it is only one of several similar instances during the past year. Yet we learn that Sheffield's army of unemployed is growing, the total being now over 14,000. In addition, some thousands are working short time. Rolling mills are engaged only two days a week, and, owing to Continental competition and the undercutting of prices, steel production is restricted to less than one-fifth of the normal output. All this seems to indicate that there is something very radically wrong with the industry and we hope that both masters and men will carefully investigate the cause.

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Increasing British Trade with China.

An important new means of developing trade and industry with China has been provided by the Chinese Government, who have granted a charter to two prominent Englishmen in the Far East. The petition for the charter was ably supported by the Commercial Secretary to the British Legation in Peking, Mr. C. A. W. Rose, C.I.E. This is said to be the first time in history that British interests have been able to secure a charter from the Chinese Government, having such unique privileges.

In granting this Charter, the Chinese Government issues a mandate giving authority to the petitioners to form a corporation, having half Chinese and half British capital, and operating under its own articles of association and bye-laws. Copies of these will be filed in the British Legation at Peking and the Chinese Ministry of Trade and Commerce.

Hitherto the most serious drawback to the expansion of trade and industry in China has been the inability of foreigners to own land and property outside the Treaty ports, and the Chinese are now becoming alive to the fact that such restrictions are serious obstacles to the advancement of their country. The new Chartered Corporation, which is now in process of formation, hopes to be ready for business at about the time that the recently instituted new four-power loan Consortium will be in working order. It is understood that the railway requirements of China will be one of the first considerations of the new Consortium, but in addition to railways there are many other enterprises, chiefly industrial, which, with the assistance of its powerful Chinese associates, the new corporation will be in a position to develop.

One of the principal features of the new corporation will be equal opportunities for all representative Chinese and British manufacturing and trading concerns, either in the direction of obtaining from the corporation technical and financial assistance for setting up works and factories of all kinds in China or as to the best means of disposing of British home-made products in the markets of China. It is not intended to call for subscriptions from the public at present, but all British manufacturers interested in the Chinese trade will have the opportunity of subscribing for founders' shares, with which capital the business of the corporation will be commenced. The formation of the corporation has been largely due to the efforts of Major Nathan (of the Kallan Mining Administration) and Mr. H. E. Metcalf, of Messrs. Babcock & Wilcox.

Electricity Supply.

MAIDSTONE Corporation has received sanction to a loan of £4,000 for house services.

FAVERSHAM Corporation has applied for a loan of £17,000 for additional generating plant.

LINCOLN City Council has applied for sanction to a loan of £62,745 for electricity supply purposes.

The LYME REGIS Town Council recently decided to acquire the local electric supply undertaking for £4,250.

The Electricity Commissioners have been asked to sanction the borrowing of £10,000 to cover the estimated additional cost of extensions at the DERBY electricity station.

DOVER Corporation cannot give a supply of electricity in bulk to the Deal Gas & Electricity Company owing to the high cost of cables and transformers.

WEST BROMWICH Corporation find it necessary to install additional generating plant at a cost of £67,000 and sanction to borrow this sum has been applied for.

The salary of Mr. J. W. BARNES, commercial assistant in the Sheffield electric supply department, has been increased from £600 to £700 per annum.

HEREFORD Corporation has received sanction to an advance of £19,857 for extending the supply of electricity in the Leominster, Weobley and Kingston area at 6½ per cent. interest.

On Thursday last Councillor Barnes, chairman of FARNWORTH (Lancs) Electricity Committee, started a new rotary converter, which was supplied by the Metropolitan-Vickers Electrical Company.

HUDDERSFIELD Corporation intend to apply to the Electricity Commissioners for a Special Order to extend the area of supply to the urban districts of Kirkheaton, Lepton, Kirkburton, Meltham, Slaithwaite, &c.

WATFORD Urban Council has agreed to acquire from the CHESHAM Electric Light & Power Company their powers of supply in the parish of King's Langley.

CASSOP Parish Council has accepted the offer of Bell Bros., Ltd., of Bowburn Colliery, for erecting poles and electric lamps for public lighting and to supply current at £5 per lamp per annum.

WALTON-ON-NAZE Urban Council has entered into a provisional contract for the purchase of the local electric light undertaking, at £5,500, subject to the sanction to borrow the money. Application has been made to the Electricity Commissioners to borrow this sum.

No fewer than 38 petitions have been lodged against the GRAMPIAN ELECTRIC SUPPLY PROVISIONAL ORDER. Though the majority of the objections are for obtaining protective clauses, it is probable that the measure will have to go forward as a Bill.

A special meeting of HULL CITY Council is to be held to authorise application to the Electricity Commissioners for a Special Order to enable a supply of electricity to be given to Anlaby, North Ferriby, Melton, Welton, Swanland, &c.

An electric supply scheme has just been successfully carried out in BALLYMONEY (Co. Antrim). Some time ago the local gas company decided to form another company with a capital of £10,000, the greater part of which was subscribed by local people. The power station is at Easter Meadow.

BLACKBURN Corporation has applied to the Electricity Commissioners for sanction to extend the new generating station at Whitebirk and for provision of a second generator and auxiliary plant, &c. There is difficulty in maintaining the pressure of electricity, owing to the overloading of the old generating station.

Owing to the increasing rates, many of the omnibus Bills of the forthcoming session of Parliament have been modified at meetings of the electors or rejected on a poll. For instance, the LEYTON BILL, which authorised street widenings at an estimated cost of £75,000 and conferred further powers in connection with electricity supply, &c., was rejected by a large majority. A similar fate has overtaken the Bexhill Bill, which contained electric supply clauses.

The decision of the WREXHAM Corporation to accept the scale of salaries recommended by the National Joint Board for the electrical staff has caused Ald. E. Hughes, chairman of the Electricity Committee, to resign. He said it meant an additional burden to the ratepayers of £700 a year and they could not afford it. The Mayor pointed out that the Council had protested against the award and asked for a revision. All they could do now was to pay or fight.

Some discussion has arisen on the proposal of the GLASGOW Tramways Committee to put down a 10,000 kw. turbo-generator at the Pinkston power station. It is contended that the proposal is contrary to the general policy of co-ordination being pursued throughout the country, and the Corporation will be asked to set up a Joint Committee of the Tramways and Electricity Committees to consider the matter on a broad basis with a view to obtaining the best results for the city as a whole.

We are pleased to notice that the Electricity Commissioners are not going to countenance the erection of PRIVATE GENERATING STATIONS, except in very special cases. In reply to a recent application by the Colwick Estates, Ltd., for permission to erect a power station, the Commissioners advised the company to negotiate with Nottingham Corporation for a supply of current, as the Corporation were making arrangements to erect a temporary station on the Clifton site. The Nottingham Electricity Committee is satisfied that there will be required plant of a capacity of at least 2,000 kw. to deal with the demads of the next two or three years, and after consultations with Mr. J. H. Rider and Mr. H. Talbot, it suggests that temporary plant be put down on the Clifton site, so as to tide over the period between now and the completion of the permanent station. On Monday the Council approved the proposals and authorised the committee to accept tenders and make all necessary arrangements for equipping the temporary station.

The Birmingham Chamber of Commerce gave consideration at a meeting last week to the suggestion recently made by Councillor Beale, chairman of the Corporation Electric Supply Committee, that in view of the financial stringency local manufacturers should undertake the responsibility for the proposed extensions by lending money to the Corporation at 6 per cent. Mr. Beale explained that if the committee could see their way to securing enough money the Corporation would be urged to start at once on a new scheme. For the tramways and for shop and street lighting, &c., only 25 per cent. of the total generated was required, the balance going direct to the factories. The committee had waiting on their books people who asked between them for about 45,000 h.p.

After discussion the question was referred to the general purposes Committee of the Chamber. At the City Council meeting last week the recommendation of the committee to carry out certain additional work at Nechells station was adopted.

The award of the arbitrator in the dispute between Torquay Corporation and the local tramways company has been issued. 'At present the company pays 1⅝d. per unit, but in consequence of the greatly increased price of coal. &c., the Council asked for 3⅛d., and the award allows 2⅜d. up to half a million units, and after that 2½d. per unit. The award is based in the price of coal at 55s. per ton, and in the event of a fall in price there is to be a revision of the charge. The award is retrospective to April last.

The capital account of the electricity department has been overdrawn by £11,964, and the revenue account by £11,060. The maximum output of the generating station had now reached 1,120 kw., leaving only 80 kw. for reserve, against the maximum safe output of 1,200. Consequently no new consumers are to be taken on after Lady-day next with the exception of power consumers, until arrangements can be made to increase the supply. The electrical engineer (Mr. Woods) having reported the result of an interview with the Newton Abbot Electric Supply Company as to erecting a new power station at Newton for the supply of electricity in the area, the Council decided to ask the company and Newton Abbot Urban Council to form, with the Corporation, a joint electricity authority in the district.

Electric Traction.

Birmingham Tramways Committee are experimenting with the service of railless trolley cars on one route, the permanent way of which is in bad condition.

A revised scale of fares has been introduced on the tramways of the Bristol Tramways & Carriage Company. Practically all stages have been increased, and the minimum fare is 2d.

Liverpoool Corporation has authorised the construction of a special tramway track along the Prince's-road. The rails will be laid on a special sleeper track.

As a result of the fusion of the managerial control of the L. & N.W. and the Lancashire and Yorkshire railways, it is anticipated that there will be an extension of the electric services in Liverpool. Apart from the Aintree scheme and the proposed Seaforth and Sefton junction railway, other local extensions are under consideration, together with probable electrical extensions on both sides of the Mersey.

There is a tramway strike in Cork and the supply of electric power is also affected, as the employees at the generating station are out in sympathy with the men. Industries are seriously affected, but at the Ford Works the management is utilising the tractors for power purposes in the machinery, foundry and other departments. A number of Fordson tractors have also been supplied to other firms to enable them to keep their business in progress.

Col. J. W. Pringle's report to the Ministry of Transport on an accident which occurred on the Baker-street & Waterloo Electric Railway on No. 7 last has been issued. About mid-way between Piccadilly-circus and Oxford-circus serious arcing suddenly commenced under the front motor-car, accompanied by heavy fumes and smoke, and the train was brought to a standstill in the tunnel. The passengers and employees suffered considerably from smoke and noxious fumes which filled the tube. The ill effects experienced by some of the employees prevented them taking duty for some days. The motorman stopped the train in a distance of about 30 yds. after the arcing became serious, when he got hold of the case containing the hand telephone apparatus for communicating with the sub-station ; the dense acrid fumes arising from the electrical burning momentarily overpowered him, and he dropped the case. Then he attempted to get hold of the short-circuiting device in the motor compartment behind the cab, but when he opened the connecting door he found the compartment full of heavy smoke, with flames apparently rising above the level of the steel floor, and the heat so great that it was practically impossible to enter the compartment. Eventually, by making a dash through the motor compartment, the motorman escaped to the rear of the train. According to the guards' evidence, the arcing was continuous in character, and was accompanied by a roaring noise, by much smoke and heavy fumes. The passengers were moved to the rear of the train, and subsequently they were detrained and walked back to Piccadilly-circus.

Imperial and Foreign Notes.

Messrs. Lincolne, MacDougall & Demaine are reporting to Cassino (N.S.W.) Council on the question of electricity supply.

The Katoomba Electric Supply Company has disposed of its business and undertaking to a newly registered company entitled the Katoomba Electric Lighting Company, Ltd.

The Victorian Electricity Commissioners have authorised the local electric supply company at Castlemaine to increase its charges to 9d. and 4½d. per unit for lighting and power respectively.

The ratepayers have approved a proposal by Scottsdale (Tasmania) Council to borrow £8,000 for installing hydro-electric plant on the Brid river. The cost is expected to be between £6,000 and £7,000.

The Bamawm (Victoria) Progress Association is negotiating with the Commonwealth Electric Lighting Company with a view to having homesteads in the township and district lit by means of electrical energy from the Rochester power house.

The report of the directors of the Ipswich (Queensland) Electric Supply Company for the year ended June 30 last states that in this, the first year of operations, the profit was £1,320. The authorised capital is £500,000, and £76,322 is subscribed.

Richmond (Victoria) City Council prohibited some time ago the erection of overhead h.t. mains in the municipality, but on appeal to the Minister for Public Works and the Electricity Commissioners, the Councils consent was dispensed with, and permission granted for the erection of the overhead mains.

The Victorian Railway Commissioners are improving the lighting of the railway stations. Nineteen stations in the country and eight in the outer suburban area have been converted to electric lighting during the last year, and also the goods yard at Kerang and the live stock yards at five country stations.

Sandgate (Queensland) Council has under consideration a scheme for taking a supply of electrical energy from the Brisbane Electric Lighting Company. The capital expenditure on the transmission cable and the distribution system is estimated at £9,900, plus 10 per cent. to cover recent increases in cost of materials.

For lighting the public lamps in Richmond (Victoria) the Metropolitan Gas Company required £5 13s. 3d. per lamp per annum after April next, compared with the present price of £3 4s. 7d. The Council has therefore decided to enter into an agreement with the Melbourne Electric Supply Company for lighting the whole of the city electrically for seven years.

It is reported that Dr. Just and others have arranged to erect electric lamp works in Budapest at a cost of 25 million kronen.

According to the "Manchester Guardian" special, the contract for the supply of the plant and material required in connection with the scheme for the electrification of the Pajares incline on the Norte Railway between Gijon and Leon (Spain) has been awarded to the Compagnie Française Thomson-Houston of Paris, in conjunction with the General Electric Company of America.

The commercial and business interests in Holland are agitating for direct telephone communication between the Netherlands and England. The Rotterdam Chamber of Commerce recently urged that arrangements might be made for direct communication between the two countries, but the Netherlands Minister of Commerce has replied that the delay was caused by the action of the British Government, which was using the telephone cable for other purposes. There was no immediate hope of the cable becoming available for telephone purposes.

On the recommendation of the Highways Committee the London County Council has authorised the trial of a limited system of through bookings between the L.C.C. tramways and the London General Omnibus Company's omnibuses. The scheme provides for both the Council and the company to issue through tickets via Victoria at fares of 2d., 3d., 4d. and 5d., based on the addition of 1d. to the tramway fares of 1d., 2d., 3d. and 4d. from Victoria, the company to convey through passengers by any omnibus for a 1½d. stage from Victoria. Through tickets will not be issued in connection either with workmen's fares or the cheap 2d. midday fare. The question of making somewhat similar arrangements for dealing with the traffic to and from other of the inner tramway termini is under discussion.

Personal and Appointments.

The Vulcan Fellowship of the Manchester University has been awarded to Mr. F. D. Reynolds, M.Sc.

Mr. F. H. Page, late of the Crypto Electrical Company, Ltd., has joined Messrs. H. W. Smith & Company (1920), Ltd., as representative in London.

Gillingham Corporation has increased the salary of the electrical engineer (Mr. C. D. Chalmers) to £600 per annum, and that of the assistant engineer to £400 from the same date.

Prof. G. E. Hale, D.Sc., F.R.S., director of the Mount Wilson Solar Observatory, has been awarded the Actonian Prize by the managers of the Royal Institution for his solar physics.

The Secretary for Scotland has nominated Prof. T. Hudson Beare to assist the committee set up to manage the fund constituted under sec. 20 of the Mining Industry Act, 1920, for the improvement of the social well-being of miners, and in particular to advise on matters of education and research.

Miscellaneous.

Our contemporary, "Aeronautics," published last week its first Foreign Edition in French to assist the aeronautical industry of this country in developing its foreign trade.

We regret to record the death, on Jan. 15 last, at Cairo, of Mr. James Cooil Garnham, formerly of Messrs. J. B. Garnham & Sons, metal merchants.

On the 28th ult., the death took place under somewhat tragic circumstances of Sir Ralph Ashton, of the firm of Kilburn, Brown & Company, of London and Calcutta. Deceased was a director of the Indian Electric Supply and Traction Company and other industrial companies.

The Girls' Football Team of the Edison Swan Electric Company played their first away match on the 3rd inst., their opponents being a team of girls from J. Lyons & Company. Although defeated by 5-0, the Ediswan girls were not disgraced, as they played better than the score indicated. Future fixtures include matches with girls teams from the G.E.C., Eley's, &c.

The February issue of the "Faraday House Journal" contains an obituary notice of the late Mr. Francis Ince, one of the pioneers of electricity supply in this country and one of the Governors of Faraday House; a biographical sketch of Mr. C. C. Paterson, President of the Faraday House Old Students' Association; and some interesting notes on personal and technical matters.

In addition to the usual weekly "World Review of Industry, Trade and Commerce," the publisher of the "Manchester Guardian" issued on the 27th ult. an "Annual Review of Trade, Industry Transport and Finance in 1920." The combined price of the two publications is 6d., and they contain much imformation on the subjects indicated by the titles, not only as concerns the Manchester district, but also the United Kingdom, the Colonies, and other countries.

Owing to the increasing cost of Underground Telephone Work, the Post Office authorities have notified Chiswick Urban Council that the arrangement made in 1906 must be modified. According to this when the number of wires on a line reached 32 the line was removed and the wires placed underground. The Council has agreed to a modification, on condition that notice be given to the Council each time wires were put up in excess of 32, but in no circumstances must the total number of wires exceed 40.

A serious accident occurred on the Bradford Corporation Tramways on Thursday last owing to the dense fog. A double deck tramcar jumped the lines and overturned with 52 passengers, of whom 23 were injured. The car was proceeding from Bradford to Thackley and it overturned at 11 p.m. at Five Lane End. The car was travelling about ten miles an hour and the driver was not aware he was approaching the points. Immediately he tried to apply the automatic lever, but the car must have caught the points half-way, for it jumped them, and ran off the metals into the roadway.

The annual social of the employees and wives of Messrs. Robson & Coleman, electrical engineers, Newcastle-upon-Tyne, took place on the 4th inst, when about 150 guests were received and entertained by Mr., Mrs. and Miss Robson. After a whist drive, supper was served, and this was followed by a concert and dance until 1 a.m. Mrs. Robson presented prizes to successful whist players, and Mr. E. L. Wilson was presented with a gold watch by Mr. Robson on having completed 21 years with the firm. He is the third employee on the present staff to have received this token of appreciation. Special trams and a motor char-a banc (for the Whitley Bay staff) were provided to convey the guests to their homes.

The coroner's jury which investigated the cause of death of the 17 victims of the recent Welsh railway disaster returned a verdict on the 3rd inst. that the deceased persons died from injuries as a result of the collision between two trains; that the cause of the collision was the issuing of a wrong tablet to the down train; that Acting Station-master Lewis and Signalman Jones were guilty of great neglect, and that Porter Rogers and Clerk Thompson were guilty of negligence and excess of duty; that there had been a lack of supervision in carrying out the working of the tablet system. They also recommended the tablets to be worked from the signal-boxes and that all the level crossings should be connected by telephone to stations on both sides.

Bankruptcies.

Claims against Jas. Cruickshank Thomson, lately electrical engineer and contractor, Station-street, Mansfield, are to be sent by Feb. 25 to Mr. E. W. Humphreys, 4, Castle-place, Nottingham.

The Grassington Electric Supply Company, Ltd., is being wound up voluntarily, and Mr. G. J. Harker, Grassington, near Skipton, has been appointed liquidator.

A meeting to receive an account of the winding up of the Leyburn Electric Supply Company, Ltd. (in vol. liq.), will be held on March 14 at the company's office, Leyburn.

A petition for the winding up of the Llanrwst Electricity Supply Company, Ltd., has been presented by Mr. P. Dawe, 11, Banister-road, Southampton, and will be heard in the Carnarvonshire County Court, Blaenau Festiniog, on Feb. 15.

The first meeting of creditors of John Wm. Gladwin, electrical engineer, 81, Burcot-road, and 1a, Meersbrook Park-road, Sheffield, will take place to-day (Feb. 11), and the public examination at the County Court Hall, Bank-street, Sheffield, on March 3.

Institution Notes.

The twenty-sixth annual convention of the Incorporated Municipal Electrical Association will be held at Dundee from June 13 to 17, 1921, both dates inclusive. The Convention headquarters will be at the Queen's Hotel.

A dinner to celebrate the admission of women to membership of the Chemical Society was recently held at the Lyceum Club, under the presidency of Sir William Tilden, who, in replying to the toast of the evening, welcomed the advent of women to the ranks of the Society. Chemists are very much behind electrical engineers in this respect.

The Annual General Meeting of the Institute of Metals will be held at the Institution of Mechanical Engineers, London, on March 9 and 10. The annual dinner will be held at the Trocadero Restaurant on the evening of March 9, and on the afternoon of March 10 a visit will be paid to the National Physical Laboratory.

The Scottish District Committee of the Electrical Trades Union has been notified by the Scottish Contractors' Association that electrical workers' wages will be reduced by 3d. per hour as from Feb. 28. The union has made a counterclaim for a rise of 6d. an hour, and the employers suggest a conference to consider the matter.

As we go to press we receive a communication from the Chairman and Hon. Secretary of the Electric Vehicle Committee on the important question of electric industrial trucks and motor taxes, from which it appears that until the question has been further considered by the Minister of Transport the taking out of licences for electric industrial trucks, which are mainly used on manufacturers' premises and only for short distances on roadways, will not be necessary.

An interesting account of the Sussex ironworks industry, in which its history was traced from prehistoric times down to about 1568, when it was at the height of its success, was given by Mr. Rhys-Jenkins in a Paper which he recently read before the Newcomen Society. It is probable that iron ore was worked in Sussex in Roman times and that the blast furnace was first used in the fifteenth century. French craftsmen were mainly employed, and a large export trade was built up, this, however, being eventually killed by restrictions in a way which is not unknown in more modern times.

A joint meeting of the Faraday Society and the Manchester Literary and Philosophical Society will be held at 36, George-street, Manchester, to-day at 6.30 p.m., to discuss "Measurements of Surface Tension." Two Papers, entitled "Some General Considerations and a Discussion of Methods for the Measurement of Interfacial Tensions" and "On a Modification of the Capillary Tube Method for the Measurement of Surface Tensions," will be read by Dr. Allan Ferguson.

A joint general discussion on "The Failure of Metals Under Internal or Prolonged Stress" will also be held on Wednesday, April 6, by the Faraday Society and the Institution of Mechanical Engineers, the Iron and Steel Institute, and the Institute of Metals. Members wishing to contribute Papers are requested to send them to the Secretary of the Faraday Society before March 1 next. An exhibition will be held in connection with this meeting and members are invited to prepare any specimens which will suitably illustrate the subjects under discussion.

The January issue of the British Engineers' Association "Bulletin" contains an article by Mr. D. A. Bremner entitled "Some New Year Thoughts on the Engineering Industry" in which he points out that the engineering industry is now bearing its share of the universal burden of trouble and anxiety and that it is high time that the strong, sanguine men, of whom there are many in the industry, should have their way to the exclusion of those poor-spirited people who do nothing but croak and vapour. At home and in the empire there are vast possibilities for engineering production, but the future prosperity of the industry and of those engaged in it will depend on our ability to enter into firm contracts to deliver the goods within reasonable time at a price which the consumer is able to pay. In another part of the issue some interesting statistics dealing with the engineering industry and export trade for the years 1913 to 1920 on the basis of the equivalent values for those years are given.

Business Items, &c.

Wm. Smith and Geo. Jubilee Scragg, motor and electrical engineers, Nantwich-road, Crewe, have dissolved partnership. Debts by Mr. Smith.

Messrs. Johnson & Phillips, Ltd., have opened a branch office in Bristol at 1, Nelson-street (telephone, No. 2499), where it is proposed to carry stocks of cables, wires and accessories, as at the company's other branches.

With reference to the recent reduction in prices of Gasfilled and Vacuum Type Lamps, we are informed by the Edison Swan Electric Company that supplies of leaflets, etc., containing the new prices of Royal Ediswan lamps are now available for overprinting with contractors' name and address.

The Kent Bros. Electric Wire Company, formerly the Eastcombe Engineering and Trading Company, manufacturers of Cotton Covered Copper Wires, have appointed the following sole selling representatives: England and Wales:—E. H. Phillips, 172, Wardour-street, London, W.1; Scotland, W. Brown & Company, 200-208a, St. Vincent-street, Glasgow.

Messrs. Sagar-Richards, Ltd., switchgear manufacturers, Woodbottom Works, Luddendenfoot, S.O., Yorks, are the sole United Kingdom licencees for the manufacture of all "Emcos" cut outs (electrical mercurial cut-out series), including cut-outs, distribution boards, current limiters, combination switches and cut-outs, circuit breakers and all types of switchgear. Applications to the Switchgear Department of the firm.

Tenders Invited and Accepted.

Kensington (London) Borough Council require tenders, by February 21, for arc and other lamp globes and arc lamp fittings. Particulars from the Borough Engineer, Town Hall, Kensington, W.8.

The Commissioners of H.M. Works, &c., invite tenders by Feb. 21 for supply of electric bell fittings for six months. Forms of tender from the Controller of Supplies, Charles-street, Westminster, S.W.1.

Southampton Harbour Board require tenders by Feb. 26 for six or 12 months' supply of electrical stores, oils, &c. Forms of tender can be obtained at the Board's offices, Town Quay, Southampton.

Tenders are wanted by March 1 for additional electric fittings for the County Sanatorium, Almeley, Herts. Specification can be seen at the office of the County Surveyor, High Town, Hereford.

Doncaster Corporation require tenders by Feb. 14 for electric light wiring in 100 houses. Forms of tender from Mr. R. E. Ford, 3, Priory-place, Doncaster.

Belfast Tramways Committee want tenders by Feb. 26 for stores, including electrical accessories, copper strip, cable, lamps, insulating tapes, carbon brushes, wire and ears, g.i. wires, &c. Forms of tender from the General Manager.

Pretoria (Transvaal) municipality require tenders by March 10 for one 20 ton overhead crane, six boilers to evaporate 18,000 lb. an hour each at 350 lb. pressure; three 3,000 kw. steam turbo-generators, condensing plants, five 750 kw. converters. Specification from Town Clerk.

The Southend Electric Power Board, of New Zealand, invite tenders for bare copper and galvanised iron wire and jointing sleeves. Specifications from the Chairman of the Board (Mr. A. W. Rodger), 54, Tavistock-square, London, W.C.1, to whom tenders must be sent by Feb. 18.

The Argentine Department of Sanitary Works (Buenos Aires) invite tenders (by March 21) for 11 sets of centrifugal pumps with electric motors and accessories. Firms who propose quoting must have a representative resident in Buenos Aires. Specification will be available at the Department of Overseas Trade by Feb. 20.

Leicester Corporation invite tenders for the manufacture and erection of two 10,000 kw. three-phase turbo generators, and condensing plant, and screens for straining condensing water. Specification from the city electrical engineer, Mr. T. Robert Smith, and tenders by Feb. 19.

The Argentine Department of Sanitary Works (Buenos Aires) invite tenders (by March 21) for two groups of water turbines and generators, including switch-board transformers, &c. Representation by a resident agent is essential, and specifications which will be available at the Department of Overseas Trade by Feb. 20.

The British Consul at Canea (Crete) reports that tenders are invited (by March 20) for the electric lighting of Rethymo. A booklet (in modern Greek) giving conditions of tender, with a summary translation and a plan, can be seen in Room 48, Department of Overseas Trade, 35, Old Queen-street, S.W.1.

The Victorian Railway Commissioners want tenders by March 2 for resistances and condensers (Contract 33,053), and for pumping equipment or oil tank trucks (Contract 33,834), and by March 9 for electric crabs and equipment for cranes (Contract 33,840). Specifications can be seen at the Dept. of Overseas Trade, 35, Old Queen-street, S.W.1.

The Tramways Committee of Manchester Corporation invite tenders for various stores, including permanent way points, tongues and hardened steel centres, welding portions, &c., also motor controller parts, resistances, commutator segments, armature and field coils, &c. Schedules from the general manager, Mr. J. M. McElroy, 55, Piccadilly, Manchester, and tenders to the Chairman of the Committee by Feb. 15.

Tenders are invited up to March 2 for the supply and delivery to the Australian Postmaster-General's Department, State of South Australia, of (a) telephone parts (Schedules 558 and 559); and (b) telegraph and telephone materials (Schedule 560). Forms from High Commissioner for Australia, 406, Australia House, Strand, W.C.2.

The City of Auckland (N.Z.) invite tenders for the supply and erection of one 3,000 kw. and one 5,000 kw. turbo-alternator, rotary converters (1,500 kw. and 500 kw.) switchgear and transformers, also water tube boilers, conveyor pumps, pipework and h.t. and l.t. cables. Specifications, &c., from the consulting engineers, Messrs. Preece, Cardew & Rider, 8, Queen Anne's-gate, S.W. 1, and tenders by noon, February 22, 1921, to Mr. Alex. Wyllie, C/o. Messrs. Preece, Cardew & Rider.

Tenders are invited in connection with the electrification of the Cape Town–Simonstown and Durban–Pietermaritzburg Railways, for the supply of turbo-alternators, boilers, condensing plant, passenger and freight locomotives, motor coaches and underframes, motor bogies, electrical equipment of coaches, sub-station equipment and transformers. Specifications and forms of tender from the High Commissioner for the Union of South Africa, 32, Victoria-street, London, S.W., or the General Manager, Johannesburg. Further technical information can be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, Westminster, S.W.1. Tenders to the High Commissioner by noon May 3.

Plymouth Corporation recently accepted the tender of A. Reyrolle & Company for the supply of h.-t. and e.-h.-t. switchgear at £8,452.

The tender of Messrs. Ramsay, Sharp & Company for the supply of plant for the supply of electricity in Wollongong (N.S.W.) at £8,933 has been accepted.

Last week Halifax Corporation accepted the tender of a London firm for the supply of two marine type boilers, superheaters, stokers, chimneys and fans at the electricity works at £28,340.

The English Electric & Siemens Supplies, Ltd., have secured a contract from the London County Council for 100,000 metal filament electric lamps.

Leeds Corporation has accepted the following tenders:—A. Reyrolle & Company, switchgear, £26,185; W. T. Henley's Telegraph Works Company, cables at £3,385, and the Enfield Ediswan Cable Works at £3,468.

The tender of the English Electric & Siemens Supplies, Ltd., has been accepted by the Director of Army Contracts for the supply of metal filament lamps (vacuum and gasfilled types), covering approximately 100,000 lamps.

Warrington Council has accepted a tender for the supply of steel tram rails from the Anglo-Belgian Improvement Corporation, as it was £400 lower than any other, whilst delivery was guaranteed almost immediately, and British firms could give no guarantee.

Hammersmith (London) Council is recommended by the Electricity Committee to accept the tenders of C. A. Parsons & Company for a 10,000 kw. turbo-alternator (£47,570) and Hick, Hargreaves & Company for a twin-type condensing plant (£15,800). The scheme for extending the generating station adopted by the Council in March last provided for two 8,000 to 10,000 kw. turbo-generators, at a cost of £124,000; and one 10,000 kw. turbo-generator and condensing apparatus were ordered from C. A. Parsons & Company and Hick, Hargreaves & Company respectively at £41,100 (subsequently increased to £42,470) and £14,952. Neither of the firms was prepared to accept an order at the same prices for the second set.

Catalogues, Price Lists, &c.

The City Electrical Company, Emerald-street, London, W.C.1. send us an artistic hanging calendar with monthly tear-off slips.

In order to meet the requests of customers for a Drum Type Reversing Switch suitable for use in connection with squirrel cage motors the Electrical Apparatus Company have now developed a modification of their well-known drum type star-delta starter, and they have issued a leaflet dealing with the new apparatus.

We have received from Messrs. Wood & Cairns, Ltd., 5, 7 and 9, Meuse-lane, Edinburgh, a useful hanging calendar with large monthly sheets, and a feature which especially commends itself to us is that, in addition to the current month, each sheet also shows the preceding and succeeding months.

A booklet recently issued by the British Aluminium Company, 109, Queen Victoria-street, E.C.4, gives illustrated particulars of a few of the more interesting uses of aluminium, and is a good indication of the extent to which the metal is now employed in modern industry. Aluminium is used extensively for overhead conductors, electric cables and tramway feeders, dynamo windings, field coils, meter cases, switch covers, reflectors, fittings, and for a variety of other electrical purposes.

We have received from the British Thomson-Houston Company Ltd., a pamphlet dealing with the design and manufacture of their rotary converters. This pamphlet is very much more than an ordinary catalogue and contains a number of interesting technical details which do a great deal towards bringing our knowledge on the subject of these interesting machines up to date. We shall, therefore, hope to refer to the matter at greater length in a subsequent issue.

The Bell Electrical Company (Northern), Ltd., Market-street, Halifax, have issued a descriptive sheet of the new "Emcos" Cut-Outs in wood (distribution) cases, which are described in another column of this issue. The Bell Company are sole sub-licencees for the manufacture of "Emcos" distribution boards in wood cases and they are on view at Stand No. 1 of the Efficiency Exhibition, Olympia, London, W.

The General Electric Company, Ltd., 67, Queen Victoria-street, London, E.C.4, have issued a list (Leaflet F.2480) giving particulars of a special offer of electric-light fittings and accessories at reduced prices. These reduced rates are only available during February, but they apply to a great variety of electric-light fittings and accessories, including some artistic bowl and pendant fittings for semi-indirect lighting and some vitreous enamelled-steel reflectors and lanterns, &c.

Among other trade literature issued by the Company is a 4-page pamphlet (F.I. 2462), which gives particulars of and prices of Benjamin R.L.M. standard dispersive reflectors designed for use with all sizes of Osram and Osram gasfilled lamps. It is claimed that these reflectors combine the latest scientific principles with the best British workmanship and that they are designed for the most effective distribution of light. Care has been taken to ensure that the lamp filament is shielded from direct view in order to prevent glare, and on account of the substantial construction and high-class workmanship they are suitable for even the hardest service.

Messrs. Dieny & Lucas, 329, High Holborn, London, W.C., notify that they are sole concessionaires for Great Britain, the British Colonies and Protectorates for "Adhex" patent belting. They have issued a catalogue describing this patent belting, which is claimed to be a happy combination of oak-tanned and chrome leathers, possessing, in addition to the usual qualities of the former, the great adhesive properties of the latter. The coefficient of friction is more than double that of the best ordinary leather belting, and in most cases the necessary width of the belt can, therefore, be halved. These, as well as the other advantages of the belting, are set forth in the leaflet.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & CO., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

COMPLETE SPECIFICATIONS.

139,497 PUPIN. Electrically-operated sound-generators. (4,2'18.)
139,521 SIEMENS-SCHUCKERTWERKE. [illegible] (26 6 14.)
140,579 VAVRE. [illegible]
140,799 SIEMENS & CO. Searchlights. (1,8 17.)

The [illegible] surrounded by a carbon tube in such a manner that there is an intermediate space between the carbon tube and the carbon rod.

142,793 AUTOMATIC TELEPHONE MANUFACTURING CO. Telephone systems. ([illegible])
143,194 ZECCHINI & PANZA. Electric foot-rest and foot-warmer. (13,5'19.)
144,264 WESTERN ELECTRIC CO. Telephone systems. (5 6 19.)
145,442 KRUPP AKT-GES. GRUSONWERK. Magnetic separators. (2 8'18.)
149,618 METROPOLITAN-VICKERS ELECTRICAL CO. Electrical discharge-gap apparatus. (15 8 19. Addition to 123,064.)

Consists in combination of an auxiliary spark gap with a selective discharge device, so that the potential of the auxiliary electrode is raised to substantially that of one of the discharge members or higher, when the auxiliary gap breaks down. The auxiliary spark gap is provided with a protecting member so that the electrodes thereof and the space intermediate the electrodes will be protected from the rain, thereby maintaining substantially the same breakdown voltage at all times.

149,619 METROPOLITAN VICKERS ELECTRICAL CO. Electrical discharge-gap apparatus. (15 8 19.)

Comprises an electrical discharge-gap apparatus having two discharge members spaced apart, and an auxiliary electrode in proximity to the discharge members and connected to said members through impedance connections, and also to one of said members through an auxiliary spark gap in series with a condenser.

153,524 IGRANIC ELECTRIC CO. (Cutler Hammer Manufacturing Co.) Electric switches (16 3 20.)
153,532 BRITISH THOMSON-HOUSTON CO. (General Electric Co.) Devices for controlling electric discharges through vapours, and methods of operating said devices. (15/4,15. Divided Application on 5,684 15.)

An alternating current, or other variable current, periodically falling to a potential too low to support an arc is employed to operate a succession of arcs and the starting of the successive arcs, is timed in accordance with the potential of an electrical field, established in the path of the arcs, and varying in accordance with the variations of the current to be amplified.

153,809 HODGES. Electric distributing switches. (17'1/20.)
153,825 WESTERN ELECTRIC CO. (Western Electric Co.) Printing telegraph systems. (28 2 20.)
153,858 ISENTHAL. Variable electric condensers. (28,10 19. Divided Application on 8,628 17.)

APPLICATIONS FOR PATENTS

July 10

20,833 SIGNAL GES. Submarine sound-signalling apparatus. (18 3 16, Germany.)
20,834 SIGNAL GES. Signal-transmitting devices. (25 9/17, Germany.)
20,835 SIGNAL GES. Sound-transmitting installations. (1/10 17, Germany.)
20,836 SIGNAL GES. Electromagnetic sound producers and receivers. (14 8,'18, Germany.)
20,837 SIGNAL GES. Device for adjusting degree of coupling in sound apparatus. (16/8 '18 Germany.)
20,838 SIGNAL GES. Electromagnetic sound apparatus. (1/11/18, Germany.)
20,839 SIGNAL GES. Electromagnetic sound apparatus. (18 11/18, Germany.)
20,840 SIGNAL GES. Devices for assisting navigation. (27 12 18, Germany.)
20,842 SIGNAL GES. Sound-signalling device. (27 4 17, Germany.)
20,845 SIGNAL GES. Electromagnetic sound producers and receivers. (20,1,19, Germany.)
20,846 SIGNAL GES. Signal-transmitting devices. (25/9/17, Germany.)
20,847 SIGNAL GES. Reception of submarine sound signals. (25/1/17, Germany.)
20,848 SIGNAL GES. Submarine sound signalling. (1,10 15, Germany.)
20,849 SIGNAL GES. Submarine sound-transmitter. (3 5,18, Germany.)
20,850 SIGNAL GES. Receiving device for submarine sound signals. (19,5,17, Germany.)

July 12.

20,863 GELL. Telegraph receiving instrument.
20,865 PILKINGTON. Electric furnaces.
20,877 REGNAULD DE BELLESEIZE. Receiving circuits for wireless telegraphy.
20,878 REGNAULD DE BELLESEIZE. Electro-magnetic wave-receiving system.
20,880 BERTHENOD. Electro-magnetic wave-signalling systems. (France.)
20,882 GESELLSCHAFT FUR DRAHTLOSE TELEGRAPHIE. Generator of electric oscillations. (7,8 17, Germany.)
20,883 GESELLSCHAFT FUR DRAHTLOSE TELEGRAPHIE. Electro-magnetic wave-receiving arrangementx. (8,2 16, Germany.)
20,890 BELIN. Secret telegraphic, telautographic, &c., wire, or wireless transmission system.
20,891 LATOUR. Thermionic tube relay arrangements. (France.)
20,892 LATOUR. Electrical systems involving three electrode thermionic tube elements. (16/12'18, France.)
20,893 LATOUR. Thermionic tube elements arrangement. (France.)
20,894 LATOUR. Telegraphic communication systems. (France.)
20,912 WARDMAN. Electric cable attachment.
20,916 SIEMENS BROS. & CO. & CHRISTIAN. Automatic, &c., telephone systems.
20,919 PLANER. Paper insulated wire. (24/7 17, Germany.)
20,920 PLANER. Paper band covering for electric wires. (15 10/17, Germany.)
20,921 PLANER.– Power line for indoor wiring. (13 11'16, Austria.)
20,924 HUTH. Energy translation connection by vacuum tubes. (19'10 18, Germany.)
20,928 LOEWE. Installation for operation of Rontgen tubes. (5/3,19, Germany.)
20,929 HUTH. Arrangement of connections for generating and receiving electrical vibrations. (7/7'17, Sweden.)
20,930 HUTH. Telegraphy, &c. (15,9 15, Germany.)
20,931 HUTH. Method for generating and reinforcing vibrations for wireless telegraphy. (17/7 18, Germany.)
20,932 LOEWE. Appliance for vacuum tubes. (9'7/18, Germany.)
20,933 HUTH. Arrangements for wireless telegraphy from submarines. (8'12,16, Germany.)
20,934 HUTH. Method of connection to produce oscillations with vacuum tubes. (16 7 17) Germany.)
20,935 HUTH. Reception process for electrical vibrations. (5,5 19, Germany.)
20,936 HUTH. Antenna for wireless telegraphy. (14'7'15, Germany.)
20,937 HUTH. Connection for sending and receiving electric waves. (13 10/17, Germany.)
20,938 LOEWE. Device for transmitting high frequency energy to vacuum tubes. (19/10/18, Germany.)
20,947 ALLAY WELDING PROCESSES, LTD., & JONES. Electrodes for soldering, &c.
20,952 MYLO. Inclined carbon lamp.
20,955 HUTH. Arrangement for surging-reception of electric waves. (29/4,19, Germany.)
20,956 HUTH. Combined transmitting and receiving arrangement. (14,12/17, Germany.)
20,957 HUTH. Multiple boosters, &c. (8 3 17, Germany.)
20,958 HUTH. Electric discharging vessels. (3/4,17, Germany.)
20,959 HUTH. Receiving arrangement for wireless telegraphy. (28/10 18.)
20,960 HUTH. Device for preventing self-sounding in vibration producers, &c. (4,7,17, Germany.)
20,961 LOEWE. Connection for telephony. (29'10 18, Germany.)
20,962 HUTH. Radio-telegraphic apparatus. (28 8/17, Germany.)

Companies' Reports, &c.

The directors of MESSRS. GREENWOOD & BATLEY, LTD., have declared an interim dividend of 2½ per cent. on the ordinary shares.

Mr. John H. B. Noble has been elected vice-chairman of SIR W. G. ARMSTRONG, WHITWORTH & COMPANY, LTD., and Mr. Alfred H. J. Cochrane a director.

The LONDON ELECTRIC RAILWAY COMPANY recommend a final dividend on the ordinary shares of 1 per cent., making, with the interim dividend of ½ per cent., 1½ per cent. for 1920, carrying forward £22,350.

The CITY & SOUTH LONDON RAILWAY COMPANY recommend a final dividend on the consolidated ordinary stock of 1¼ per cent., making, with the interim dividend of ¼ per cent., a dividend for 1920 of 1½ per cent., £13,820 being carried forward.

The METROPOLITAN DISTRICT RAILWAY COMPANY recommend a final dividend on the 5 per cent. second preference stock of 1¾ per cent., making with the interim dividend of 1¼ per cent., paid in August, a dividend for 1920 of 3 per cent., £20,537 being carried forward.

The profit of the HONGKONG TRAMWAY COMPANY for 1920 amounted to £86,295, which, with amount brought forward, makes £93,411. The directors have transferred £50,000 to contingent liability account, and recommend a final dividend of 1s. 3d. per share, making 2s. for year, carrying forward £10,911.

A petition has been presented to confirm an alteration of the objects of the BRITISH ELECTRICAL FEDERATION, LTD., so as to include the words "to undertake and execute any trusts the undertaking whereof may seem desirable, and either gratuitously or otherwise," and will be heard in the High Court of Justice, London, on Feb. 15.

The CENTRAL LONDON RAILWAY COMPANY recommend a final dividend on the undivided ordinary stock of 2 per cent., making with the interim payment of ¼ per cent. a dividend for 1920 of 2¼ per cent.; a final dividend on the preferred ordinary stock of 3½ per cent., making 4 per cent.; a dividend for the year on the deferred ordinary stock of ½ per cent., carrying forward £15,160.

At an extraordinary general meeting of the ADELAIDE ELECTRIC SUPPLY COMPANY, LTD., on Friday, the resolutions passed at the meeting held on the 19th ult., transferring the control of the Company to Australia, were unanimously confirmed and a vote of thanks to the chairman and the directors for their past services was passed.

During the past year the CENTRAL ELECTRIC SUPPLY COMPANY supplied 38,246,260 units of energy to the Westminster Electric Supply Corporation, the St. James' and Pall Mall Electric Light and the Chelsea Electricity Supply Companies. The balance brought forward from 1919 was £8, and, after making a full allowance for sinking fund and depreciation there is a credit balance for the year of £7 leaving £16 to be carried forward.

The directors of the UNDERGROUND ELECTRIC RAILWAYS COMPANY OF LONDON, LTD., announce that, subject to confirmation of the dividend announcements by the associated companies, the revenue will enable them to pay the full interest to Dec. 31, 1920, on the 6 per cent. first cumulative income debenture stock, and to pay interest at rate of 2 per cent., tax free, on the 6 per cent. income bonds of 1948 for the half-year ended Dec. 31, carrying forward £20,236.

Sir H. Leon, who presided over the annual meetingof the YORKSHIRE (WEST RIDING) ELECTRIC TRAMWAYS COMPANY, LTD., on Friday last, said that the past year was even worse than the previous year 1919, and he could not see any relief in for the near future. In 1920 they faced almost daily demands higher wages, hampered by the exorbitant prices asked for various commodities used in the business, delayed by the impossibility of getting delivery of materials required, and annoyed by the apparent indifference of the Government Departments to what they considered was a reasonable application for powers to charge increased fares. On Sept. 4 they obtained an order authorising them to increase the ordinary passenger fares by 50 per cent. over the pre-war basis, and to advance by 100 per cent. the fares charged to the labouring classes on the pre-war basis. The increase in revenue to date had been fairly satisfactory. Mr. Smithson said that as chairman of a great municipal undertaking at Leeds, he knew what is going on with regard to tramway matters. In Leeds and many other places they are actually working at a loss.

The gross receipts of the METROPOLITAN RAILWAY COMPANY, during 1920, were £2,109,988, and the expenditure was £1,658,493. Adding miscellaneous receipts and balance from 1919, and deducting interest, rentals and other fixed charges (£328,245), and the preference dividends (£239,107), the balance available is £127,020. The interim dividend of 1 per cent. per annum absorbed £37,201, leaving £89,819, out of which the directors recommend payment of a dividend at the rate of 2 per cent. per annum for the half-year ended Dec. 31, making 1½ per cent. for the year, and carrying forward £15,416. The amount transferred to general renewals fund is £50,000, against £40,000.

Further increases in fares to and from stations outside the London area were brought into operation in August last, but the London area revisions could not be applied before Sept. 26 last. The increase in revenue which has so far resulted from these revisions may be considered satisfactory. During the year large additions made to the rolling stock have had a marked effect in relieving the congestion of traffic experienced during the rush hours of the day. Of the new cars ordered for the electric service, 12 have been delivered, and others will be available shortly. The re-equipment of the existing electric locomotives with higher-powered motors is being gradually effected. Arrangements for augmenting and improving the generating plant at Neasden are proceeding favourably.

New Companies.

The following list has been compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, Chancery-lane, London, W.C.2 :—

DUTTONS (SOUTHPORT), LTD. (172,755)—Reg. Jan. 24, capital £3,000 in £1 shares, to carry on business of manufacturers of accumulators, magnetos, dynamos, &c. Directors : H. Dutton and A. Dutton. Reg. office : 1A, Marlborough-road, Southport.

MEAD ENGINEERING WORKS, LTD. (172,727)—Reg. Jan. 21, capital £5,000 in £1 ordinary shares, to carry on businesees of mechanical,electrical and general engineers. Directors : G. E. Mead, F. Griffiths and A. E. Mead. Reg. office : Hurmna-street, Bute Docks, Cardiff.

NORTH-WEST ELECTRICAL MFG. COMPANY, LTD., capital £5,000 in £1 shares, to carry on business of electrical engineers. Registered office, Motherwell.

Companies Incorporated Outside U.K.

ELECTRICAL APPARATUS EXPORT CORPORATION. (1,925 F.)—Reg. Jan. 19, capital $50,000 in 500 shares of $100 each, to carry on business of shipping and forwarding by land and water. Incorporated in U.S.A. J. A. Campbell, 408-9, Bank-chambers, High Holborn, W.C.1, is authorised to accept service.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics."—"The Napier 1,000 H.P. Aero Engine" ; "Ground Engineering," by Wing-Commander H. W. S. Outram.

"The Cabinet Maker."—"Furnishing Textiles," by W. Foxton ; "The Decoration of Furniture : Carved Mouldings" ; "The Efficiency Exhibition."

"Chemical Age."—"Ozone and Hyzone and their Technical Applications" ; and "The Driving of Centrifuges," by F. J. Broadbent.

"Farm and Home."—"Lambing Season Problems" ; "Farmers and the Wages Burden" ; and "The Government and 1920 Wheat Prices."

"Fruit-Grower."—"Rain and the Setting of Fruit" ; "Trade Benevolence" ; and "The Wages Problem."

"Gardening Illustrated."—(Sweet Pea Issue).—"The Problem of Varieties" ; "Sweet Peas for Every Garden" ; and "Mendelism and Sweet Pea Breeding."

"The Gas World."—Analyses of Corporation Gas Accounts ; "Education and Training of the Gas Engineer" ; and "Complete Gasification of Coal at Harrogate."

"Hardware Trade Journal."—"Hardware for the Garden" ; "The Elusive Order" ; and "How to Warm the Shop."

Prices of Metals, Chemicals, &c.

TUESDAY, Feb. 8.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£76 0 0	£2 0 0	—
Electro Wirebars ...	,,	£79 0 0	£2 0 0	—
H.C. wire, basis ...	per lb.	1s. 0$\frac{1}{16}$d.	¼d.	—
Sheet	,,	1s. 1$\frac{5}{16}$d.	—	$\frac{1}{16}$d.
Phosphor-bronze Wire (Telephone) –				
Phosphor-bronze wire, basis	,,	1s. 4$\frac{1}{16}$d.	¼d.	—
Brass 60/40—				
Rod, basis	,,	0s. 9d.	—	—
Sheet, basis	,,	1s. 1¼d.	—	—
Wire, basis	,,	1s. 1½d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£10 5 0	—	£1 0 0
Galvanised steel wire, basis 8 SWG	,,	£31 0 0	—	—
Lead Pig—				
English	,,	£24 10 0	—	£0 10 0
Foreign or Colonial	,,	£22 12 6	—	£0 10 0
Tin—				
Ingot	,,	£167 0 0	—	£2 0 0
Wire, basis	per lb.	2s. 3¾d.	—	¼d.

Salammoniac.—Per cwt. 100s.-95s.

Sulphur (Flowers).—Ton £15 5s.

,, (Roll-Brimstone).—Per ton £15 5s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £36.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 10d.

Sodium Chlorate.—Per lb. 4½d.

Rubber.—Para fine, 0s. 11½d. ; plantation 1st latex, 1s 1d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co., Ltd.

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Forty Years Ago.

(THE ELECTRICIAN, FEBRUARY 12, 1881.)

THE PARIS ELECTRICAL EXHIBITION.—Several electrical railways will, it is stated, be at work at this Exhibition, the largest being in the British Section, and constructed by Messrs. Siemens Brothers.

"PUNCH" ON THE TELEGRAPH MONOPOLY.—"The Telegraph Monopoly—popularly known as the Post Office—is proving, if any proof were needed, that no Government can be trusted. Tory, Conservative, Liberal or Radical, are all alike when the law gives them, or leads them to believe that it has given them unlimited powers as traders. The so-called Post Office, having made a bad and improvident bargain with the Telegraph Companies, is determined to burke invention, and earn an evil reputation as the champion of everlasting stagnation. The impertinent inventors of the telephone have been made aware of this in a court of law, and are now made even more bitterly aware of it in their subsequent negotiations with the Government. In the first place, they are told they must be taxed, and this is a communication they can hardly be astonished at. Nearly every living thing in this country is taxed, except vermin—the child in its cradle, the dying man on his bed. The only thing practically exempt is the corpse in its coffin. However sluggish the Government may be the tax-gatherer is superhumanly active. A Government that once taxed the light of heaven can see no injustice in taxing a telephone wire. In the second place, the impertinent inventors are told that their *radius* must be limited," &c., &c., &c.

Arrangements for the Week.

FRIDAY, February 11th (to-day).

PHYSICAL SOCIETY.

5.15 p.m. At the Imperial College of Science, South Kensington, London, S.W. Discussion on "Absolute Measurements of Electrical Resistance, and Instruments based on the Temperature-variation of Resistance."

FARADAY SOCIETY.

6.30 p.m. At 36, George-street, Manchester. Joint Meeting with the Manchester Literary and Philosophical Society. Discussion on "Measurements of Surface Tension."

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At Caxton Hall, London, S.W. Lecturette : "Notes on Some Limit Gauges," by Mr. F. A. Simpson.

INSTITUTE OF INDUSTRIAL ADMINISTRATION.

8 p.m. At Central Hall, Westminster, London, S.W. Address on "Present Day Industrial Psychology," by Sir Lynder Macassey, K.B.E., K.C.

ELECTRO-HARMONIC SOCIETY.

8 p.m. At Cannon-street Hotel, E.C. Concert. (Ladies' Night.)

ROYAL INSTITUTION.

9 p.m. At Albemarle-street, London, W. Discourse on "Isotopes and Atomic Weights," by Dr. F. W. Aston, M.A.

SATURDAY, February 12th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, London, W. Lecture on "Experimental Spectroscopy," by Mr. A. Fowler, F.R.S.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At the Grand Hotel, Birmingham. Paper on "Reminiscences of the Test Bed," by Mr. C. J. A. McDonald.

MONDAY, February 14th.

ROYAL SOCIETY OF ARTS.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Applications of Catalysis to Industrial Chemistry," by Dr. E. K. Rideal, M.B.E. (Lecture I.)

INSTITUTION OF ELECTRICAL ENGINEERS.—INFORMAL MEETING.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn Buildings, Holborn, London, W.C. Discussion on "The Design of Large Power Stations," to be opened by Mr. J. R. Cowie.

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH-EASTERN CENTRE.

7.15 p.m. At Armstrong College, Newcastle. Paper on "Temperature Limits of Large Alternators," by Mr. G. A. Juhlin.

INSTITUTION OF ELECTRICAL ENGINEERS.—DUNDEE SUB-CENTRE.

7.30 p.m. At University College, Dundee. Lecture on "Electrical Analogies," by Mr. R. D. Archibald.

WEDNESDAY, February 16th.

INDUSTRIAL LEAGUE AND COUNCIL.

7.30 p.m. At Caxton Hall, Westminster, London, S.W. Lecture on "Control of Industry," by Mr. H. H. Elvin.

ROYAL SOCIETY OF ARTS.

8 p.m. At John-street, Adelphi, London, W.C. Paper on "Pneumatic Elevators in Theory and Practice," by Dr. W. Cramp.

THURSDAY, February 17th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Lecture on "Magnetic Susceptibility of Low Order." Lecture I. Instrumentation, by Prof. E. Wilson.

RONTGEN SOCIETY.

8.15 p.m. At University College, Gower-street, London, W.C. Paper on "Intensifying Screens and Secondary Radiation," by Mr. N. E. Luboshey.

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Notes.

Some Problems of Direction-Finding.

ONE of the most fascinating problems of applied radio-telegraphy is that which has for its object the determination of the bearing of distant stations, either on ship or shore. That something of this kind would be useful in marine work was evident even before the war, and various apparatus to obtain the desired object had been suggested by a number of experimenters, notably by Messrs. BELLINI and TOSI. While the war increased the importance of this question it also necessitated the range and accuracy of the equipment employed being very much increased, and a large amount of work was undertaken under the control of the military authorities by Capt. H. J. ROUND and others with this end in view. These investigations combined with the invention of the amplifier and the employment of long undamped waves allowed the range over which directions could be determined to be greatly increased, but at the same time they introduced fresh errors of great magnitude and variability, so that extraordinarily misleading results between the same pair of stations were often obtained. These errors were most notable in long-distance working, and have been attributed to the reflection of the waves from the irregularities in the Heaviside layer, and also to the reflection from the highly rarefied conducting strata in that layer.

An Optical Analogy.

IN an article by Dr. E. BELLINI, which we publish on another page of this issue, it is shown by means of an optical analogy that the error is due to both reflection from the Heaviside layer and to the influence of the horizontal sides of the sending antenna upon the horizontal parts of the receiving loops, so that in a transmitting station provided only with one or more vertical antennæ no errors should be observed, while similarly a direction-finder containing no horizontal parts should also be accurate whether or no the aerial of the sending station contains such horizontal parts. Dr. BELLINI further ascribes the errors that have been discovered to the Heaviside layer causing the phenomenon known as the "aeroplane effect," and points out that by working on analagous lines to those that have been followed in the case of aeroplanes it should therefore be possible to eliminate this source of trouble. Dr. BELLINI has been able to confirm his theory by observations with the Hanover Station, which, as Capt. ROUND pointed out, gives exact bearings, owing probably to the fact that it is fitted with an umbrella antenna. The principal source of error, therefore, in Dr. BELLINI's opinion, would appear to reside in the fact that the antenna employed in long wave stations is usually of the Marconi bent type, while the curious phenomena observed at the Horsea station is due to the fact that current distributes itself differently in the antenna according to the wave-length used.

Need for Further Research.

IT will be remembered that another theory as to the cause of these errors was suggested by Dr. W. H. ECCLES in the address which he delivered to the Wireless Section of the Institution of Electrical Engineers in November last. On that occasion he pointed out that many of the errors in true direction might arise from the rotation of the plane of polarisation of the signal-bearing waves by reflection at the non-level portion of the Heaviside layer between the sending and receiving stations, though the cause of that rotation was still a problem for solution. The result of this rotation was, in his opinion, that the accumulated effect of the simultaneous oscillations of a whole cloud of electrons might produce an effect at the receiver as if the cloud itself were the source. This seems to square fairly well with one part of Dr. BELLINI's theory, but it will be agreed that further experimental proofs are required before either supposition can be accepted or rejected. We hope that the matter will not be allowed to rest there, for it is important, both from the theoretical and practical points of view, that it should receive close attention from wireless investigators.

The King's Speech.

THE KING's Speech, delivered on Tuesday last, should be interesting to electrical engineers both for what it contains and for what it omits. If it is to be taken as a true shadow of coming events, the Government are to make a determined effort during the session to reduce expenditure and to curtail taxation, so as to ensure an early revival of trade and industry. They are further to attempt to increase the well-being of the country by dealing with the problem of unemployment, which it is stated may be alleviated but cannot be cured by legislative means. Recent experience, however, of Government interference indicates that legislation may make matters worse, and it is therefore to be hoped that the problem will be tackled with more care than usual and that the effects of any proposals made will be thought out beforehand. A measure is also to be introduced to deal with essential key industries, and control over coal prices is to be given up so that the industry may be restored to its normal condition of freedom. The speech contains a promise that the business of the session will be lightened as far as possible and to ensure this the Electricity Supply Bill is among the ballast that has been cast overboard. It is a matter for speculation how far the dropping of this measure, and the consequent obstacles which will thereby be placed in the way of the development of a scheme for the co-ordination of the electricity supply of the country, will counteract the other steps which are to be taken for improving our present conditions. There is, however, this crumb of comfort, that while all new legislation which is foreshadowed in His Majesty's Speech does not come to fruition occasionally measures are introduced which do not appear in this pronouncement.

Y.E.P. Progress.

The speech made by Mr. A. G. Lupton in presenting the reports and accounts of the Yorkshire Electric Power Company to the annual meeting of the shareholders on Tuesday last was a judicious mixture of pessimism and optimism. In spite of the reduction in demand for power caused by the slump, the actual output from the Company's stations has been greater during the past year than ever before owing to the large increase in new consumers, while the corresponding increase in revenue has sufficiently counteracted the increased cost of fuel and labour to enable a dividend of 8 per cent. on the ordinary share capital to be paid. It is worthy of note that, in spite of the present troublous times, this result is very much better than was ever achieved before the war, and is probably due, as Mr. Lupton pointed out, not only to the ever increasing demands for electrical energy but to the cautious policy which has always governed the operations of the Company. But such excellent results have not been obtained by stagnation, as the following figures show: The Company now has some 446 miles of mains and 164 distributing sub-stations, and is supplying energy in the areas of 84 local authorities for a large variety of purposes. This is no bad record for 20 years, trammelled as they have been by the usual legislative interference and municipal jealousies, but it might have been better had it been possible to supply small lighting consumers direct. Even this disability has, however, been circumvented by ingenuity, for though lighting consumers may not be supplied except through an undertaker, there is no similar restriction on the supply of power, so that the sewing machine, the flat iron and other small electrical appliances may be used to drive a gasfilled lamp through an Act of Parliament—an operation for which they were not originally intended.

Pessimism for the Future.

So much for the past. A change now comes over the scene, and in considering what is likely to happen during the next 20 years pessimism begins to preponderate in Mr. Lupton's outlook. Had the Company been left to itself, he thinks, it would have been possible for an unbroken supply to have been given from Newcastle to Rugby and from Lancashire to Lincolnshire, but this much-to-be-wished consummation is not likely to be attained under the present policy, which he views as being nationalisation clothed in a disguise, as exiguous as some of the present Paris fashions. If we may so express it, Mr. Lupton is at present very much in opposition, and even goes so far in his openly expressed dislike to any State Control of the electricity supply industry to drag in the telephone system as an example of what happens when our grandmotherly bureaucracy enters business. But while we have a great deal of sympathy with Mr. Lupton's point of view, and especially with the position in which the Yorkshire Electric Power Company finds itself after 20 years of hard struggle, we really do not think that things are as bad as he makes out, or rather we would qualify that by saying that there is no reason why things should be as bad as he thinks they are going to be. In our view there are only two real difficulties in the way of proper development of electricity supply at the present time: finance, an obstacle which looms large in speeches and pronouncements on all and every subject, and an inability to sink local interests for the good of the community generally. With care and enterprise the former of these will, we feel sure, be overcome, but the latter has its roots so deep down in unregenerate human nature that to eradicate it will be a herculean task, yet until it is eradicated no progress will be made by national, municipal or private interests.

Administrative Clogs upon Progress.

When the administration of the Electricity Supply Acts was transferred from the Board of Trade to the Minister of Transport we were led to expect a great improvement in methods of procedure and a new and enlightened outlook towards the demands of industry. Apart from the excellent work done by the Electricity Commissioners in the reorganisation of electricity supply we are not aware, however, that there is much else to place to the credit of this new and much belauded Ministry, the whole of whose energy seems to have been expended in the Severn Barrage and similar grandiose schemes. But now that these are, we hope, safely out of the way, we would respectfully suggest that much good would accrue to the electrical industry, and incidentally to industry in general, if some attention were devoted to removing the existing restrictions upon electricity supply, rather than in piling up new and often contradictory regulations. It will be recalled that during the war several provisional electric lighting orders were granted, but for good and valid reasons their operation was suspended until after the termination of the war. As the causes which led to the imposition of this restriction have ceased to operate, is there any reason why it should not be removed? An example of the sort of thing that is now going on is given by the case of the Electrical Power Distribution of Yorkshire, Ltd., which possesses no less than eight of these suspended orders, and though the inhabitants of the districts interested are clamouring for a supply of electricity, yet they cannot obtain it because of the technical and quite unnecessary obstacle to which we have just referred. We hope, therefore, that the matter will receive the immediate consideration of the Electricity Commissioners, and that the Company will be allowed to proceed with the work of laying its supply mains and so help to relieve the prevailing unemployment. To hold matters up any longer on such a technicality is in the highest degree absurd.

E.P.D. and Income Tax.

As we expected the foreshadowed disappearance of the Excess Profits Duty has been followed by the germ of an agitation for the reduction of income tax. In a letter to the Chancellor of the Exchequer, the Federation of British Industries point out that to collect the arrears of taxation already due to them, the Government must adopt a financial policy which will encourage the revival of industrial prosperity. Such encouragement in the opinion of the Federation can best take the form of alleviating the enormous burden of taxation borne by the community in general by reducing the rate of income tax, a policy which would not only increase the purchasing power of the nation, but would have a valuable psychological effect in restoring hope and energy to the large class who earn small taxable incomes, and who are fast sinking into apathy, if not bankruptcy. This, of course, is all very true, and everyone would welcome a relief from the six-monthly demands of the income tax collectors. But, as we pointed out last week, the real argument for the abandonment of the Excess Profits Duty is that it has ceased to pay, which is certainly not true of the income tax, so that any reduction in the rate would mean a corresponding falling off in revenue. As a result not only would all expenditure on current administration have to be cut down to the lowest possible level, which we hope will be done in any event, but repayment of debt on the present scale would have to cease. In other words, we should have to transfer a larger proportion of our liabilities to posterity than we are doing at present. We notice the Federation says nothing about the Corporation Tax, but this in many ways is as inequitable as the Excess Profits Duty, and its removal might therefore be justifiably pressed with corresponding vigour.

Dangers of Static Electricity.

We have recently had brought to our notice two interesting examples of the dangers which may occur from static electricity, where the belt drive is used in connection with electrical machinery. The first occurred where a 15 h.p. motor fixed to a platform suspended from a wooden ceiling was used in a textile factory. The frame of the motor was not earthed, and it was observed that flashing between the stator and rotor took place at frequent intervals, especially on dry days. Ordinary tests showed that nothing was out of order, until finally the flashing broke down the stator insulation, and the motor burnt out. The trouble was overcome by earthing the frame of the machine, and by taking steps to devise a means of collecting and disposing of the static charge from the belt. A relative simple solution ! The second occurrence to which we may refer is also an example of the well-known tag that the remedy is often worse than the disease. To get rid of static electricity from belting it has been usual in the past to place wire points or other metallic objects close to the belt. In this particular case the resulting sparks set fire to the explosive vapour in a japanning factory with unfortunate results. These discharges were finally eliminated by mixing graphite with the belt dressing so as to make it sufficiently conducting to prevent any accumulation of static charge. A drawback to this method however is that the belt soon ceases to be non-conducting if the graphite is not regularly renewed, and unless care is taken the danger is therefore likely to recur. We think this question of static discharge from moving electrical machinery is now one of much considerable technical and industrial interest, and that it might well be the subject of research by some Association or other interested body.

Financial Position of the Underground Railways

It is well known that tramways, railways and all transport undertakings are badly affected by high operating expenses, but so far the increases in fares have been insufficient to restore financial stability. From the directors' reports of the four underground railways operated by the Underground Electric Railways Company of London we gather that the total receipts of the Metropolitan District Railway increased by £340,675, but that the operating expenses advanced by £380,134 : the receipts of the London Electric Railway went up by £117,769 and the operating expenses by £374,897 : the receipts of the City and South London show an increase of £38,702 and the expenses of £83,197, while the corresponding figures of the Central London Company are £75,589 and £166,187 respectively. After meeting interest, rental and fixed charges and making provision for reserve, &c., in each case there is a substantial reduction in the total amount available for dividends compared with the year 1919. These figures are far from satisfactory, and give but a very meagre return on the large capital sunk in the undertakings. However, as the increased fares, representing an advance of about 30 per cent., only came into operation in September last there will no doubt be better results to report at the end of the current year, provided we have stable industrial conditions in the meantime. We notice that each company has carried an increased number of season ticket holders, though only the Metropolitan, District and Central London Companies report increases in the aggregate number of passengers conveyed.

The Efficiency Exhibition.

There is perhaps no word in the English language that is more overloaded or more generally inaccurately employed than "efficiency." But however much we may distrust its applications when we find it stretched to cloak actions to which it has little or no relation, that is no reason why we should fail to appreciate the quality when it is being correctly and honestly employed. The laity of this country, who should already feel grateful to the "Daily Mail" for the Ideal Home exhibition which it has recently organised, must now consider this debt increased by the Efficiency Exhibition which is now open at Olympia. For efficiency in method and manufacture are no less important in their way than beautiful homes and modern domestic apparatus. The scope of the Exhibition is wide, perhaps rather too wide, but even the least satisfactory of the exhibits do at least teach us that it is often possible to make better use of our resources, both human and material, than we are doing at present. It is therefore eminently an exhibition which should be visited by every progressive electrical engineer. It is hardly necessary to add that one of the reasons for saying this is that electricity is playing a large direct and indirect part in bringing about the various conditions which make for improved existence, though it is a pity to find that lighting of old fashioned kind is still being employed on numbers of the stands, and that not more opportunity has been taken of illustrating the benefits which are to be obtained by the wider employment of electric heating and cooking. We feel very strongly that no opportunity should be lost either by electrical engineers or by exhibition organisers of bringing this question forcibly before the general public.

B.E.D.A. and the Exhibition.

That being so we are glad to learn that the British Electrical Development Association is taking this opportunity to hold a meeting at Olympia to-day, at which Mr. C. H. Wordingham will preside, and at which a discussion on "Electric Power in Industry" will be opened by Mr. J. C. Wigham. This meeting should not only help the Association in its endeavours to emphasise the benefits of electricity, but should show the general public what a true help electricity is in the modern factory. In spite of its scientific connotation the word efficiency generally calls to mind the co-ordination of industrial operations, but it must not be forgotten that to bring these operations to a successful conclusion has meant a large amount of well-ordered thought and a good deal of unsuccessful experiment. It is therefore not incorrect to say that the most interesting exhibit at Olympia is not industrial in character at all, but consists of a series of lamps and valves shown by Prof. J. A. Fleming to indicate the genesis of that most successful apparatus the thermionic valve. The thermionic valve has reached a stage in its development where it has nothing to gain by being made a motley to the view. It is above that. But as illustrating the help that theory can give to practice it provides a lesson which we hope will not be lost on those who visit the Efficiency Exhibition.

Tramways and Street Accidents.

Owing to the increase in the number of street accidents there is a growing agitation in favour of greater control of tramway and motor omnibus traffic. A few Corporations, Glasgow among the number, have obtained special statutory powers to deal with the question by means of by-laws to prevent omnibuses from stopping at the same place as tramcars in narrow and crowded thoroughfares, and to compel all vehicles to come to a stop when reaching a tramcar which is standing still. At Manchester, where there were 65 inquests on the victims of motor accidents in 1920 the Parliamentary Committee inserted a clause in this year's Omnibus Bill to secure similar powers to those conferred upon Glasgow. The owners of motor cars, taxis, &c., however, organised opposition, and the clause was rejected at a meeting of the ratepayers. The subject has also been discussed by the Highways Committee of the London County Council, who seem to desire further controlling powers, and now the Shoreditch Borough Council desire to call a conference of the public bodies to discuss the matter. While we have every sympathy with any movement for securing the safety of the public we think that the tramway authority should not have exclusive control of the streets in which tramway rails are laid. Moreover, the matter is so important a one, that it should be dealt with as a whole for the entire country, and not in a piecemeal fashion by private bill legislation. The power to make and enforce by-laws for controlling street traffic should, therefore be vested in the Ministry of Transport and in the Chief Commissioner of Police for the Metropolitan area.

The Passing of the Board of Trade Unit.

The transfer of the control of the electricity supply undertakings of this country from the Board of Trade to the Ministry of Transport has not been without its minor tragedies. One of these is the disappearance of a well-tried friend whose demise, so far as we can ascertain, has hardly been noticed, much less regretted. We refer to the Board of Trade unit. Fortunately the substance remains though the shadow has departed, and we can therefore at least welcome an old friend in a new form. The doubtful point is what shape the new form should take and what it is to be called when it has taken shape. We believe the Glasgow Corporation Electricity Department and certainly one of our contemporaries are among the very few pioneers who have striven for some time to get this much-used electrical unit called the "kelvin," but for some occult reason or other, which we do not propose even to endeavour to explain, the idea has never caught on. Are we then to give the "kelvin" up as a failure or to compromise by making another attempt to attach an abstraction to a personality? If this is to be the solution of our present difficulty, might we suggest that perhaps the fault has lain in trying to amalgamate a commercial commodity with a great scientist? That difficulty at least can be overcome by re-naming our unit the "Snell" or the "Geddes," thus providing the dual advantage of keeping green the name of one of the pioneers of modern electrical industry and of marking an epoch in the history of what we believe is to be a very great development. For ourselves, we deplore such a biographico-commercial policy and shall continue to use the words kilowatt-hours and unit by themselves, except when we preface the latter with the adjective "electrical" to give greater clarity.

Underground Advertising.

In the same way that some of our daily contemporaries turn when they are short of a subject for criticism to the State-operated telephone system, we discuss the improvements which might be made in the use of high candle-power lamps by the laity. We are bound to confess that the results in both cases are about the same. But while there is this to be said in favour of the shopkeeper who uses unshaded gasfilled lamps to "illuminate" his goods, that without education he cannot be expected to know any better, the same excuse cannot be accepted from those responsible for the lighting of the carriages on certain of the London Tube railways in which unshaded lamps glare and blind the visual equipment of the unfortunate straphanger who is forced in more ways than one to stand within a few inches of these incandescent monstrosities. Realising, as we do, the care for the comfort and well-being of the passenger which is felt and exhibited by every official on the Underground railway system of London, from the latest joined lift-man to the most highly paid managing director, we suppose that there must be a reason for this which in some subtle way is for the good of the public. If it were not that we feel perfectly satisfied that this must be the case, we should suggest that some of the money and ingenuity now spent in teaching passengers how to behave and in explaining by means of posters how the service is being improved might better be used in provding better illumination arrangements than those we have just mentioned.

The Essentials of Electric Cooking Apparatus.

Considering the interest that has been taken, and is being taken, in the development of the use of electricity for cooking purposes, it is surprising that more Papers dealing with the various phases of the subject have not been presented for discussion before the Institution of Electrical Engineers. An inspection of the files of The Electrician shows that almost the sole protagonist of this important question has been Mr. W. R. Cooper, who some thirteen years ago suggested a scale of tariffs with the object of encouraging the domestic load, and later gave some experiences of his own with regard to electric cooking from the ordinary consumer's rather than from the electrical engineer's point of view. It is almost needless to add that on both occasions he was severely criticised for pointing out that before we could hope to reach the "all-electric" era obstacles of various kinds would have to be overcome and certain alterations in our policy and apparatus would be necessary.

A Curious Attitude.

In the abstract we are not surprised that these criticisms should have been made, for the electrical engineer is after all a very human person and is certainly not exceptional in disliking even a hint that anything he does falls short of perfection The attitude that is taken up when any criticism of electric cooking apparatus is made is often, however, something quite different from this simple emotion. The sins, negligences and ignorances of other electrical plant, and of those responsible for its design, may be discussed by speakers and writers, and may give rise to debates whose interest is only exceeded by the super-Parliamentary manner in which they are conducted. When, however, any author or speaker suggests ever so diffidently that our present design of cooking apparatus is not all that it should be he is as often as not subjected to a storm of abuse the virulence of which is only exceeded by the limited vision of those who point out the error of his ways. This attitude is the more curious as electric cooking apparatus is one of the newest sorts of industrial plant and might therefore be expected in the natural course of things to require more modification than does that equipment with which we have had years of experience.

The reason for this attitude is not very clear, but at least those who adopt it might allow that those who put forward constructive criticism are as single minded in their desire for the development of electric cooking as those who adopt the policy of Brer-Rabbit, and that they may at least be doing as much good.

SEQUEL TO A SPECIFICATION.

On this score, however, Dr. Ezer Griffiths and Mr. F. H. Schofield, the authors of a Paper on "Some Thermal Characteristics of Electric Ovens and Hot-plates," which was read before the Institution of Electrical Engineers last week, may sleep quietly in their beds. Perhaps taught by the experience of others they indulge in no wild prophecies or startling deductions about the apparatus which they have been testing, but confine themselves strictly to the matter in hand. The Paper consists essentially of a review of the results of certain thermal tests carried out at the National Physical Laboratory in 1918 at the request of the Engineering Standards Committee. Upon the results of these tests the thermal requirements outlined in the British Engineering Standards Association specification for electric ranges were based. The Paper is therefore a sequel, and probably for that reason lacks some of the interest of an original work.

It would, however, be an ungracious act to criticise the authors for what their Paper does not contain, and we shall certainly not do so. The more so as their communication, though hardly suitable as an opening for a discussion on such a wide subject as electrical appliances for domestic purposes, is yet an important addition to a part of the theory of the subject. Put briefly, it is a straightforward record of tests carried out on hot-plates and ovens of various sizes, with a view to determining the temperature distribution in these two classes of apparatus, and therefrom devising standard tests which shall allow the performance of the various types of equipment to be easily compared. As will be seen from an abstract of the Paper which we give on another page of this issue, the tests made were entirely thermal in character. As such they are of great interest, but the Paper suffers as a whole from the fact that the authors' diffidence did not allow them to put forward their conclusions with the definiteness which the importance of the subject requires, and in any event the very nature of the investigation necessitates that their tests should cease just at the moment when theory is beginning to join up with practice. It is true the Paper adds to our knowledge on points which have hitherto been obscure, but it only provides an incomplete fragment of what we want to know on that part of the subject with which it deals.

SOME PRACTICAL DATA WE REQUIRE.

We have called the Paper a sequel, but it is more accurately described as a theoretical introduction to a practical textbook, and its utility is therefore rather eclipsed by an intense desire to get hold of a textbook of which it forms a part. Unfortunately, that book is not yet written, though it ought to be. For what in our opinion is eminently required at the moment is just such a work as we describe. In Dr. Griffiths' and Mr. Schofield's Paper we have what, for want of a better term, may be called an account of the thermal theory of electric cooking and later on in the present session we are to have a discussion on the practical and burning question of tariffs. Between these two portions of the subject lies a vast field for investigation of quite a practical character, about which a good deal more ought to be written, and a great deal more said.

Many of the speakers on Thursday night, who with the President's leave did not confine themselves rigidly to the subject of the Paper, raised a number of these important points, and whetted our appetites for more. Cannot we, for instance, have some Papers on one or two at least of such questions as the arrangement of the elements in electric cooking apparatus, the design and use of connectors employed in this equipment, the position and marking of the terminals, the best design of accessories to employ, the theoretical best size of oven, the best diameter of hot-plates, and the efficiency of the various patterns of plates that are now being used. The effect of the design of a hot-plate on the way it transmits heat to the cooking utensils, and what is the best shape and sort of utensil to use with a particular design of hot-plate, the relation of time and temperature in a particular sort of oven or on a particular sort of hot-plate or grill, so that schedules may be prepared whereby the ordinary domestic cook is relieved from the reading of scientific instruments, and yet the equipment is used in the most efficient way, are only further points on which we should know more. While a third section includes how cleanliness may best be obtained, details of earthing, fusing requirements, the arrangement of indicators, the best ratings to employ for different kinds of work, the various phases of what Mr. Beauchamp calls "the art of switching," the relative advantages of different methods of operation, and last but not least, questions of nomenclature which, as pointed out by Mr. Good, is in rather a disorganised state at the moment.

A NECESSARY SIFTING OF DATA.

These are all matters which are important in the development of this means of using electricity, and are all questions on which data is being independently collected by those who are most intimately concerned with the use and manufacture of cooking apparatus. A discussion on one or more of these points would mean a sifting of this data, and the instruction of all concerned by dividing the wheat from the chaff. The tone of the discussion which took place on Thursday night is at least an indication that ideas on the subject are changing, and that critics are no longer open to suspicion, but are even welcomed. For instance, the remarks made by Prof. Macgregor Morris would, a short time ago, have been very badly received. On this occasion the meeting showed that points such as those he mentioned must receive attention if electric cooking is to develop in the way in which it should and must.

A NEW PHASE OF CRITICISM.

We have said above that no other type of electrical plant is exempt from discussion of this kind, and we hope that this exemption will not be very much longer extended to electric cooking apparatus. For constructive and destructive criticisms, especially the former, at least mean that there is something in electric cooking, and that there is sufficient interest taken in its possibilities by electrical engineers to desire to improve what already exists into something better. In electric cooking, as in other fields of engineering endeavour, British electrical engineers were the pioneers. We must avoid our own bad example which we have followed in so many cases of falling behind in the race for improvement, but we shall certainly not keep our place if the super-sensitiveness to criticism to which we have referred above is not quickly overcome.

The Errors of Direction-Finders.

By Dr. E. BELLINI.

In the early period of the existence of the direction-finder it was generally thought that a well-constructed direction-finder apparatus, installed upon a homogeneous stretch of land and free from local influences, would give exact bearings. Experiments confirmed this idea. At that time, spark transmitters and moderate wave-lengths were used, and, since amplifiers had not then been discovered, the distance at which a station could be located was limited.

But the discovery of the amplifier, which enormously extended the range of the direction-finder, and the adoption of undamped waves of very great lengths, completely changed the working conditions of these apparatus. The satisfaction of being able to reach enormous ranges was counterbalanced by the dissatisfaction at finding a new source of errors, errors which could be attributed neither to the conditions of the earth's surface nor to the influence of neighbouring bodies. The characteristics of these new errors are their magnitude and their variability. Minimum in the day time, they become larger at sunset and reach their maximum at night, becoming sometimes enormous, as much as 50, 60 and even 90 deg. Their rate of change may reach several degrees per minute.

THE CAUSE OF THE ERRORS.

The cause of these errors has been attributed by Round,[*] Howe,[†] Hoyt-Taylor[‡] and others to the reflection of the waves from the highly rarefied conducting strata of the atmosphere (Heaviside layer), and by Eckersley[§] to the reflection of waves from the irregularities in the Heaviside layer. In this article I hope to demonstrate that these errors are due both to the reflection of waves from the Heaviside layer, considered as homogeneous and continuous, and to the influence of the horizontal parts of the sending antennæ upon the horizontal parts of the receiving loops.

At night time the upper strata of the atmosphere are certainly conductive because of the rarefaction, whilst the low strata are insulating, owing to the absence of causes of ionisation. The waves are reflected from the upper strata, and they, consequently, travel in the insulating medium comprised between two conductive surfaces (earth and Heaviside layer).

In the day time the light of the sun ionises the lower strata of the atmosphere. The difference in conductibility between the upper and the lower strata of the atmosphere tends to disappear and the transmission approaches the theoretical conditions of a homogeneous medium through which the waves travel. The bearings obtained in the day time must, therefore, be in closer agreement with those obtained by theoretical considerations than those obtained at night.

DETAILS OF EXPERIMENTAL WORK.

During the war a large amount of experimental work on direction finding was carried out. The most important observations and facts, which can be utilised for finding an explanation of the errors, may be summarised as follows :—

(*a*) Errors are much larger at night than in the day time.

(*b*) In southern latitudes larger errors are generally obtained than in northern latitudes.

(*c*) Waves sometimes appear to come at the same time from different directions and to be shifted in phase, so that the minimum may be ill-defined or even non-existent.

(*d*) Errors are larger for long than for short waves. In particular, the bearings of the Horsea arc station, taken on the marking or on the spacing waves, differ by 30 deg. (Round).

(*e*) Errors are larger for continuous-wave than for spark stations (Round, Hoyt-Taylor).

(*f*) Errors do not exist when the distance of the located station does not exceed about 15 miles (Round).

(*g*) Some stations practically give exact bearings, both in the day time and at night. Round mentions the station of Hanover (Eilvese) and that of Malta, when located by direction-finder stations situated in England.

(*h*) Two transmitting stations placed side by side, but with differently shaped aerials, give different bearings (Round).

(*i*) A sending station utilising a loop aerial gives different bearings according to the angular position occupied by the loop (Round).

The facts cited under (*d*), (*g*), (*h*) and (*i*) clearly show the influence of the form and excitation of the aerial of the sending station. The mere difference in conductivity of the different strata of the atmosphere cannot, therefore, account for all the facts observed.

AN OPTICAL ANALOGY.

The reflection from the Heaviside layer can, at a first approximation, be compared with that from a horizontal reflecting mirror placed some kilometres above the earth surface. We can apply, therefore, the ordinary rules of geometrical optics. The receiving station *B* (Fig. 1) will receive not only the waves directly sent from the sending station *A*, but also those sent from an imaginary station *C* placed behind the mirror on the perpendicular *AO* to it, at a distance $OC = OA$.

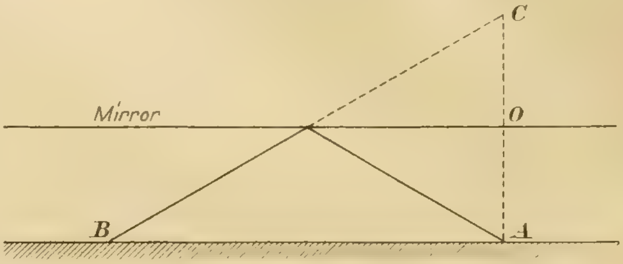

FIG. 1.

Let us suppose a sending loop *A* (Fig. 2) and a receiving loop *B* parallel to each other. If the reflection phenomena were not present no reception should take place, both because the sending loop *A* does not radiate towards the receiving loop *B* and because this is unable to pick up energy sent from a station placed in the direction *BA*. The Heaviside layer acts as if an imaginary sending loop, situated in the same vertical plane as *A*, existed at *C*. The plane of this being inclined to the direction *CB* at an angle less than 90 deg. will send energy to *B* ; and the plane of this, being inclined at the same angle to the direction *BC*, will pick up a fraction of this energy. If, therefore, the receiving loop *B* is swung so as to determine the direction of the impinging waves, a bearing with an error of 90 deg. will be obtained. If the sending loop *A* (Fig. 3)

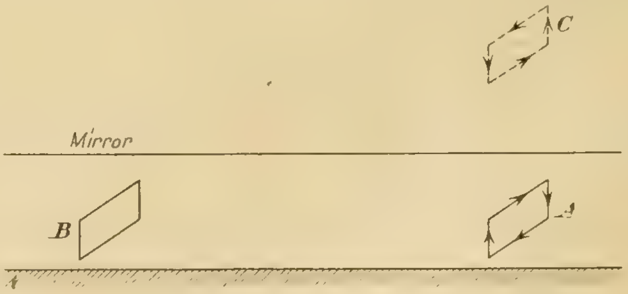

FIG. 2.

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[*] Captain H. J. Round. "Direction and Position Finding." "Journal" of the I.E.E., March, 1920 ; THE ELECTRICIAN, Vol. LXXXIV., p. 217, March 19, 1920.

[†] Prof. G. W. O. Howe. "The Upper Atmosphere and Radio Telegraphy." "The Radio Review," May, 1920.

[‡] Lieut.-Commander A. Hoyt-Taylor. "Variation in Direction of the Propagation of the Long Electromagnetic Waves." Scientific Papers of the Bureau of Standards, No. 353, November 29, 1919.

[§] Cited by Round, *loc. cit.*

is directed toward the receiving station *B*, the action of the image *C* will give the same direction as the loop *A*, and the bearing will be exact.

In the general case, the plane of the sending loop is inclined at a certain angle to the direction *AB*. The plane of the image will be inclined at a certain angle to the direction *CB*.

The receiving station will, therefore, receive at the same time the waves sent by *A* and those sent by its image *C*.

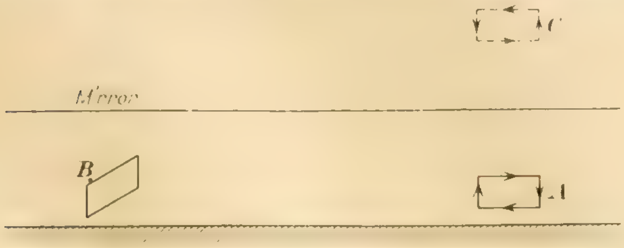

FIG. 3.

The electromagnetic field at *B* will, in consequence, be the resultant of two fields of different directions and of generally different intensities and phases; it will, in general, be an elliptical rotating field. The minimum may, therefore, be good, broad, or non-existent; and if possible to obtain a bearing at all the result will be more or less inaccurate.

TRANSMITTING STATION WITH VERTICAL ANTENNA.

Let us consider now a transmitting station provided with a vertical antenna *A* (Fig. 4). The Heaviside layer acts as if another vertical antenna *C* existed in the space and were contained in the same vertical plane of *A*. Both will give the same bearing at *B* and no errors will be found. The results are different if a horizontal sending antenna is considered. If this is perpendicular to the direction *AB* (Fig. 5) it will not directly affect the receiving station *B*, but the radiation from its image *C* will be received at *B* and an error of 90 deg. in the bearing will be observed. If the horizontal antenna is directed towards *B* (Fig. 6) its image *C* will be received at *B*, but the bearing will be accurate.

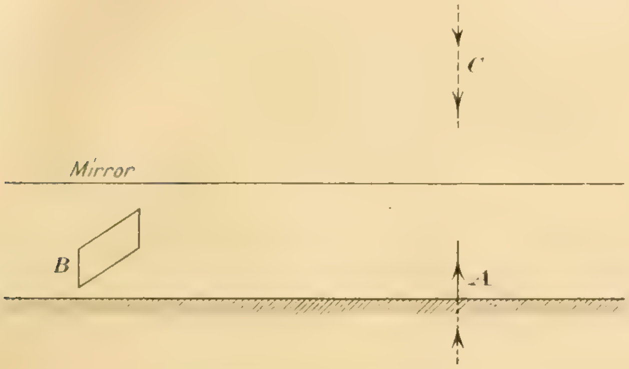

FIG. 4.

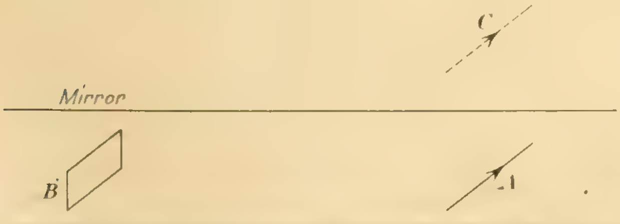

FIG. 5.

It appears, therefore, from the above examined particular cases that it is the influence of the horizontal sides of the sending antennæ upon the horizontal sides of the receiving loops that produces errors in direction finding. And as these errors depend upon the angular position of the sending loops, the fact cited under (*i*) would be explained. If a transmitting station is exclusively provided with one or more vertical antennæ, directive or otherwise, no errors should be observed. For instance, the directive sending station *A* (*see* Fig. 7), the aerial of which is formed of two vertical antennæ a fraction of wave-length apart, should according to this theory give no errors.

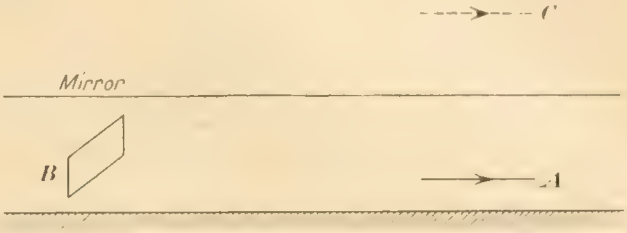

FIG. 6.

On the contrary, if the antenna of the direction finder could be so formed as to contain no horizontal parts, no errors in the bearings should be observed, independently of the fact that the aerial of the sending station contains or does not contain horizontal parts. In particular, the system of double loop employed by Weagant* as an X-stopper and the special receiving loop due to Franklin† (used alone, not in connection with an ordinary loop) should furnish exact bearings.

THE AEROPLANE EFFECT.

The Heaviside layer acts, therefore, by producing what Round calls the "aeroplane effect," which means that the image of the sending station acts as an aeroplane station high in the sky. Consequently, the methods which have been employed for eliminating the errors in the bearings of aeroplane stations should be valuable for eliminating the errors in the bearings of stations on the ground.

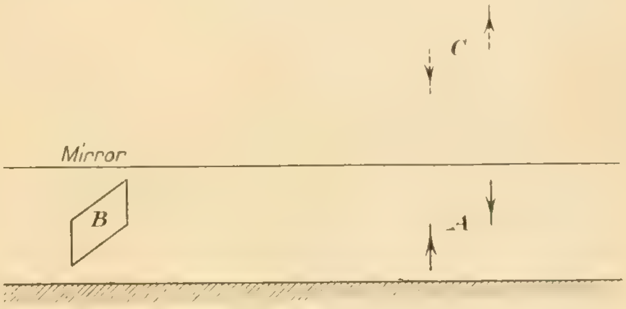

FIG. 7.

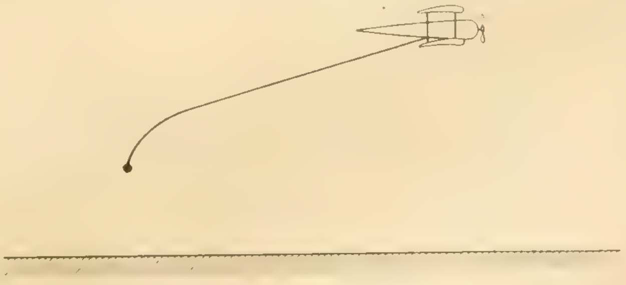

FIG. 8.

It is known that an ordinary aeroplane antenna is strongly directive, because it is of the form shown in Fig. 8. It is a kind of Marconi bent antenna. The bearings furnished by such an aeroplane antenna are wrong except when the aeroplane flies towards or from the direction finding station: positions in which the action of the horizontal side is nil. Experiments have shown that if the action of the horizontal projection of the aeroplane antenna is eliminated, which in this case means that a non-directive antenna is employed, all errors disappear and the bearings become exact (Baldus and Buchwald[*]). This fact appears to be an indirect confirmation of the present theory.

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* R. A. Weagant, "Elimination of Strays in Wireless Telegraphy," "Proceed." Inst. Radio Eng., June, 1919, and THE ELECTRICIAN, July 25 Aug. 1 and Aug. 8, 1919.

† C. S. Franklin, "Uni-Directional Transmitting Systems," "Wireless Age," June, 1919.

CONFIRMATION OF THEORY.

A direct confirmation would be given by the observations of the bearings of transmitting stations with rigorously vertical antennæ or with antennæ containing horizontal parts. The former stations should give exact bearings, the latter inexact results. We are able to verify the exactitude of the theory only for the station of Hanover (Eilvese). Round observed that the bearings of this station are exact. And as it is provided with an umbrella antenna[†], which is equivalent to a vertical antenna, it verifies the theory. Round has also found that the Malta station furnishes exact bearings. Lacking information about the antenna of this station, it is not possible to ascertain if it verifies or not the present theory.

According to this idea, it is not surprising that almost all the long-wave stations furnish inaccurate bearings. As a matter of fact, the antennæ of these stations are almost all of the Marconi bent type. They must, therefore, give bad bearings except in the particular cases where the directive finding station is in the vertical plane containing the horizontal part of the antenna. The observed fact that long waves furnish the more inaccurate bearings than short waves can be equally attributed to the circumstance that for long waves the type of antenna adopted is the bent antenna, the horizontal side of which is longer the longer the wave. To the same cause may be attributed the fact that continuous waves give larger errors than spark stations, as continuous waves are generally longer than spark waves.

THE HORSEA ERRORS.

The phenomenon observed in the Horsea arc station, which furnishes different bearings when the marking or the spacing wave is utilised, may be attributed to the fact that the current distributes itself differently in the antenna according to the wave-length used; the action of the horizontal side will, therefore, be more or less pronounced in comparison with the action of the vertical side, according to the wave-length used. If the transmitting and the receiving stations are not too far from one another, the action of the image, which is presumably very high in the sky, may become negligible in comparison with the direct action of the transmitting station, so that errors can be small or non-existent. In this manner the fact that when the located station is not further than 15 miles its bearings are accurate, whatever the type of the sending aerial may be, can be explained.

This rough sketch of a new theory requires further experimental proofs before it can be accepted or rejected. In the event that it were recognised as accurate, it would have as its first practical result that it would be obligatory to revert to the original Marconi antenna or to its equivalents in transmitting stations destined to serve as beacons for directional wireless telegraphy.

Some Thermal Characteristics of Electric Ovens and Hot-Plates.[‡]

By EZER GRIFFITHS, D.Sc., and F. H. SCHOFIELD, B.A., B.Sc.
(From the National Physical Laboratory.)

The British Engineering Standards Association recently issued a Standard Specification (No. 106—1920) for electrically-heated cooking ranges. It was thought that an account of the thermal tests specified in the report and based largely on work at the National Physical Laboratory might usefully be published. Heating appliances have been evolved for various purposes. For toasting or grilling, a high proportion of radiant energy is required, involving the use of bare resister elements run at a red heat; for intermittent operations the lightly-constructed plate or oven embodying a minimum amount of metal has advantages; for prolonged or continuous operations the heavily constructed plate or well-lagged oven is probably best. A temperature of 200°C. (392°F.) has been taken as the upper limit of working, representing the point generally aimed at for roasting, baking or frying operations.

HOT-PLATES.

Hot-plates are used mainly for frying and boiling. Frying demands a plate of small thermal capacity, facilitating the rapid rise of temperature of a light pan for the least expenditure of energy, while for boiling large volumes of water a plate which, when working at an approximately constant temperature, will transfer to the water the largest fraction of the energy supplied, is necessary. Ordinary cooking utensils are not sufficiently standardised to be used for quantitative tests, and it was necessary to substitute metallic discs of suitable cross-section and thermal capacity. Experiments were also made with special cast-iron vessels containing oil.

EXPERIMENTS WITH DISCS.

In certain tests carried out with discs the following factors were investigated: (1) Distribution of temperature over disc. (2) Influence of the relative size of disc and plate. (3) Influence of oxidation of the disc surface. (4) Difference produced when the disc was in good thermal contact with the hot-plate, and when separated from it by steel pegs.

Except where otherwise stated, the copper disc used was 4·8 mm. thick and 17·8 cm. in diameter, it was supported off the plate by steel pegs about 2 mm. long, and the surface of the disc oxidised. Temperature distribution was studied by means of thermo-couples pegged into the upper surface of the disc.

Temperature distribution.—During the heating up of the plate this was quite uniform both for open and enclosed types of plate. But where the disc was larger than the heat-emitting area, the outer edge of the disc lagged behind the centre.

Influence of diameter of disc.—Copper discs of the same thickness but of different diameters (13·3 cm. and 17·8 cm.) were placed over an enclosed hot-plate of diameter 20·3 cm. There was only a very slight difference between the rate of temperature rise in the two cases.

Influence of surface oxidation.—When supported off the hot-plate by the steel pegs the copper disc is heated primarily by radiation and by air conduction through an air layer of 2 mm. thickness. Convection is probably negligible. Hence the oxidation of the receiving surface exercises a considerable influence on the heat transfer by radiation.

THEORY OF HEAT TRANSMISSION FOR A DISC ON PEGS.

The authors, in considering the conditions theoretically, use the primary formula $H_R=\sigma(T_1^4-T_0^4)$ (where σ is a black body constant and T_1 and T_0 the absolute temperatures of the surfaces). Assuming the coefficient of emission of a cast-iron plate to be 70 per cent. of that of a black body, and for oxidised copper 50 per cent., the right side of the above formula requires to be multiplied by 0·35. Multiple reflections increase heat transfer by radiation. Assuming that the temperature difference between two adjacent surfaces is about 300 deg. C. it appears that:—

$H_R=0{\cdot}095$ calories per square centimetre per second
$H_c=0{\cdot}075$ „ „ „ „

so that radiation is more important than conduction in transmitting heat.

CONDITIONS WITH OPEN HOT-PLATES.

With the open spiral type of hot-plates the conditions are different. The spirals are running at a steady bright red heat and the fireclay grooves are also at a fairly high temperature. Since the air-gap is increased some convection probably occurs, and thermal conduction may be relatively unimportant compared with radiation and convection transfer.

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[*] R. Baldus and E. Buchwald, "Versuche über drahtlose Antheilung von Flugzeugen," "Jahrb.d. Drahtl. Tele.," March, 1920.

[†] A. S. M. Sorensen, "Wireless Station at Eilvese (Hanover)," "E.T.Z." May 22, 1919.

[‡] Abstract of a Paper read before the Institution of Electrical Engineers.

Some experiments were made with a closed-type plate to illustrate the influence of the surface condition of the receiving copper disc. The watts supplied were approximately equal in the three experiments, being about 1,490. In the first experiment, using an oxidised disc, the temperature rise at the end of 13 minutes was about 30 deg. C. more than for the second experiment, in which the disc was cleaned on both sides with emery paper. In the second experiment the rise was nearly 30 deg. C. more than in the third experiment, where the receiving surface was highly polished and the top surface oxidised. Polishing the surface thus reduces considerably the rate at which the disc absorbs heat.

Effect of Metal Contact between Hot-plate and Disc.—For these experiments a rectangular hot-plate 20·3 cm. by 15·2 cm. and a copper disc 12·7 cm. diameter and 0·8 cm. thick were taken.

In the first experiment, with the copper disc in contact with the hot-plate, the surface was initially well polished. For the second experiment, it was left in contact with the hot-plate, and heated until the exposed surface was well oxidised. The oxidisation did not affect the rate of rise of temperature, and the two surfaces were in sufficiently intimate contact to prevent oxidation of the receiving face of the disc.

For the third and fourth experiments the copper disc was raised with the three steel pegs of the standard disc. The time required to heat up to 200 deg. C. was reduced from about 13 or 14 minutes to 6 minutes, by placing the surfaces in close contact.

SUMMARY OF RESULTS WITH COPPER DISC.

Some typical results obtained with the copper disc selected are shown in Table I. In the columns of "efficiencies" is given the ratio of the heat absorbed by the disc, *i.e.*, the heat capacity of the disc multiplied by the temperature-rise of 100 deg. C. or 200 deg. C., to the energy supplied to the hot-plate during the time interval taken by the disc to rise 100 deg. C. or 200 deg. C.

These experiments bring out two important points: (1) The interposition of an air-gap by means of pegs makes the contact conditions reproducible, but this may operate unfairly against the hot-plates with machined surfaces compared with the radiant types. Manufacturers of flat-top plates assume that the utensils should have a flat bottom and would in practice make reasonably good thermal contact with the surface of the hot-plate. Makers of the open-type design the plate so as to obtain the maximum transfer of heat by radiation. The test should therefore be devised so as to take account of this essential feature of the plain type by providing the disc to be heated with a flat surface.

(2) The disc has a very small thermal capacity, being equivalent to only 0·18 pint of water.

The electricity energy supply to the hot-plate is used partly for warming up the plate itself, partly in heating the receiving disc, and partly to supply the loss by radiation, &c. Hence the rate of rise of a disc of small heat capacity is largely dependent on the thermal capacity. Such a test therefore gives a measure of the energy wasted in heating up the hot-plate to the working temperature, rather than its efficiency for normal working.

EXPERIMENTS WITH THICK DISCS.

Further experiments were made with thick discs. A plate of mild steel was used 18 cm. in diameter, and 3·8 cm. thick. One face was machined on a surface grinder to an accuracy of ±0·0005 in. Uniformity of temperature over a plane of the disc was quite satisfactory and the mean temperature could conveniently be obtained by observations with a mercury thermometer. A hole was drilled in the plate and the bulb was inserted at a point two-thirds along the radius from the centre. A little mercury was run into a hole and sealed with asbestos to ensure good thermal contact. The heat capacity of this disc was equal to 1·6 pints of water, while a similar copper disc had a rather larger capacity.

Results with these discs, similar to those given in Table I., are presented in the original Paper.

The efficiencies recorded during heating range from 29·3 to 60·2 per cent., and the corresponding efficiencies for a complete run from 31·3 to 62·7 per cent. The times taken to rise to 200 deg. C. vary from 17·33 to 25·92 minutes, and the maximum temperature from 204 deg. to 226 deg. C.

EXPERIMENTS WITH CAST-IRON VESSELS.

The experiments described in this section were made with two cast-iron vessels 17·8 cm. and 20·3 cm diam. The bottom surface had been machined up, but were not quite true. The cotton-seed oil used as the liquid could be raised to a temperature exceeding 200 deg. C., but was very viscous at low temperatures, making thorough stirring by hand impossible.

The loss by evaporation was 0·046 gm. out of 986 gm. at 150 deg. C. lost 0·046 gm. per minute. Water maintained at 80 deg. C. showed a loss of 2·35 gm. per minute.

The time temperature curves for repeat experiments were not as concordant as those with the discs, possibly due to variable thermal contact and to inefficient stirring.

Calculations of the efficiencies of the hot-plates were made on the basis of the above experiments, assuming that the bowl is at a uniform temperature throughout, and that the specific heat of the oil is 0·5. With bowl diameters of 7 and 8 inches efficiencies of 31·8 to 53·4 per cent. for the full run, and 27·4 to 42·7 per cent. for the first 100 deg. C. rise were recorded. The temperature interval for the full run ranged from 12 deg. to 122 deg. C. up to 14 deg.-182 deg. C.

CONCLUSIONS ON EXPERIMENTS WITH HOT-PLATES.

The experiments suggest the following factors for consideration when framing specifications for hot-plates:

1. Vessels containing liquid for testing hot-plates involve difficulties due to the necessity of stirring, heat loss due to evaporation, &c. It seems preferable to rely on metallic discs of known thermal capacity for such tests.

2. The disc should be of the diameter for which the hot-plate is designed.

3. The apparent efficiency of the plate depends upon the mass of the disc. Hence one should use a receiving disc of thermal capacity roughly the same as the kettles or other utensils used in practice.

4. The major part of the heat transmission with the enclosed type of hot-plate is apparently by metallic conduction. Consequently the test disc should have a plane surface.

Utensils with enamelled surfaces, oxidised and irregular bases will give efficiencies much below those obtained with a clean disc. These defects have much less influence on an open type of hot-plate. It might be advisable to have one surface of the receiving disc polished (in contact with enclosed hot plates) and the other oxidised, and facing the radiator when testing the open or radiant types.

5. Disc tests might be used for defining the minimum require- for hot-plates, *e.g.*, that for a certain energy consumption the hot-plate should raise the temperature of the disc to a certain maximum (say 200 deg. C.) within a certain time, and that the energy required to maintain the disc at that temperature should not exceed a certain amount. The energy limits would be fixed relative to the effective area of the plate.

COOKING STOVES.

When specifying tests for cooking stoves two distinct phases have to be considered. First, the heating-up period when the temperature of the oven is raised from that of the room to a certain maximum, say 200 deg. C. Secondly, the cooking period, the duration of which may vary considerably, when the temperature is maintained steady or allowed to fall slightly. Hence the efficiency of an oven should consist in the determination of (1) the number of electrical units

Table I.—*Hot-plates.*

Copper Disc on Pegs 17·8 cm. diameter: 4·8 mm. thick. Weight, 1,073 *g.*

Plate	Time to Switching Off.	Temp. at switching off.	Mean watts.	Time to rise 100 deg. C.	Efficiency.	Time to rise 200 deg. C.	Efficiency.
	Min.	deg. C.		Min.	Per cent.	Min.	Per cent.
Open Type, A	11	248	1,295	4·5	12·1	7·9	13·7
Open Type, B	10	215	1,259	5·4	10·4	10·0	11·2
Closed Type, C, 7 in. diameter	18	247	1,150	10·2	6·0	16·1	7·6
Copper Disc 133 *mm.* × 4·8 *mm. Weight,* 596 *g.*							
Closed rectangular plate, 8 in. × 6 in.	6 min. (Plate in contact)	203	930	3·1	13·5	–	—
	14 min. (Plate on pegs) ...	200	910	9·0	4·8	—	—

required to bring the temperature of the interior to the maximum within a certain period, (2) the energy required to keep it at the minimum temperature necessary for cooking operations.

The measurement of energy is easy, but the temperature observations present difficulties, owing to thermometric lag and non-uniformity of distribution in the oven.

Experiments on Thermometric Lag.—In the first instance thermo-elements of iron-constantan were used with the hot junction formed of sheets of oxidized copper foil 5 cm. in diam. by 0·005 cm. thick. It was thus possible to measure temperatures at places inaccessible to mercury thermometers. The thermometric lag was practically negligible, and the relative lag of the mercury thermometers could be obtained by comparison. In an oven which took 12 minutes to reach a temperature of 200 deg. C. from cold, the mercury thermometer lagged about 20 deg. C. behind the thermo-element, and for an oven taking 40 minutes to reach 200 deg. C. the lag was only 5 deg. C. However, some method of obtaining the average temperature of the volume in the centre of the oven appeared advantageous. Experiments were made using a hollow copper sphere with the two wires of the couple soldered to the top and bottom hemispheres respectively. This arrangement gives the average temperature of the space occupied by the envelope. The sphere lags behind the disc by about 25 deg. C. in an oven taking about 16 minutes to reach a temperature of 200 deg. C. This lag could be reduced by making the sphere of thinner metal. The indications of the spherical form are independent of the orientation, whereas with disc couples the indications necessarily depend on the angle which the faces of the receiving discs make with the plane of the heating elements, owing to direct radiation.

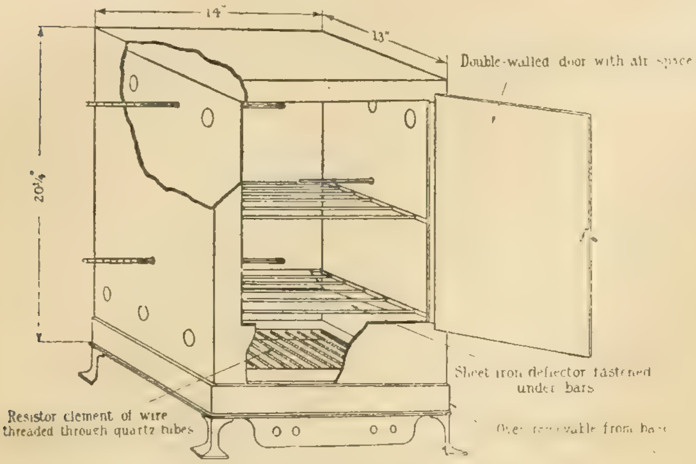
14"
13"
20¼"
Double-walled door with air space
Sheet iron deflector fastened under bars
Resistor element of wire threaded through quartz tubes
Oven removable from base

FIG. 1.—RELATIVE DISPOSITION OF HEATING ELEMENTS AND THERMOMETERS IN TEST OVEN P.

For works' use the thermo-element is not so convenient as a mercury thermometer, and accordingly further experiments with the latter were made. In the thermometers, of the nitrogen type, and 18 in. long, developed for this work, the zero of the scale was distant 6 in. from the bulb, permitting an immersion of 5 in. into the oven. The range of the thermometers was from 0 deg. to 250 deg. C., occupying 12 in.

It was found that the differences obtained for the various sized commercial thermometers were almost negligible compared with the lack of uniformity in the oven.

DISTRIBUTION OF TEMPERATURE.

The distribution of temperature differs considerably in the different types of ovens.

In the case of oven P (Figs. 1 and 2) the temperature observations were taken during the period of heating up and with the current switched off; in the other case during the heating-up period, and during the period of steady temperature with the heaters at low heat. No general rules can be laid down for the distribution of temperature and it would be impracticable to attempt an integration to obtain the true mean temperature. It will probably suffice to take readings given by a single thermometer projecting into the centre of the oven.

TESTS OF OVENS.

The oven was run at "full heat" to the temperature desired and then reduced to the medium or low heat by switches. This corresponds closely to what occurs in practice. The data obtained are summarised in Table II. The lagged ovens, usually of heavy construction, require from 1 to 1½ units to raise the temperature to 200°C., but are efficient when working at a steady temperature if account is taken of the cubic capacity in relation to watt supply.

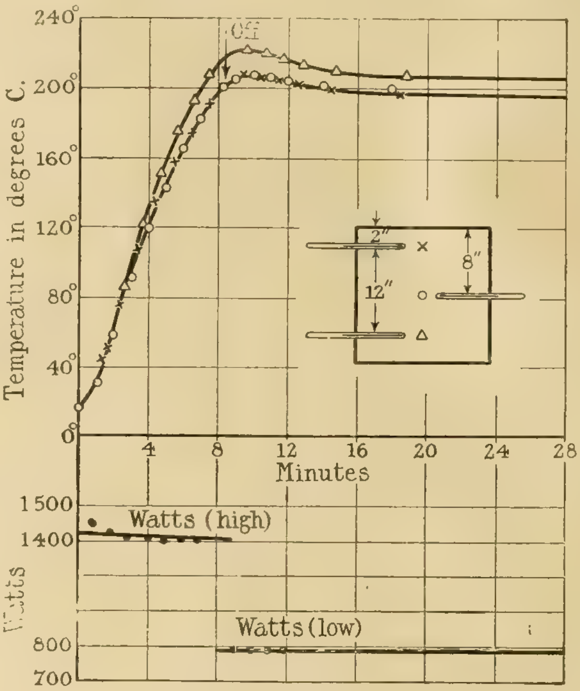

FIG. 2.—DISTRIBUTION OF TEMPERATURE IN TEST OVEN P.

CONCLUSIONS.

Specifications for tests on ovens should cover :—

1. Maximum time permissible for the oven to heat up to a certain temperature (say 200 deg. C.) from room temperature for a certain watt supply.

Table II.

Summary of Data on Ovens.

Type of Oven	Time taken to reach 205 deg. C. from Switching On		Average Watts	Total Raise to 200 deg. C.	Approx. Cubic Capacity.	kWh per cub. ft.	Temp. after following Time from Switching Down		Watts for Temp. under Col. 7	Watts per c. ft. on Medium Heat.
							15 min.	30 min.		
	Min.	Sec.	Watts	kWh	m^3	kWh.	deg. C.	deg. C.	Watts	Watts
Ovens of Light Construction and Air-gap Insulation	21	21 top heaters	570	0·203	0·58	0·350	199	199	360	621
	14	10 bottom heaters	785	0·185	0·58	0·319	205	204	360	621
	8	18	1,410	0·195	0·88	0·222	198	195	790	898
	24	12	1,210	0·488	1·91	0·256	197	188	655	343
	36	50	1,790	1·100	1·88	0·585	170	145	550	293
	19	27	1,990	0·645	1·55	0·416	169	165	810	523
Ovens of Heavy Construction, Lagged	33	50	2,275	1·283	2·06	0·623	214	225	1,350	655
	43	16	2,065	1·489	2·14	0·696	200	186	820	383
	24	27	2,590	1·055	2·71	0·389	197	200	710	262

NOTE.—The temperatures are those of the centre of the oven in each case.

2. Variation in temperature from top to bottom.
3. Permissible variation in temperature during a period of half an hour from switching down to medium heat.
4. Method of stating efficiencies in relation to cubical contents.

Thermal Insulation of Ovens.

The thermal efficiency of an oven is largely a question of providing suitable insulation. The transfer of heat from the hot air inside an oven to the outside cold air involves :—

1. *Transfer of Heat to the Inside Wall of the Oven.*—The heating units will dissipate heat partly by convection and partly by radiation. Some of the latter may be intercepted by objects in the oven, hence convection may account for a large proportion of the heat transfer.

2. *Transfer of Heat from the Inside Wall to the Outside Wall of the Oven.*—In lightly constructed ovens one may have merely air between the walls. Transfer will then take place by convection and radiation. In heavy ovens the space is usually packed with insulating material through which some heat will pass by conduction.

3. *Transfer of Heat from the Outside Wall.* This will take place by convection through the air and by radiation to the surroundings. The laws governing convection are complex and have not yet been fully investigated Taking a freely exposed vertical surface as being typical of oven walls, the curve connecting convection loss and temperature difference will be approximately that shown in Fig. 3 (see bottom curve).

The remaining curves give the total heat loss for surfaces of various emission coefficients, and illustrate the importance of employing surfaces of low radiating and absorbing power. Thus for a temperature of 100 C. above the surroundings, the heat loss of a surface with a 10 per cent. coefficient will be only about one-half of that of a black body. Paints * of all colours and surfaces (from matt to enamel) have coefficients of 80 to 90 per cent., oxidised metal surfaces 50 to 90 per cent., dull metal surfaces 20 to 40 per cent., polished metal surfaces 3 to 10 per cent. Naturally highly polished metal surfaces cannot be used in oven construction, but the use of clean unoxidisable surfaces adds considerably to efficiency.

The authors give a brief analytical treatment of ovens with thin solid walls, and with a double wall with either air or insulating material between. The interposing of insulating material may diminish the rate of heat flow per unit area of wall by 50 per cent., but this assumes a steady state, *i.e.*, an oven run continuously. In practice working is intermittent and a heavily lagged oven may be disadvantageous. Its greater heat-capacity causes energy to be wasted in heating up the mass, and it takes longer to attain maximum temperature. It is inferred that while the air and internal wall of the oven reach their maxima in less than 50 minutes the exterior wall may take over 100 minutes to reach a steady condition.

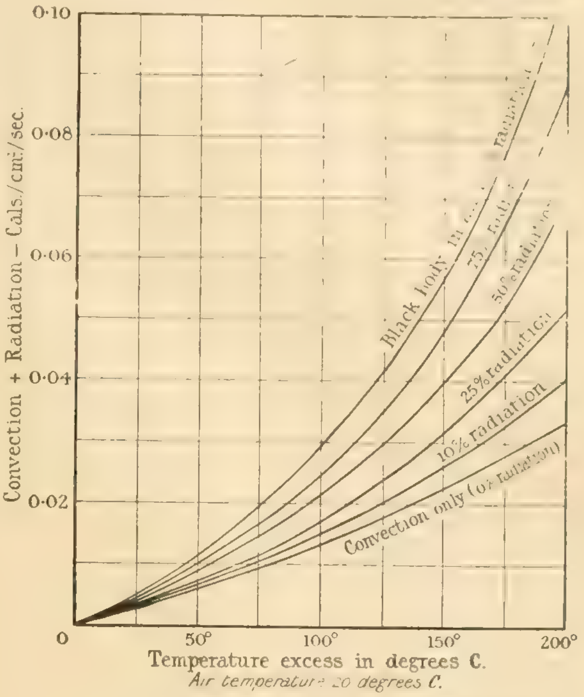

Fig. 3.—Total Losses from Heated Surfaces in Air.

Institution of Electrical Engineers.

There was a crowded meeting at the Institution of Civil Engineers on Thursday, February 10, when the Institution of Electrical Engineers met to consider a Paper on "Some Thermal Characteristics of Electric Ovens and Hotplates," by Dr. **Ezer Griffiths** and Mr. F. H. **Schofield** and to discuss "Electrical Appliances for Domestic Purposes." An abstract of the Paper will be found on another page of this issue.

We were glad to see that a larger proportion than usual of younger members were present, especially at the Council table, and that the conduct of the discussion generally was in the hands of the coming, or perhaps it would be more accurate to say of the present, generation. In opening the meeting the **President** announced the resignation on the grounds of ill-health of Mr. S. L. Pearce from Vice-Presidency of the Institution, and said that Mr. A. A. Campbell Swinton had been elected by the Council to take his place, a statement which was received with openly expressed approval. Those who are interested in such subjects will now be able to make a calculation as to how the change from an electricity supply engineer to a wireless expert will affect the balance of representation on the governing body.

An Open Discussion.

After the Paper had been read the **President** announced that the discussion need not be rigidly confined to its subject matter This concession, as will appear, was taken full advantage of. He added that the Paper was a record of important investigations and would be useful in providing a basis for future work.

He was followed by Mr. J. W. **Beauchamp**, who is, of course, well at home on this subject, and who is one of those speakers who is able to put forward his points clearly and with unmistakable effect. He began by pointing out that the authors' tests disclosed a very small difference in efficiency between the best and worst of the apparatus tested. This was all very well as far as it went, but in practice that very important additional factor, the efficiency of the operator, must not be forgotten. The authors had called attention to the undesirability of using a large hot-plate to heat a small pot. But that kind of thing was continually being done in practice and could only be overcome by providing better switching facilities and more instruction. It was, in fact, the art of switching that must above all things be taught. In an ordinary coal fire only a very small percentage of the heat emitted was used for cooking the food, and care must be taken that this did not take place when electricity was the agent. He looked forward to the time when boiling by means of hot-plates would be discarded and their place taken by an immersion heater with a stream line or pear shaped body which could be lowered into the pots among the food and, being of metal could be easily cleaned.

Some Few Criticisms.

To enthusiasts for electric cooking Mr. H. H. **Berry** must have seemed to have adopted the role of devil's advocate. He thought that electricity could only be used as a secondary agent for heating or cooking, and that to get the highest efficiency the original fuel must be directly employed. As far as the supply of hot water was concerned his idea would be to use a central coal-fired furnace with electric heaters for "topping up" and the same scheme could be used for heating rooms with efficiency, economy and comfort.

Mr. W. A. **Gillott** speaking from the back benches, adopted the attitude which is popularly supposed to be associated with those who occupy that quarter. He began by making the excellent point that the terms used in electric cookery must be standardised. The term hot-plate employed by the authors should be dropped for boiling plate. A cooking stove might mean anything—Tommy's cooker, for instance. Oven was the term to use. As a maker of this class of apparatus he thought that the authors' tests were too much of a laboratory character and were without commercial value. Would it not have been possible to specify that say, an eight-inch hot-plate should boil a definite quantity of liquor in a definite time? Such an efficiency would be understood by a cook, while she would be completely mystified by the terms used in the B.E.S.A. specification. A laboratory atmosphere also attached to the oven tests. What was wanted by the consumer from this apparatus was a definite result in cooking. In an electric oven the elements should be at the side and rapidity of heating up was essential. The authors had said nothing about the most suitable type of element to use. His own opinion was that for grills and boiling plates the open type consisting of a fireclay core with a spiral wound upon it left little to be desired. This core must be capable of standing extreme temperatures and tests such as being plunged into cold water when red-hot without fracture.

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* A metallic paint such as aluminium paint is an exception, having a coefficient of about 50 per cent.

The Paper Discussed.

Mr. W. R. Cooper, who followed, discussed the authors' Paper a good deal more closely than did many of the other speakers. He pointed out that they had confined themselves to tests starting from cold while continuous running tests were equally desirable. He did not like the disc on pegs which had been employed in the tests, as they raised the question to a remoteness from practical conditions. When vessels containing water or some other article were being heated up the under surface was comparatively cool, leading to a high temperature gradient at the surface of contact. The procedure followed by the authors did not allow a fair comparison between closed and open type plates. Their care in surfacing the discs used went beyond commercial conditions, and a metal disc would get very much hotter than a saucepan containing water would ever do. He also objected to the methods adopted by the authors for determining efficiency as they included both the thermal loss from the plate and that from the metal disc. The method employed was indeed condemned by the results obtained, which were very contradictory. In considering heat losses in ovens we must take account of the heat radiated and the heat absorbed. He had applied the authors' interesting indicator diagram to his own oven. He found that in one hour, starting cold, his oven, if unlagged, would take about 1,000 watt hours to supply the radiation loss, whereas in its lagged condition it would require about 200 watt hours. In the latter case the heat absorbed would be something like 500 watt hours, so that there was 700 for the lagged against 1,000 watt hours for the unlagged oven.

Scorn and Practicality.

Mr. Hadyn T. Harrison began by throwing scorn on those who objected to the Paper because it did not work out results in beefsteaks per hour. Having got rid of this gibe he went on to discuss various matters from quite a sufficiently practical point of view. Electric ovens were passing through an evolutionary stage. Those tested by the authors seemed in fact to have derived their origin from the gas oven. The original oven, which consisted of a hole in the ground, had a smaller ratio of cooling surface for its contents than the cubic gas oven, but electrical engineers had not yet taken advantage of that fact. It was curious also that electric ovens were always made of a material that radiated the heat. An oven of some non-conducting material would have a higher efficiency than any of the present arrangements. For the moment our cooking utensils would be used discriminately on coal fires, gas fires and electric cookers so that the bottoms would become not oxidised but carbonised. It would be interesting to know what the effect of this would be. He supported Mr. Beauchamp as to the need for education. He had heard of a case where the monthly cooking bill by electricity in a fairly large house came to £46, the cook having used the cooker to keep the kitchen warm. In inviting the use of electrical appliances too much should not be made of their economy. Convenience was a very much stronger card, and the fact that electric cookers kept servants in a house was really more important than that one oven used 10 per cent. less energy than another. On the day when supply undertakings were able to supply energy for domestic purposes he hoped that a genuine campaign of propaganda would be inaugurated by installing cooking apparatus free so that consumers might learn from actual experience of their convenience.

"Absorption Ratio."

Mr. P. Good, another back-bencher, turned out to be a supporter of the Government. He objected to the word "efficiency" in connection with the authors' tests. "Absorption ratio" would be a better term. The difficulty of using the heating of a certain quantity of water to boiling point as a standard was that it was not easy to repeat the results with any considerable degree of accuracy. The authors did not pretend to deal with absolute efficiencies, but rather to point a way of measuring the relative values of various apparatus. Cooking apparatus was not the only domestic appliance to which the care and attention of men of eminence in the industry should be given. The standard wall plug was a case in point. No doubt something would be done in this way when trouble was taken by all concerned to demand interchangeable wall plugs.

Prof. E. W. Marchant objected to the methods of testing employed by the authors on the score that they gave more unfavourable than truthful results. What they determined was not so much the efficiency as the rate at which energy was radiated away. This was corroborated by some tests he had made. While he did not suggest that experimenters should cook their results they should at least try to get a figure which truly represented the performance of the apparatus.

The Use of the Immersion Heater.

Mr. C. G. Nobbs also thought that hotplates should be tested by boiling water, using, say, three consecutive rates of heating. He agreed with Mr. Beauchamp that the future for boiling lay in the use of immersion heaters, either of a universal portable type or fitted to special vessels for particular operations. The oven tests given by the authors should be extended into more practical fields, as the food that was being cooked had a considerable effect on the temperature distribution in the oven. This was particularly important in considering the effects obtained with air lagging and slag-wool lagging. In addition, the mere opening of the oven door might cause a very large drop in the thermometer reading. Testing hotplates by boiling water introduced a great temperature difference owing to the greater receptivity of the underside of the vessel due to the difference in the temperature of the source of heat and of the vessel. He added that manufacturers would welcome the standardisation of ovens and on such points as top and bottom heating, shape, depth, &c This is certainly a consummation which should be worked for.

Mr. A. F. Berry said that Mr. Gillott's remarks about efficiency in cooking showed how complex the whole question was. Another complexity was introduced by the use of thermometers, and figures which had been placed before him only a short time ago showed that a thermometer sticking into an oven about 2 in. read uniformly 100 deg. lower than a thermometer in the centre of the oven up to a maximum temperature of 600°F. If cooks were to leave ovens on night and day, as had been usual at one time, an unlagged was better than a perfectly lagged oven. He was in agreement with Mr. Beauchamp about the need for instruction in the art of switching.

An Outspoken Critic.

About this time the discussion seemed rather to fizzle out, probably because several members who had sent in their names were not present when called upon to speak. Prof. Macgregor Morris, however, stepped into the breach with a good fighting speech. He began by deprecating the use of turned iron vessels, as he thought their life would not be very long. He regretted that nothing had been said about reliability. (A very important point this.) His own experience with electric cooking over a period of 15 years showed that repairs and renewals of the boiling elements was a serious matter; and if he had not been an electrical engineer he would have turned the apparatus out of his house long ago. Similar drawbacks were found in many electric radiators, where the springs in the bayonet holders perished after a time owing to the heat, or something else was affected for the same reason. Little details like this did not mean much to the designer perhaps, but they meant a great deal to those who used the apparatus, and must be considered if electrical appliances were to be used by everyone, as we all hoped they would be. The meeting took this in good part, and there were no unparliamentary incidents.

Mr. E. T. Williams thought a solution of switching difficulties might be obtained by the introduction of automatic appliances.

Mr. W. P. Adams thought that the domestic electric problem was the same as it was 20 years ago. The housewife could not afford to employ electric ovens unless some means were provided for boiling water.

Dr. E. Griffiths, in reply to the discussion, agreed that some other term instead of efficiency might be advisable. The evaporation of water would introduce complications into tests employing cooking vessels.

The President, in moving a vote of thanks to the authors, said it was regrettable that no ladies had taken part in the discussion, as he was sure that they could have told them a good deal, at any rate on a side of that practical subject which he was sure nobody in the room understood anything about.

This really sums up in a word the criticism against putting forward an interesting, but theoretical, Paper as an opening for what must and should, be a practical discussion. We refer to this matter more, particularly in our Leading Article, but surely the time has now come when discussions on the design and manufacture of electrical apparatus from a practical point of view are not only desirable but eminently necessary.

The Physical and Optical Societies' Annual Exhibition.

(*Concluded from p.* 201.)

CALLENDER'S CABLE AND CONSTRUCTION CO.

The Yardometer. A new instrument exhibited, which has for its object the easy measurement of the length of cable on a drum or coil, is called the "Yardometer," and has been designed by Messrs. Callender's Cable & Construction Company, Ltd., and Mr. W. E. Benson. Cable manufacturers and stores often require to know the length of cable on a drum without the trouble of unwinding and passing it through a lineal measuring machine. It is further often necessary to check the length of cable returned to the stores after a drum has been issued to have a length cut off. This instrument has, therefore, been specially designed to enable a boy or girl without any skill or technical knowledge to measure unknown lengths of cable in a few seconds by a simple mechancial operation. The instrument can also be used very simply to indicate the approximate position of a fault in a drum of cable.

The instrument, which is illustrated in Fig. 26, comprises a handle for rotating a cylinder, on which the scale in yards is marked, a number of balancing resistances corresponding to 110 yards at 60 deg. of all the various C.M.A. sizes from 1/0·036 to 19/0·064, an indicating galvanometer and a key. In order to test a length of cable, say, for example, 7/0·044, the balancing coil marked with this gauge is plugged in, the handle rotated and the key momentarily depressed, until the galvanometer pointer is stationary, when the correct length in yards is read off on the scale through the window in the front. The whole operation can be carried out in a few seconds, as the galvanometer being a central zero instrument, the operator is enabled to determine in which direction the handle should be turned.

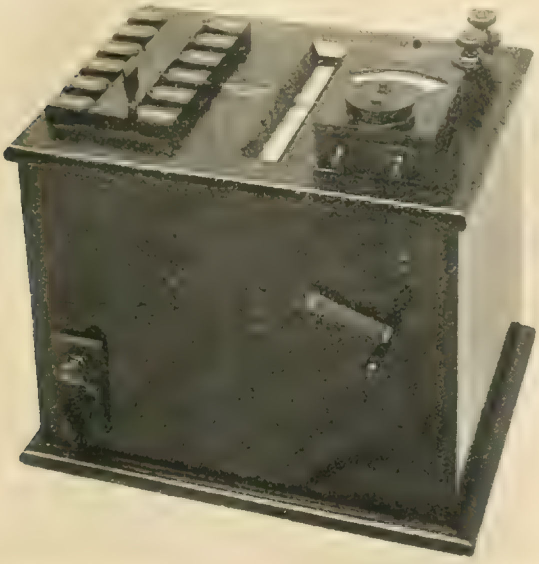

Fig. 26.—The "Yardometer."

Principle of the Instrument.

The instrument acts on the Wheatstone bridge principle, as shown in Fig. 27. In this diagram A is any one of a number of resistances corresponding to various standard sizes of cable which can be plugged in to balance the cable under test. B is the cable under test, $C\,D$ is a slide wire of 1,000 actual inches in length wound on a drum with a contact maker, E, working on a threaded rod operated through gearing from the handle by which the drum is rotated. G is a sensitive indicating galvanometer and K_1, K_2 are battery and galvanometer keys operated by the same knob. The correct length of cable is indicated on the dial when the ratio of B/A = the ratio CE/DE, this condition being shown by the needle of the galvanometer remaining stationary when the key is depressed.

Fig. 28 shows the operation of the instrument when used as a fault locater. Suppose a fault exists at F. The length of cable is first measured on the machine, as previously explained, then by means of a two-way switch S the bridge junction is changed from the end of the cable to the fault F; the handle is then rotated until the needle is at rest, when the

$$\left.\begin{array}{r}\text{Actual distance from } F\\ \text{in yards}\end{array}\right\} = \frac{\text{the observed distance}\times(L+110)}{\text{observed distance}+110}$$

where L=length of cable in yards. For example, suppose the cable length is 220 yards and is faulty, and with the switch on F suppose a balance is obtained at 80 yards:

$$\left.\begin{array}{r}\text{Then the actual distance}\\ \text{of the fault}\end{array}\right\} = \frac{80\times(220+110)}{80+110} = 139 \text{ yards.}$$

The instrument will be found particularly useful for locating faults in cables lying in water in the test tanks, when the cable has no metallic sheath. The fact of being able to locate a fault easily in cable lying in water is a distinct advantage, as in the event of a fault during manufacture the cable shops very often want to know the position at once, with a view to determining what shall be done with the cable. It is a very laborious operation to wind the cable on to a second drum, through a wet swab, only to find the fault is at the bottom end, perhaps within 1 ft. or 2 ft.

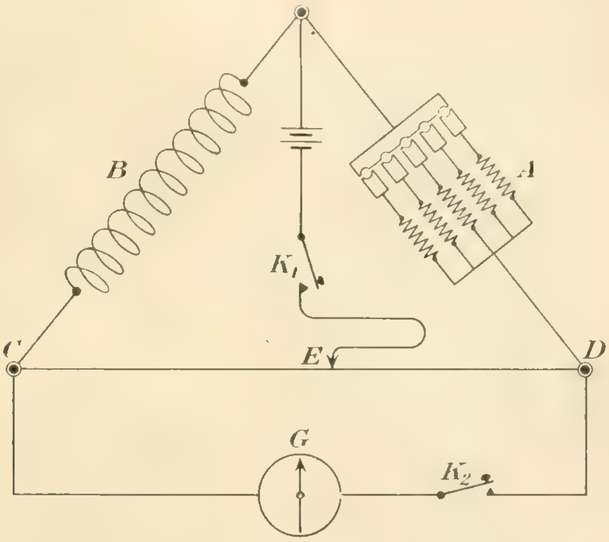

Fig. 27.—Diagram of Yardometer for Indicating Length of Cable.

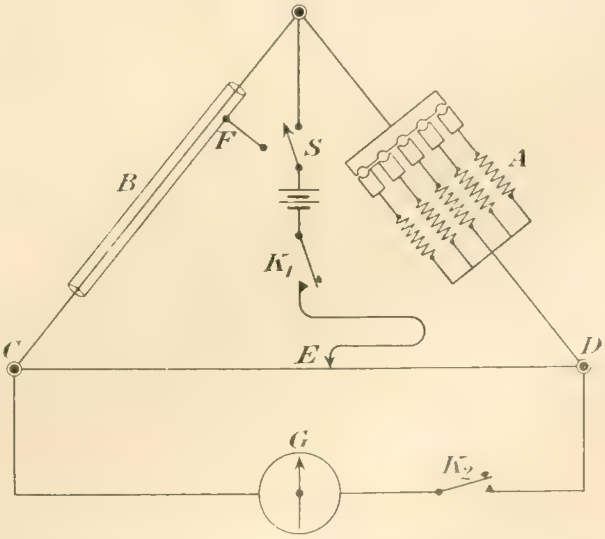

Fig. 28.—Diagram of the Yardometer Connected to Locate a Fault.

of the end, whereas, by previously locating the position, the end could have been examined and the fault found without the whole of the cable being unwound. The location is, of course, facilitated by dropping a handful or two of common salt into the water in the neighbourhood of the cable thus reducing the resistance of the water.

CROMPTON & COMPANY.

Messrs. Crompton & Company exhibited a number of their well-known potentiometers and kindred apparatus. We noticed particularly a Kelvin bridge made up with a slide wire, variable standard and variable ratios, the dial switches being under glass. The standard consists of a resistance of 0·01 ohm divided into nine sections, each of 0·001 ohm, and a slide wire also of 0·001 ohm. The ratio arms give multiplying factors of 0·01, 0·1, 1, 10 and 100. A very useful adjunct is a set of ratio arms mounted in a box with suitable keys, and operated by a dial switch under glass. This is arranged to give the percentage difference from the standard in several steps on either side of equality, the actual percentage errors being arranged to suit requirements. Such an accessory is very convenient when adjusting a number of low resistances, such as ammeter shunts, to a standard.

A simple type of potentiometer was shown, made to the design of Prof. Robertson, of Bristol. It is intended for use in educational laboratories to meet the double purpose of an ordinary four-gap slide-wire bridge, and a simple form of potentiometer. Bearing in mind the usage to be expected from elementary students, this has been made simple and robust, while at the same time there have also been kept in view the requirements of lowest cost consistent with good workmanship and accurate adjustment, and of ease of storage when not in use. The complete set consists of a four-gap slide-wire bridge of improved pattern; a three terminal dial switch resistance box of 1–10 ohms, to carry 1 ampere; and 1 ohm and 100 ohm standard coils of open pattern and high current-carrying capacity, made to screw directly into the gaps of the bridge. Among the special features of this bridge we may mention that the slide wire is adjusted to have a resistance of 1 ohm with an accuracy of 0·1 per cent., so that each scale division is 1 milli-ohm. Besides being useful for other purposes, this makes ordinary resistance coils convenient as extension coils, enabling the dial box intended as an extension of the slide wire when used as a potentiometer to be graduated in ohms, so that it is also available for other purposes. While fully visible and easily accessible for dusting, the slide-wire is completely protected from accidental injury. It does not offer much temptation to the user to employ it as a banjo string, to which young students so readily succumb.

There is a second detachable slide-wire, which in most tests forms a connection between the slider and the terminals at each end of the bridge, to one of which the galvanometer is connected. This wire can be replaced by any wire up to 16 S.W.G. whose conductivity may be required, in which case the main slide-wire is used as a connector. Or it may be used instead as the main slide-wire, by a simple change in the connections, in such tests (*e.g.*, a comparison by the Carey-Foster method) in which a slide-wire of lower resistance than 1 ohm may be desired. The slide itself is of a new pattern of the utmost simplicity, which makes the contact certain between the two slide-wires. It can be removed by sliding it beyond the limits of the scale at either end, and can be as readily reinserted in place. The actual contacts are gold wires soldered across the contact springs. Simplicity and visibility have been kept to the forefront throughout.

New Stroboscopic Device.

Another exhibit, also due to Prof. Robertson and shown by Messrs. Crompton & Company, was a stroboscopic device. It consists essentially of a vibrator, or practically a tuning fork, maintained in vibration by an electromagnet, together with a disc for attachment to the rotating shaft whose speed is to be determined, the disc having various geometrical patterns upon it. With the disc we are already familiar. The points of novelty are concerned with the details of the vibrator. This consists of two similar bars clamped into a cast-iron base, the motion of one of the bars interrupting the coil circuit. The form of clamp permits the ready substitution of other bars, so that the frequency may be varied if desired. The bars carry aluminium "wings," and the rotating disc can be viewed by either "edge" vision or "slit" vision. With edge vision the path is normally closed, but is opened when the displacement is great enough in one direction. For slit vision, slits in the two wings are exactly opposite to one another when the bars are at rest, but the path is closed when the displacement of each bar is half the slit width. Consequently, edge vision gives a view at each extreme of positive displacement, while slit vision gives a view each time the bars pass their equilibrium position. It follows, therefore, that with edge vision the frequency of the glimpses is the same as that of the bar, but with slit vision it is twice as much. Frequencies of 6,000 and 12,000 per minute are generally used, as these numbers have a large number of factors, are divisible by all the integers up to 6, and are multiples of the standard alternating-current frequencies of 25, 40 and 50 per second. The stroboscopic disc may either be viewed directly through the device, or it may be illuminated by passing a beam from, say, a Pointolite lamp through the vibrator, in which case the disc can be viewed conveniently at a distance. There are, of course, many advantages in the stroboscopic indication of speed to which we need not allude in detail. The vibrator is shown in Fig. 29.

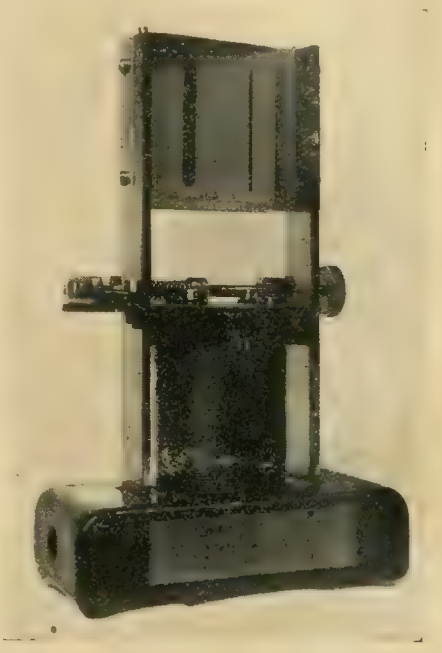

Fig. 29.—Vibrator of Robertson Stroboscope.

EVERSHED & VIGNOLES.

Messrs. **Evershed & Vignoles** showed a neat device, due to Mr. Needham, for signalling and controlling the speed of propelling machinery on board ship. The underlying idea is shown in Fig. 30. In the engine-room is a rotating contact-maker *D*, which continually reverses the connections to a condenser *C*. The condenser is in series with resistances R_1, R_2. At the controlling station is a rheostat R_3 with a sliding contact *P*. The points *P* and *Q* are connected through zero indicators *E* and *F*, one in the engine and one at the controlling station. Connection is made at *A* and *B* to the ship's supply mains. When the contact is rotated the condenser acts

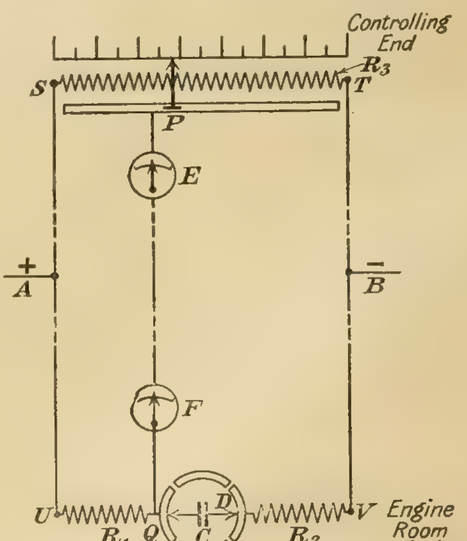

Fig. 30.—Diagram showing the Principle of the Pulsator Telegraph.

somewhat as a resistance, allowing the intermittent currents on charge and discharge to flow in the same direction, owing to the reversal of the connections, the mean value of the current being limited by the capacity of the condenser and the speed of rotation. Thus a change in the speed is equivalent to a change in resistance between Q and V. When the indicators E and F show that no current is flowing through them, the ratio of the drop over SP to that over PT is equal to the ratio of the drop over UQ to that over QV. If P is now moved the ratio of SP to PT is changed, but by altering the speed of the condenser contact the ratio of the drop over UQ to that over QV can be correspondingly changed, so that balance is again secured.

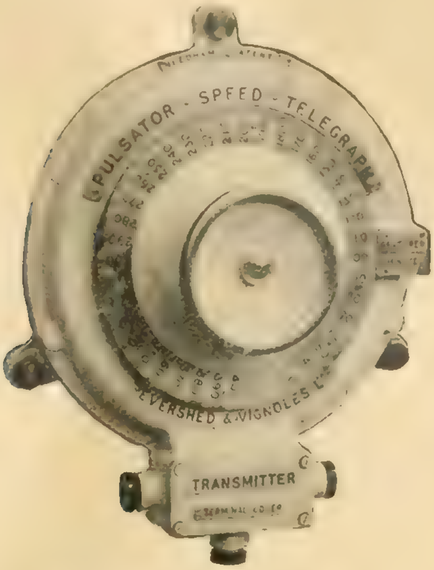

Fig. 31. View of Transmitter.

In the actual apparatus the rheostat is given a circular form, so that the position of the sliding contact is shown by a pointer moving over a dial marked in speeds. This is shown in Fig. 31. A balance indicator is seen in Fig. 32, and the chain-driven rotating contact with condenser in Fig. 33.

The advantages of such an apparatus will be readily appreciated. It is not liable to errors such as arise from a friction drive or centrifugal devices. To solve the same problem, tuned reeds have been used, but their application is limited; also voltmeters connected

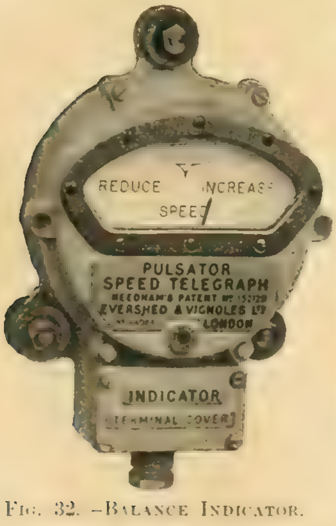

Fig. 32. –Balance Indicator.

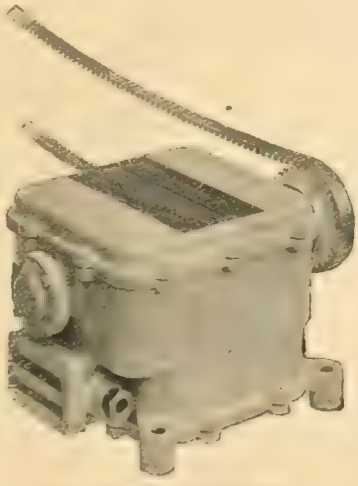

Fig. 33.–The Pulsator.

to a small magneto driven from the engine shaft, but the scale reading of such an instrument cannot be relied upon for any great accuracy. Moreover, none of these systems can be used for the transmission of orders relating to the speed.

On the other hand, the "Pulsator" is driven by a chain drive, so that there can be no question of slip, and it enables the speed to be measured with great accuracy at any number of stations. It provides a means of signalling from a station to the engine-room with an absolutely automatic reply. By suitably engraving the dial it can be used as an engine-room telegraph with an automatic reply, as seen in Fig. 34.

Messrs. Evershed & Vignoles also showed a direct-current motor generator for 12,000 volts. This was similar to one shown last year for about half the voltage. It is comparatively small and consists of six magnetos on the same shaft connected in series, the magnetos

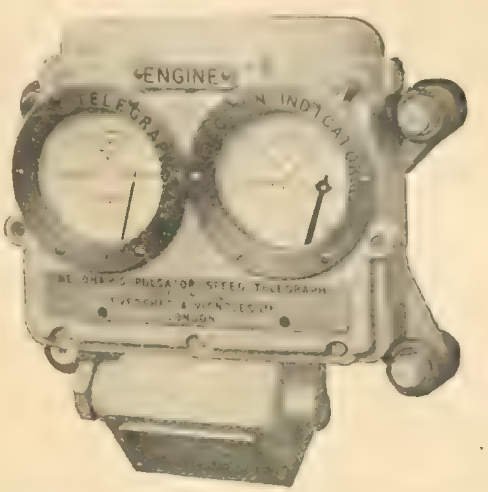

Fig. 34. -Ship's Telegraph as used with the Pulsator.

being specially constructed to avoid ripples. Such a generator would prove very useful in many investigations. It was shown operating a Braun tube.

BRITISH OIL & FUEL CONSERVATION, LTD.

The Freeman temperature control, which is an interesting device, was shown by British Oil & Fuel Conservation, Ltd. It depends essentially upon an air thermometer placed in the apparatus of which the temperature is to be controlled. The tube from the bulb of the thermometer is taken to the control apparatus, which is shown diagrammatically in Fig. 35. This tube, which is marked A, terminates in a glass tube E. The end of the tube E is left open to the air until the desired temperature of the apparatus has been reached, after which it is made to dip below the surface of water contained in the tube F. Any further variation in the temperature of the bulb will then cause positive or negative pressures in the tube A. These pressures are in communication with a mercury column B. The

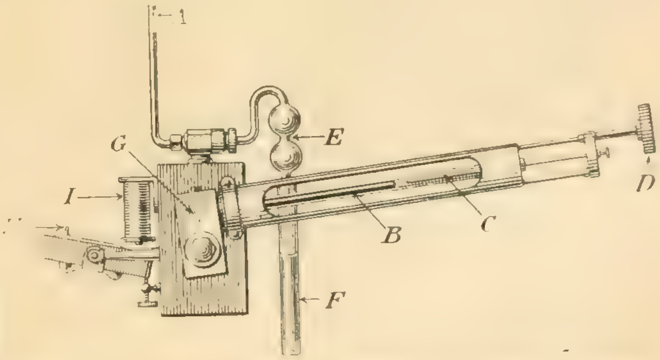

Fig 35.—Diagram of Freeman Temperature Control System.

latter can be inclined at any desired angle so as to be sensitive to variations, and makes contact with a contact C, which can be adjusted so that the circuit is completed under the desired conditions. The current which passes when this contact is made actuates a cut-out if electric heating is employed. If the heating is by gas then a valve can be operated electrically. In the diagram, H is a nitrogen tube switch, and this is actuated by the electromagnet I. A fine adjustment is provided by the screw D. If the temperature is above 1,400 deg. the bulb of the air thermometer is placed outside the furnace and is heated by radiation.

GAMBRELL BROTHERS, LTD.

A number of useful instruments were shown by Messrs. Gambrell Brothers. One that appealed to us particularly was a students' potentiometer with slide wire. This can be supplied with a separate box of ratio coils so as to convert it into a Kelvin bridge, thus extending the readings from 0·00001 ohm to 1·5 ohms. The price is particularly low, being £11 10s., and in these days of high prices this point should appeal to those who desire reasonable accuracy at a reasonable cost.

J. ST. V. PLETTS.

Mr. J. ST. V. PLETTS showed the Davis-Pletts slide rule, which was recently described before the Physical Society. This embodies two novel features which greatly extend the usefulness of the instrument in calculating such functions as ac^x. The first is a log-log scale, and its reciprocal to the base of 10, so that the logarithms can be read off quite easily by reference to one of the usual log scales. This is much more convenient than the log scales which have hitherto been used. The other feature is the provision on the scale for all the ordinary exponential, circular or hyperbolic functions arranged to read on the same log scale, so that the product or ratio of any such functions can be obtained.

Works Committees for the Electricity Supply Industry.

By A DISTRICT INDUSTRIAL COUNCIL SECRETARY.

At the meeting of the National Council, which is to be held to-day, the task will fall to those present of approving a constitution for Works Committees for the electricity supply industry, Works Committees coming under the proposals in the Whitley Report. The Whitley scheme itself is, in fact, referred to in the Final Report as "a triple form of organisation representative of employers and employed, consisting of Joint Industrial Councils, Joint District Councils and Works Committees, each of the three forms of organisation being linked up with the others so as to constitute an organisation covering the whole of the trade." The scheme, although not making Works Committees an absolutely indispensable part of the Whitley scheme, recommends the formation of such Committees in the strongest possible terms, in all industries where it is possible to do so. There is no doubt that the conditions in the electricity supply industry are such that Works Committees would fit in most admirably with the Whitley scheme as at present at work in the industry. It urgently needs, in fact, the setting up of Works Committees to make the whole a finally coherent structure. The Whitley scheme is, in fact, pyramidal in form, the lowest and most extensive strata being the Works Committee of each undertaking—the next strata is the District Councils, under which the Works Committees would be grouped territorially—and super-imposed above the District Councils there is as the apex the National Council.

THE CONSTITUTION OF THE WORKS COMMITTEE.

As regards exactly what the Works Committee will be, each undertaking would have its own Works Committee—representative of both employers and employed. The members representing the employees would be elected presumably by ballot; the members representing the employers would be appointed. It is obviously unnecessary that they should be numerically equal. According to the Whitley recommendations, there should be regular meetings at fixed times and not less frequently than once a fortnight. I mention this general constitution simply as giving a rough idea of what a Works Committee will be like, but without the slightest idea of anticipating the recommendations of the National Council. These Works Committees would, of course, deal with all matters affecting the undertakings individually, but where any questions involve the interests of other undertakings in the district, such action would, of course, be limited to the expression of opinion to their District Council. That such Councils would be pre-eminently useful goes without saying. In the first place there are many little grievances which occur in an individual undertaking which can readily be settled offhand to the satisfaction of everyone concerned, provided some machinery of this kind is available. The District Council will naturally be relieved of dealing with all these small cases, which can be settled locally. In the second place, and really this is the most important aspect, these regular meetings should result in a constant improvement in the relations between individual employers and employees. If this is not the effect, there must be something radically wrong personally with one side or the other. Above all, the qualities for which the administrative staff (*i.e.*, the employers' side) are chosen should here find full exercise. If by training and aptitude the staff are fitted to lead in the ordinary commercial matters of the undertaking their influence should be equally valuable in the present exchange of views which will take place in the Works Committees. These meetings of Works Committees will give the fullest opportunity to labour and capital of finding a *modus vivendi* in the widest possible sense, which, after all, is the principal sociological problem with which we are nationally faced. At present, when employers are talking about what direction labour movements ought to take, it is usually to an audience of brother employers. The same obtains in regard to labour. Now what is wanted is obviously some common ground where each side will be able to exert its influence on the other side, and the best ideas be allowed to win, as they must in the long run. Now Works Committees certainly afford this opportunity, and if properly conducted nothing but good could come of their immediate institution in every undertaking.

WORKS COMMITTEES AND TRADE UNIONS.

With regard to the relation of such Works Committees with the various Trade Unions, to which the Whitley Report directs special attention, there is an entire absence of any difficulties on this score in the electricity supply industry and no need of adjustment, since we can regard all employees as being members of one or another Trade Union, and as the election of the employees of the Works Committee is in the hands of the men themselves they could elect with a view to proportional representation of the Unions as they thought fit, if they wished to pay regard to such point. In passing it might be mentioned that the Whitley Committee published a special report on Works Committee (Cd. 9001).

Works Committees, of course, although they are new to the electric supply industry, have been most successfully at work in other industries. The supporters of Works Committees can be impartially quoted from both sides. Mr. F. S. Button on the side of labour has written enthusiastically in support. It may be of interest to quote one view he expressed :—

> "The Works Council will separate the technical expert and the specialist in factory organisation from the man whose bent is in the direction of social work and Trade Union government. The former will buttress and add to the power of Capital; the latter will bring a trained mind to bear in departments of activity now run almost entirely by rule of thumb. The Works Committee will afford an opportunity to men of constructive ideas, and provide an outlet for the superabundant energy of the type who to-day are the despair of those responsible in any way for orderly and disciplined government, whether of the Trade Union, the industry, or the nation. Let us look at the scheme as an intelligence department and a clearing-house for constructive ideals. In any case, the community gains by a more enlightened citizenship."

On the employers' side equal support is to be found. Mr. Whitley, speaking as an employer, views Works Committees as of most valuable potentialities. Also, in conversation with the writer, the most prominent perhaps of the present-day leaders, dealing with labour matters from the employers' side only a few days ago, speaking from an experience unparalleledly wide, eulogised to the full the great benefits derivable by both parties from Works Committees and the notable service which they afforded in the way of the smooth working of industry. Finally, a phrase of Prof. Chapman might not unfittingly close this short consideration. He says, speaking on the wide question of a readjustment of the inner industrial factors of an organisation (as in a Works Committees), that in so far as such re-adjustments take place, "a soulless machine is transformed into a vital organisation."

Mr. Llewelyn B. Atkinson at Manchester.

In an address delivered to the members of the North-Western Centre of the Institution of Electrical Engineers at Manchester on February 5th, the PRESIDENT said that visits to the territorial centres were one of the growing and varied responsibilities of his office; but we hope that, in whatever light future presidents may regard it, the visit to Manchester will become an annual pilgrimage. Manchester is proud of its own vigorous activity, and yields to no centre, London included, in the thoroughness and vitality of its discussions, as many contributors of Papers have learned. This, however, does not necessarily mean that the presidential visit affords an opportunity for country members to criticise the executive, though that has been known to happen. The visit is fully justified by the contact of the President with the local officers and members, and the presence and support of some members of the Council would add distinction to it. Some day (who knows ?) the president may be chosen from Manchester, and the centre will doubtless then respond generously by loaning his services for London meetings.

Mr. ATKINSON's address followed closely on the lines of his presidential address, of which an abstract appeared in THE ELECTRICIAN for November 26, 1920. He specially referred to the widespread membership of the Institution and to the manner in which the development of the body had been determined by the association of the industry with public services. He ventured to prophesy that the charter of the Institution would be completed before the present session ended, and promised that members should have an opportunity of deciding what policy should be adopted with regard to registration. He thought the possibility of a building for the united institutions at present rather remote, but there were favourable signs.

The absence of sting in the subsequent discussion suggests that the feeling prevalent a few years ago that the Council was out of touch with the industry has now disappeared. This is doubtless partly due to the greater knowledge among members of the activities of the Council. There is still room for improvement, and the Institution Notes might well be used to furnish from time to time news of the work of the Council and its numerous Committees.

Informal Meetings at Manchester.

During the subsequent discussion, Mr. W. A. **Coates** suggested that economies should be made by diminishing the subsidies for "Science Abstracts," research and standardisation, and by spending less on the conversazione. Compared with the American Institute, a smaller proportion of the income was devoted to the "Journal," which was all many members got from the Institution, while a third of the income went in maintaining the buildings in London. He suggested informal meetings in Manchester, alternating with ordinary meetings and specialists' meetings, at which short Papers might be read by experts, followed by a discussion. A revival of visits to works was desirable, and each visit might be followed by an evening meeting on a subject related to the visit.

Mr. J. D. **Paton** recommended that firms be allowed to subscribe to the Institution, and asked whether the technical press remunerated the Institution for matter supplied by it. Interest might be aroused among students in schools by distributing back issues of the "Journal."

Mr. G. S. **Wallace** said that if firms were circularised for suitable members the results might be as promising as had been the case with the Post Office.

Mr. E. C. **McKinnon** emphasised the necessity for the charter, and said that author's replies to discussions should be communicated to those concerned in the discussion before being printed. A systematically arranged programme of Papers would give more variety to meetings.

Mr. H. T. **Wilkinson** referred to the Engineers' Club movement, which originated in Manchester, and was now being actively pursued in Birmingham and London. If such clubs existed in all large cities the social intercourse afforded by them would tend to produce the state of mind required before a common building for all societies could be founded.

Mr. A. B. **Mallinson** said the territorial centres were the strongest assets of the Institution, and should take a more direct interest in electing members in their territories.

The President on the Technical Press.

Mr. Ll. B. **Atkinson**, in reply, said that expenditure on standardisation, which was very small, was for the benefit of all members, and the work done by the Institution in research had been followed by the establishment of an organisation with an income of £16,000 per annum, largely found by the industry. He doubted whether the circulation of "Science Abstracts" could be maintained if the subscription were raised. Other societies in this country had not followed the lead of the Institution and the Physical Society in supporting "Science Abstracts." The conversazione afforded the Institution an opportunity of extending hospitality to other bodies. It was said by some that the "Journal" cost too much and by others too little, and the Council pursued a medium course. Sectionalising the "Journal" would save each member very little. The Council had considered expenditure on the building, and had found it impossible to obtain the accommodation required for a smaller sum than the annual upkeep of the present building. The way to minimise expense was to increase the membership. The Council regarded a powerful technical press as a great asset to the industry, andhence gave the press the facilities it enjoyed. Mr. Atkinson's replies gave general satisfaction.

A misapprehension has arisen as to the meaning of the word "owner" in the **Licensing Registration Book**, issued under the Roads Act, 1920, to the person registering the vehicle and paying the licence duty. This misapprehension has arisen in connection with mechanically-propelled road vehicles let on simple hire or hire-purchase agreements. The regulations shortly to be issued will define the term "Owner" as meaning the person by whom the vehicle is "kept and used," who is, of course, not necessarily the legal owner. Purchasers of vehicles should not, therefore, accept the production of the Licence Registration Book as absolute proof of legal ownership with a power to sell, but only as evidence that the person therein named is registered as the "person keeping and using it." At the same time, failure by a vendor to produce the registration book should warn the purchaser to make inquiries as to how the vendor came into possession of the vehicle, and as to his right to sell it.

The Efficiency Exhibition at Olympia

A Mental Jazz Band.

The word efficiency suggests to the engineer the relation of output and input and conjures up visions of tests beds, instruments, water tanks and long hours with a tin can; to the factory supervisor it suggests systems and motion studies; to the doctor it brings to mind the interminable fight against the microbe; and to the office manager and organiser it suggests super-desks, card indexes, and —calculating machines; whilst the scientist connects efficiency with progress in the harnessing of the forces of nature to the benefit of mankind. Each and all of these representatives of the complex community that make up modern civilisation will find something of interest at the **Efficiency Exhibition** at Olympia. In fact, the exhibits are so varied in character and quality, that after having visited each stall the mind feels as if it had been subjected to the violent vibrations of a mental jazz band. The space at Olympia is limited, and therefore it is only to be expected that in considering each of the sections omissions are prominent. A purely Engineering Efficiency Exhibition, for example, could be made much more complete than it is possible to make the Engineering Section in a combined exhibition.

Wave Transmission.

The exhibit of wave transmission of power at the stand of Messrs. W. H. **Dorman & Company, Ltd.**, attracted a great deal of attention. The theory of this system has already been fully dealt with in our columns. In this instance the chosen application was for riveting, and continuous demonstrations of which were being made when our representative visited the exhibition. The work done was certainly all that could be desired, and it is claimed that, in comparison with compressed air, the cost is reduced by seventy-five per cent.

Motion Study.

A large section of the gallery is devoted to Major **Frank Gilbreth's** "Motion Study" Laboratory, an exhibit which is of decided interest and value to all engaged in manufacturing or in large office organisation. It is unfortunate that the lighting arrangements for this exhibit are not all that could be desired, and a better arrangement of explanatory cards on the photographs shown would have added to the ineffectiveness. We hope this exhibit will not immediately find its way back to America when the exhibition closes. It is quite worthy of a resting place in this country in the library of one of the technical institutions where reference could be made to it by those seeking improved methods in manufacturing.

X-Rays.

The progress in X-Ray working naturally fills a prominent place in the exhibits of the various hospitals. The newest development in this connection was to be found at the **British Thomson-Houston Company's** stand, in the form of a portable X-ray outfit. This apparatus comprises everything that is required for bedside diagnosis. It is easily portable and can be carried in a motor car, and erected at the bedside in any private bedroom, ward, or surgery. No special preparation is required, simply connection to a lighting socket or pendant. The decided advantage of being able to bring the apparatus to the patient instead of transporting the patient to the apparatus is thereby obtained. The consumption of the apparatus is 660 watts, and for short exposures there is no necessity to strengthen the local fuses in the house, though for prolonged exposures such action might be desirable. The apparatus packs up into four parts, each light enough to be carried by one person, yet sufficiently strong and mechanically protected to withstand transport conditions. Ample protection by lead insulation is also provided for the operator.

Electric Riveting.

Another novel exhibit by the **British Thomson-Houston Company, Ltd.**, was an electric riveter, which is a self-contained unit, capable of handling any size rivet from ¼ in. to 1¼ in. diameter and from 1 in. to 5 in. in length. The apparatus essentially consists of an air-cooled transformer, the secondary winding of which is connected to two copper electrodes, each of which can be raised vertically by means of a foot pedal to permit the insertion of the rivets. The primary winding of the transformer is connected to the supply through a 6-tap drum controller. The whole apparatus is mounted on a rigid angle iron framework, provided at the base with wheels to aid portability. The drum controller provides six heats, enabling the rate of heating to be made suitable to varying sizes of rivet. The consumption on full heat is 15 kw., and the output is 5 lbs. of rivets per kw. hour.

Wireless Telephony.

At the Marconi Company's stand frequent demonstrations were given in the operation of the wireless telephone and there were also displayed on the same stand a representative collection of wireless apparatus and sets.

Electric Heating.

Messrs. Belling & Company displayed a wide range of their electric fires, cookers, hotplates, &c., providing quite a radiant spot of attraction in the gallery. The use of a "Pyrex" casserole filled with water on a radiant hotplate made a good eye-catching device, the radiant element having quite a pretty effect when seen through the casserole, whilst the bubbling water provided movement. The latest Wild-Barfield flat furnace was to be seen in the main hall and was attracting considerable attention from those interested in tool hardening and the heat treatment of metals.

Electric Lighting Sets.

The T.B.S. Electrical Construction Company, Ltd., and the Ballot Light Plant Company were both showing automatic electric lighting plants for country houses. The former company were also exhibiting electric miners' lamps. Stannos wiring, and a new non-sulphating battery, in which it is claimed that the old troubles and loss of efficiency due to sulphating have been overcome.

Fractional Horse Power Electric Motors.

An interesting display of small motors was to be seen at the stand of Messrs. Scholey & Company, Ltd. The sizes ranged from 1/50 h.p. upwards, the motors being series wound, self cooling, and it is claimed are highly efficient. Certainly the finish and general design left no room for criticism. Applications of these motors were also shown in the form of the Croydon Premier Handelek industrial and domestic types of suction cleaner, and in the Kutmore portable electric drill.

Cable Telegraphy.

The Eastern Associated Telegraph Companies were contributing evidence of their quota toward modern efficiency by exhibiting a demonstration circuit for submarine telegraphy comprising a keyboard perforator and Wheatstone transmitter at the sending end, and electrolytic magnifier, "Jockey" relay, and receiving perforators at the receiving end. As a comparison with modern appliances the original model of Lord Kelvin's siphon recorder and "Dipper" cable relay were shown.

Education.

Various universities and educational institutions were represented amongst the exhibitors, but we were particularly attracted by the fine display made by the Loughborough College. The specimens of practical work exhibited proved that this important side of an engineer's training is not neglected at this Institution, and the general arrangement and design of the stand calls for a word of praise and commendation. Not only was it most artistic and pleasingly laid out, but those interested could easily and readily see and examine the various exhibits of students' work, apparatus, &c.

We may include under this heading because it is exhibited at the London University stand, though it is, of course, of much wider appeal, not only to electrical engineers, but to the general public if they only knew it, a most interesting historical exhibit of original valves and lamps employed by Prof. Fleming in inventing the thermionic valve, whose uses in every branch of electrical engineering we are only just commencing to see the beginning. The apparatus shown dates back to 1904, and even earlier, at which time Prof. Fleming was beginning to make experiments which have led to such historical results. From an educational point of view, using the word in its most valuable sense, it is an exhibit which should not be missed by any electrical engineer visiting the exhibition.

General Engineering Exhibits.

In addition to those specially mentioned we noticed the following engineering exhibits: Rawlplug Company, Sheringham Daylight Reflectors, W. R. Patents, Ltd. (CO_2 Indicators), Vislok Ltd., Stothert & Pitt, Ltd. (Pumps), Ozonaire Ltd., Vickerys (1920) Ltd. (Loading transporters), George Kent, Ltd. (Water meters), H. C. Slingsby (Trucks), Superheater Corporation, Ltd., The London Telephone Company, Ltd., W. & C. Pantin (Gravity Conveyers), Skefko Ball Bearing Company, Ltd., Low Temperature Carbonisation, Ltd., Reliance Telephone Company, Ltd. Thus showing that engineering science is daily becoming more and more important in bearing on efficiency as civilisation advances.

Journalism.

The power of the Press has often been referred to, but there is, perhaps, no section of the Press that has a more important bearing on modern progress than Technical Journals and the Trade Press. Messrs. Benn Brothers were exhibiting in the gallery an imposing collection of Trade and Technical Journals and Text Books, comprising The Electrician, "Aeronautics," "Cabinet Maker" series.

The Training of Disabled Soldiers.

The whole of the annexe is devoted to working exhibits showing the methods and results obtained in training disabled men to earn a livelihood. Though a visit to this section naturally has a saddening effect upon the visitor, one cannot leave it without feeling admiration at the results obtained, at the patient "stick-to-it-iveness" of the disabled, and at the mechanical ingenuity displayed in providing appliances to enable the handless, the fingerless, and the armless hero to attain a marked degree of mechanical dexterity. Almost every conceivable trade is represented in this section.

Business Organisation and Advertising.

In addition to the large number of engineering exhibits there are a wide variety which deal with Business Efficiency and the art of selling. Such appliances as calculators, typewriting and filing apparatus, &c., are mainly to be found in the body of the hall, whilst in the gallery there is a special section dealing with advertising and publicity.

A number of lectures and conferences on various subjects have been arranged for, and on Thursday, February 17, an official visit was made by members of the Electrical Development Association, a reception being held by the President of the Association at 4 p.m. on that day, in the Prince's Room, which had been set apart for the purpose by the directors of the Associated Newspapers, Ltd.

Conclusion.

So far as the exhibition arrangements as a whole are concerned, there is nothing particularly novel. Electric lighting is predominant but there are usual numbers of examples of the use of old-fashioned glass shades and instances where no shades at all are used. Nor is there any great display of originality in the design of the stands. The only stands that made an impression of distinctness or originality were those of the B.T.-H. Company, Daylight Reflectors and the Loughborough Technical College.

The exhibition was opened by Sir R. Horne on Thursday, Feb. 11, and will remain open daily from 10 a.m. to 10 p.m. until Feb. 26. Two Fridays, viz., Feb. 18 and Feb. 25, have been set apart as business men's days, when the charge for admission is increased from 2s. to 5s.

The British Industries Fair.

In three days' time the British Industries Fair (London) for 1921 will be opening its doors at the White City to the buyers of the world. This will be the seventh London Fair and promises to be even more successful than its predecessors. Since its inception in 1915 the record of the British Industries Fair has been one of continuous growth in scope, utility and reputation. Started as a means of promoting the manufacture in the United Kingdom of articles previously made in enemy countries, the Fair made so instant an appeal and received such warm support from its exhibitors that it is now established in a predominant position among the great trade fairs of the world. It is a business exhibition for business men. Producing trades are carefully grouped for the convenience of the inspecting buyer, and these groups are again split up into sections and so housed and exhibited as to facilitate to the utmost a rapid and thorough survey of British production in any given line. The foreign buyer is invited by the Department of Overseas Trade, and invitations only extended to bona fide firms and representatives. The goods to be displayed in London include:—Books, jewellery, watches and clocks, glassware, china, earthenware and stoneware, fancy goods, medical and surgical instruments, toys and games, scientific and optical instruments, &c.

At the Birmingham Fair, which also opens on Monday at the Castle Bromwich Aerodrome, the overseas visitor will have the opportunity to inspect some 20 sections covering the trades for which that city is world famous. Every type of fitting for lighting and cooking and a wide range of hardware, india-rubber goods and motor accessories—in fact, almost every branch of the British metal industry will be represented.

The exhibits at Kelvin Hall (Glasgow) will include textiles of all sorts, chemicals and dyes, &c. This Fair opens and closes a week later than the London and Birmingham Sections.

No opportunity has been missed by the Department of Overseas Trade and the organisers of the Birmingham and Glasgow sections of bringing the present favourable conditions for meeting export orders to the notice of the foreign buyer. With the financial support of the exhibitors the Department has conducted a wide publicity campaign in the overseas press, in addition to the normal propaganda activities. Invitations have been issued to some 60,000 overseas buyers of standing, and the same number of illustrated booklets translated into eight languages have been issued all over the world. Liberal use has also been made of show cards with the assistance of overseas banks, shipping companies and the Consular Diplomatic Officers of the Department in all parts of the world.

A Discussion on E.H.T. Distribution.

A discussion on Mr. Kapp's Paper on the above subject took place before the North Eastern Territorial Centre of the Institution of Electrical Engineers on January 24th. This Paper was given in abstract in The Electrician for December 3rd.

Mr. G. L. Porter questioned Mr. Kapp's statement that with E.H.T. cables the limiting capacity was usually set by heating conditions and not by voltage drop. The speaker considered that voltage drop was often the limiting factor. With regard to the point of minimum potential *X* shown in a diagram in the Paper, the loop would be completed on other parts of the system. Hence there would be a circulating wattless current passing through the point *X*. It would be preferable not to have any connection at this point, and so avoid the circulation of wattless currents which could not be shared equally by different parts of the system

While the cost of a fully-loaded cable per kilovolt-ampere transmitted was less the higher the voltage a better basis of comparison would be cost of cable per kilovolt-ampere cable capacity. The value of 6,600 volts for the highest voltage at which power should be sold was unusual. If the cost of step-down transformers were included in the cost of 11,000-volt distribution the curves for 6,600 and 11,000 volts transmission should cross near the origin. The curve of the cost per kilovolt-ampere mile of 6,600-volt cable was misleading. For larger sections of cable the curve would rise again, thus there must be a section of minimum cost Actually a cable of 0·2 sq. in. and not 0·075 sq. in. would give the lowest cost per kilovolt-ampere for all voltages. If small cables were used in parallel expenditure on switchgear and protective gear would be increased. Apparently it was more profitable to spend money in cables and generating plant than in switchgear. To supply a consumer situated between the power station and transformer house, the method of looping in the main cable to the sub-station would be more economical than the schemes put forward. In all considerations of extensions due account must be given to the question of interest on expenditure.

Mr. J. W. Townley thought the figures quoted for distribution costs were high. For a coal cost of 0·28d. per unit with coal at 30s. per ton, the consumption would be 1·75 lb. of coal per unit sold, but 1·88 lb. of coal per unit at the 'bus bars was more usual. The position of a power station was more often decided by water considerations than by load relationship. The employment of transformers with tappings had proved useful in distributing load evenly between direct and long feeders to sub-station.

Mr. A. W. Compton suggested that a fault on one feeder should not cause other feeders to be disconnected. For a consumer situated between a power station working at 11,000 volts and a sub-station it would be cheaper to supply from the sub-station than from the power station, otherwise transforming plant would have to be installed on the consumer's premises. Also the cost of switchgear (dependent upon the short-circuit current of the system at the point of installation) would be very much lower. The difference in pressure at the ends of tie lines would be small, and they should have the lowest possible resistance. The time constants of cables indicated in Mr. Beaver's curves showed great discrepancies. If one constant was applied to all the cables leaving a power station, the results would not be accurate.

Cost of Laying Important.

Mr. C. Turnbull said that theoretical considerations of loading were of no assistance, as one could not predict conditions. The cost of laying was at present the all-important item, and it paid to install as large a cable as possible. The heating of cables would have to be considered precisely as the heating of generators and transformers, &c. A round cored conductor was preferable to the clover leaf form of cable, on account of its improved heat dissipating properties. The consumer farthest away from the distribution point should pay more than a consumer close at hand. When laying down a new power station the position best suitable for the encouragement of additional load should receive more attention. It should be possible to invite factories to come alongside, and space should be allowed for this purpose.

Mr. J. R. Beard said that at present theoretical considerations were upset by difficulty in obtaining money. It was necessary to use everything to the fullest extent possible regardless of economy of operation. Hence the equalising of load between parallel feeders was of great importance. More consideration should be given to boosters and regulators. Regulators for the 20,000-volt system in the neighbourhood came from Switzerland and could not be obtained here under three or four times the cost. Manufacturers should prepare for large future demands for regulators. The Americans were developing calculating tables to determine experimentally what would happen in a system. By means of a series of plugs and wires a model network was built up on a small scale and the load and voltage drop on any feeder on a direct-current network measured. The accurate measurement of small alternating-currents presented difficulties. An endeavour was being made to construct a device to take account of both resistance and reactance, and this would be useful here.

Mr. R. O. Kapp (in reply) agreed that occasionally the voltage drop might be the determining factor of extra-high-tension cable capacity, but not for any ideal scheme. He concurred that it would be preferable not to have any connector at the point of lowest potential between two areas owing to the heavy circulating wattless current. As a 30,000-volt system would almost invariably be divided into sections at the power station by reactances, the systems could easily be sectionalised by having the switches open at the points of lowest potential. The inclusion of the cost of step-down transformers in the 11,000-volt distribution costs was debatable; on a railway the supply would have to be stepped down and converted to direct-current in any case. He agreed that the larger sections of cables were more economical when pilot cables were included, but protective gear would not be so extensively used in the future. The figures of 0·2 and 0·05d. per unit capital charges on distribution were extreme limits. The cost of 0·28d. per unit for coal applied to power at the station bus bars. The cheapest electricity was obtainable from power stations of about 100,000 k.w. capacity, taking into account cost of cables, capital charges, &c. Stations of larger size were not advocated. The importance of improving power and load factors in order to save future extensions was evident. Theoretically tie lines should be of large section, but actually they were usually of short length and the extra power required on account of the small sections was negligible. He agreed that the same time-constants should not be used for all cables laid under different conditions: also that in practice one could never design a network on purely scientific lines. The suggestion that the charge to the consumer should bear some proportion to his distance from the distribution centre was interesting, but much could be said on both sides.

The Reduction of Wages.

By ERNEST J. P. BENN.

For the past six years wages have been rising very rapidly. The movement has been very general, has affected all classes, and until recently nothing has arisen to check it. These advances have been secured by the force of the trade-union movement, which was so strengthened by the withdrawal of labour for the army as to put it into a position where it could dictate its terms. Since demobilisation began the organisation has been kept complete, and until the last few weeks nothing has occurred to weaken its position as the master of the industrial situation. All through this period Labour has been frankly and openly endeavouring to profiteer; it has not scrupled to use mutually contradictory arguments to secure its aims. When it has suited it the cost of living has been put forward, as the basis of a claim for wage advances, and when that did not apply, then the old demand for an improvement in the standard of living has been advanced. Nothing has ever surpassed the strategy of the Labour organisation; an unskilled section has forced up its price, and this has been used as a starting point from which to adjust all other classes of labour; so soon as the process was finished it began again, and several times has the circle been completed. The end of it all is that when the roads require to be cleared of snow the unemployed prefer to remain out of work rather than accept eighteen pence an hour for road sweeping.

No Objection to High Wages.

All this is not to say that the movement has been a bad one. No serious student of the question can object to high wages as such. If we admit that civilisation is a process of progress, then we must look forward to an ever-increasing return for honest work done. If we have the welfare of the human race at heart, then we must rejoice in the disappearance of a condition of affairs when capable men could not secure for themselves and their families the ordinary comforts of life. If we merely take a sensible business view, we must admit that high wages, in so far as they represent purchasing power, are altogether good for commerce and industry. There can be no doubt that prosperity is well founded when it starts from the bottom, and a condition of affairs in which the working man is prosperous is one that is very highly to be desired.

A new factor has arisen within the last few weeks, which has led a great many people to suppose that the moment has arrived for a reversal of the process of raising wages. The phenomenon of unemployment has appeared upon a large scale: it is at once attributed to high wages, and all the reactionaries rub their hands and delight in the thought that at last wages are coming down. Mr. Roscoe Brunner writes to "The Times" to suggest a statutory reduction in everybody's wage of 20 per cent., and he merely voices the hopes and views of a large section of the public. This attitude is strengthened by the fact that in America reductions in wage rates have been made, and it is to be feared that a certain amount of the closing down which is so prevalent at the moment is prompted by a desire to force along the movement. Some reductions, of course, will have to be made; there are cases where rates have been pushed up to figures which cannot be justified on economic grounds. These are mostly in connection with national and municipal work, where the economic consideration is always overshadowed by the political. There are several classes of unskilled labour, especially among women, which have succeeded in securing rates of remuneration that cannot last, but that is not to say that the great body of workers as a whole are in receipt of rates beyond those to which they may reasonably aspire, or which they may not hope still further to improve. Employers who are real employers, who take the word employer literally, will be as anxious to avoid any general reduction in real wages as the most enthusiastic of Labour leaders.

Work Given for Wages Received.

This question of wage reduction should not be allowed to overshadow the much more important and vital question of work given for wages received. There are very few workers to-day who could not be worth all the money they receive and a great deal more. Side by side with the increase in wage rates there has all along been a much more dangerous movement for the lowering of efficiency and the reduction of output.

The whole tendency of Labour propaganda is to unfit the working man for his work. He is not invited to ask for higher wages by reason of any value which he may be able to give in return; he is invariably taught to regard himself as the victim of an iniquitous system, as the dupe of the capitalists, as the disinherited possessor of wealth, and led to believe that if he will only make himself difficult, he will force others to disgorge that which really belongs to him. When a man gets into this frame of mind he can rarely be worth even the lowest rate of unskilled pay. He cannot put his heart into his work, he will dawdle and procrastinate, he will make difficulties and will always be suffering from a grievance. A grievance corrodes the mind of man. The practical result of this frame of mind has been the tightening up of trade-union regulations and the invention of many more of them. So that many classes of workers to-day not only receive double or treble their pre-war money wages, but are prevented from giving in return more than a percentage of the values which they delivered for the old wage. The increase in labour cost attributable to these causes is in some cases quite as high as that which can be traced to actual wage advances.

If employers use the present crisis to effect wage reductions, they are merely storing up trouble for the future, and ensuring a movement of revenge when the pendulum swings in the other direction. If, on the other hand, the present unemployment trouble is used to remove the frame of mind which makes work impossible and to strengthen that spirit of co-operation between employers and employed, which alone can give security to either, then labour costs can come down without alteration in wage rates, and we shall be able to flatter ourselves upon real progress.

The Tramway Inquiry.

The Court of Inquiry resumed on Tuesday the investigation of the claim of tramwaymen for an increase in wages of 12s. per week for adults and 6s. for youths. Evidence was given by Mr. J. Beckett as to the route mileage, car-miles run, the excess of expenditure over revenue, and the source from which excess was met, the disposal of excess revenue in cases where such had been obtained, variations of wages rates between 1905 and 1914, and the amount granted by each undertaking on the base rate subsequent to the Industrial Council agreement of March, 1920.

Ald. C. Higham, chairman of Blackburn Tramways Committee, said that district had 20,000 unemployed out of an industrial population of 56,000, who earned less than tramwaymen and had less security of employment. On three occasions in Blackburn they had raised fares, and the minimum was now three half-pence. Any further increase would result in a decrease of revenue. By the end of the financial year the loss on the tramways would be between £5,000 and £6,000. The cost to Blackburn of the proposed increases in wages would be £5,865 per annum.

Mr. C. D. Johnson, controller of the London County Council tramways, stated that a further increase was made in fares in October last. The additional revenue would not meet the increased expenditure. So far as he could see, the total deficit on March 31 next would be £516,000.

Other evidence was given, and the inquiry was adjourned.

Electricity Supply in North Wales.

At Llandudno, on Tuesday, the Electricity Commissioners opened an inquiry into the reorganisation of electricity supply in the North Wales and Chester Electricity District. Sir John Snell presided and there were a number of electrical engineers, representatives of local authorities, counsel, solicitors, &c., in attendance.

Mr. J. H. Dickson, Town Clerk of Chester, gave an outline of the scheme prepared by his Corporation for the formation of a Joint Electricity Authority. He said that in the North Wales and Chester district there was a great diversity of industrial development and population, and that in a portion of the area a statutory power company operated large hydro-electric works. The area was approximately 4,000 square miles, the population about 900,000, and the rateable value was over £4,500,000. The scheme provided representation for all interests, and was framed with the aim of giving equitable representation to each. It might be assumed that only a fourth of the total authorities and persons who had the right to be represented on the Joint Authority would join it in the first instance and it would not be in any way unwieldy. It was not proposed that the Joint Authority should buy out any existing generating station or interfere with the North Wales Power Company in its operations. After consideration Chester came to the conclusion that power could not be conveyed economically from the western part of the district to the eastern part. The installation of a hydro-electric station involved much greater capital outlay than did a steam generating station. In addition, there would have to be long transmission lines going over sparsely populated districts, where there would be a very small demand for current en route. All the expenditure would have to be incurred straight away, at the inflated prices which now prevailed. In the meantime, the demand for current in the east was very urgent.

Details of Scheme.

Chester Corporation believed that the soundest proposal was that the east should put down at once an up-to-date steam station, on the banks of the Lower Dee, in conjunction with hydro-electric low-fall stations on the Upper Dee. That would enable the demands of the east to be met for a considerable time, and would give a maximum value in productivity in relation to capital expenditure. In the west the North Wales Power Company would continue to operate; their transmission lines would be gradually extended over the area, as consumers would purchase in bulk or otherwise, and the Joint Authority would be assisting them when necessary in their negotiations. As the development proceeded extensions from the east would meet extensions from the west, and the two areas would become interconnected. It was, moreover, considered that in an area so extensive as that it would not be safe to rely upon water power alone, and that the provision of a steam generating station was an essential adjunct.

Mr. Dickson stated that the eastern part of the district in the main supported the principle of public control and favoured the Chester scheme. Crewe Council were neutral and Northwich wished to join the area of the Mersey Power Company. Wrexham desired compensation for discarding their present generating plant, but the promoters of the scheme could not accept that. Connah's Quay Council opposed the scheme and Rhyl Council desired to perpetuate the old parochial system. The North Wales Slate Quarries Association had sent objections to clauses. Having dealt with the objections to and criticism of the scheme, he said he hoped the Commissioners would consider the Chester scheme as a legitimate attempt to proceed on the lines the commissioners would desire. Chester Corporation had expended in what they regarded as the public interest a large amount of money, and they felt they must have regard to the principles which the Commissioners had themselves put forward to keep the costs within reasonable limits. They put the scheme forward with a strong conviction that it was based on right and proper lines.

Evidence was then given by Mr. E. Noel Humphreys, of Chester, and the inquiry was adjourned.

The Engineers' Club.

The first meeting of the provisional committee of the proposed Engineers' Club was held at 39, St. James's Street on Thursday, February 10th, Mr. E. L. Hill being in the chair. Formal resolutions proposing the establishment of the club and the appointment of an executive committee were passed, the following being asked to constitute the first members of the committee:—Mr. Howard Foulds, Mr. A. H. Allen, Mr. R. W. Hughman, Mr. G. Layton, Mr. W. Prescott, Mr. P. C. Pope, Mr. H. T. Wilkinson, Mr. A. R. Fenn, Mr. C. T. Colpitts, Mr. H. C. B. Sainsbury, Mr. H. W. Couzens, Mr. T. C. Pulman, Mr. D. Wilson, Mr. J. S. Huddleston, Mr. H. Scholey and Mr. W. Hewison.

In the course of an opening statement Mr. Hill reiterated that the membership should be made as wide as possible and suggested that subscription for London members should be ten guineas per annum, for country members five guineas per annum, and for overseas and foreign members two guineas per annum, with a fee of 100 guineas for life membership. The great difficulty, he added, would be the premises, but they hoped to obtain temporary accommodation in a central situation which would do for a year or so. This would have the great advantage of getting the club going.

Electricity Supply.

The Eton Rural Council has consented to the extension of the overhead cables to Farnham by the Slough & Datchet Electric Supply Company.

Finchley Urban Council has applied to the Friern Barnet Urban Council for permission to supply electric current to portions of Friern Barnet district.

Ammanford Urban Council has now completed arrangements for the purchase of the local electricity works from Mr. William Herbert, who has withdrawn his opposition to the Council's application for a Special Order. In addition to the agreed purchase price of £14,375, the Council has now agreed to pay a further sum of £2,000 for the installation of a new battery.

The accounts of the Liverpool Corporation electric supply department for the year ended Dec. 31, 1920, show that the total capital expenditure is £1,715,311, of which £128,107 is outstanding. The year's income was £885,262 and working and special charges amounted to £642,795, leaving gross profit £242,467. After providing £82,081 for interest, £70,782 for sinking fund and £39,604 for renewals fund, there remained £50,000 to apply to relief of rates.

Owing to the increasing demand for electrical energy, Perth Town Council requires additional generating plant, and the Electricity Commissioners have intimated that steps should be taken to install a 1,000 kw. set, while the question of providing another boiler should be considered at an early date. Council decided on Monday to provide the plant and obtain the necessary borrowing powers.

Municipal electric supply usually suffer from the fact that committees have inadequate powers to enter into contracts for electricity, and we are glad to notice that Taunton Corporation has now empowered its Committee to arrange all contracts for the supply of electricity, and to affix the common seal to any such contract. The chairman of the Committee (Councillor J. E. Kingsbury) said they were very much hampered in getting new business owing to the fact that considerable delay ensued before a contract could be completed. The result was that their competitors obtained an unfair advantage, and it was difficult to make satisfactory arrangements without a little more power. The matter was discussed at length, but common sense prevailed, and the Electricity Committee ultimately got the required authority.

Imperial and Foreign Notes.

Mackay (Queensland) Council have under consideration a hydro-electric scheme.

The construction of the Mitta Mitta dam is expected to make cheap electric power available in Albury (N.S.W.).

Owing to the desire of several British firms to take part in the competition for tenders for the electrification of the Chilean railways, the final date for sending in tenders has been extended.

According to a Berlin cable the Price Bureau of the German Electrotechnical Industry has reduced the prices of all electrical machines by 10 per cent. This is the third price cut since the maximum prices were reached last year.

The Thomson-Houston Company of Paris, together with the General Electric Company of the United States, have formed a new company at Bilbao, to be known as the Sociedad Iberica de Construcciones Electricas (S.I.C.E.), for the purpose of manufacturing all kinds of electrical plant and apparatus. The company will erect works near Bilbao.

By a Cuban Presidential Decree the concession of the Western Union Telegraph Company for landing the cable from the Barbados on the Cuban coast has been suspended, as the company has failed to fulfil a provision in the concession that the laying of the cable should be carried out under the inspection of the competent Cuban authorities.

Wireless Telegraph Concessions in China are likely to lead to diplomatic representations to the Chinese Government by this country and by the United States. Some time ago the Marconi Company secured a concession which, it is claimed, conferred exclusive privileges, but recently the American Federal Wireless Company were authorised to erect a station at Shanghai. Great Britain has protested against the contract given to the American Company on the ground that it violated the contract with the Marconi Company, while the State Department at Washington has now notified Mr. Crane, the American Minister in Pekin, that the United States will support the claim of the American Federal Company, and it has also taken up the question with Great Britain.

The Commercial Secretary to H.M. Legation at Belgrade (Capt. E. Murray Harvey) reports that the Ministries of Communications and Public Works of Jugo-Slavia have been in consultation regarding the formation of a technical commission for drawing up a scheme for the electrification of Jugo-Slavia. According to the plan now adopted, the State will henceforth have the first right to establish any electrical undertaking, but private individuals may carry out electrical undertakings where the State has not constructed such, the special permission of the Ministry of Public Works being necessary in such cases. The State may expropriate such individuals on condition of indemnification, and it may also nationalise existing undertakings. The upkeep of the transmission lines and cables devolves on the "electrical administration of each Commune." All electrical questions will be dealt with by the electro-technical State Council, which will be composed of 15 members and 16 substitutes. The Council will include representatives from the Ministries of Commerce and Industry, Public Works, Agriculture, Forestry, Health, &c.

Electric Traction.

The Minister of Transport has authorised the use of Trailer Cars on Twenty-two Tramway Routes of the London County Council on the South side of the Thames.

Some time ago the Highways Committee of the London County Council offered a prize of £1,000 for designs for a new electric tramcar, but it is now announced that the designs submitted disclosed nothing new, and no prize has been awarded.

Wigan Corporation are revising tramway fares, as it is estimated there will be a deficit of £15,000 on the present year's operations, but alterations, reconstruction of rolling stock and other expenditure which has been met out of revenue, totals over £6,000.

A sub-committee of the Halifax Tramways Committee recommends the expenditure of £250,000 during the next three years on the repair and renewal of the tramway tracks. As there is a deficit of £9,000 a year on the undertaking, the fares will have to be increased without further delay.

In consequence of the success of the electric train service between Newcastle and Whitley Bay the North Eastern Railway Company has decided to proceed with the work of converting the main line between Newcastle and Darlington into an electric system, which will be later extended to York.

With an attendance of 81 out of 99 members at the last meeting of Durham County Council, Labour succeeded in obtaining a clear majority for the Transport Scheme. For the proposed tramways from Boldon Colliery to Cleadon and from the termination of the proposed South Shields light railway to Sunderland, the consent of the local authorities had not been received, and the omission of these portions will reduce the estimated cost from £1,631,473 to £1,426,857.

A public inquiry was held at Bradford on Friday into the tramcar accident which occurred at Thackley on the 3rd inst., and resulted in over 40 persons being injured. The inspector (Major Hall) visited the scene of the accident, and then heard evidence at the Tramway Offices. The driver of the car (Fred Benson) stated that on the way from Bradford the fog got so thick that he could not see the walls on either side of the road. He lost his bearings, and he did not know where he was. He could not see the walls or find Norman Bank, which was a landmark where they usually cut off power and applied the brakes. He did not see it when he struck the points. He had no power on at the time; otherwise he should have operated the points. After the car left the rails it seemed to travel faster, and he applied the brake. As soon as he realised that the car had jumped the points he applied the electric brake. It seemed to him that the car was almost at a standstill when it hit the kerb and fell over. It was difficult to gauge speed in such a thick fog; he had never driven in such a bad fog. The authorised speed for the route was 14 miles per hour. He had never wished to become a driver, and had only taken the position because it was the alternative to going into the Army during the war. He had had 18 years' service with the Corporation and he had been a driver for four years.

The conductor of the car (S. Hainsworth) said he thought Benson was carrying out the usual practice in driving slower in fog. The speed did not seem to increase before the vehicle hit the points. After the car left the rails he felt the electric brake applied, but it did not seem to cause any check. Mr. Dawson (assistant engineer) said he had examined the car after the accident, and found all its gear in order and the brakes applied. The car was re-wheeled last year. He had tested the mechanism of the facing points with another car, and found that it worked quite all right.

The members of the Liverpool Tramways and Electric Power and Lighting Committee made their annual inspection of the various sections of the tramways undertaking on Friday, and subsequently the members had lunch at the Midland Adelphi Hotel. In reply to the toast of "The Chairman," Mr. F. C. Wilson said that when war broke out a large number of the cars were approaching the end of their useful life, and consequently needed more than the usual renewals in order to be kept fit for the roads. With the war intervening, many of those cars could not be repaired and they had reached such a state that they required complete rebuilding. That work would extend over a number of years, and would require larger works in order to cope not only with the arrears of renewals, but also to deal with ordinary repairs and renewals of the rolling stock and the building of new cars. In future renewals would be greater than in the past, when practically the whole of the rolling stock was new. The Lambeth-road works were not big enough to meet the increasing demand for repairs and renewals, and the building of the new works in Edge-lane should, at once, be proceeded with.

The committee, fully appreciating the unsatisfactory financial position of the undertaking, had adopted the new scheme of stages and fares suggested by the general manager. Even with the estimated increase in revenue under the scheme, there would be very little, if any, surplus during the present year. The past year had been one of great difficulty, and it was impossible for the committee in less than three or four years to place the rolling stock, permanent way, &c., in a satisfactory condition for efficient and economical working.

The General Manager, in replying to the toast of his health, said there were now more tramcars on the streets of Liverpool than ever before. With regard to the crowds in the rush hours, particularly in the evening, it was now possible to clear those crowds by about twenty minutes past six, whereas some 18 months ago it took until seven o'clock and after. He wanted to see Liverpool with the finest system, and he hoped to see before long Liverpool having the full number of 1,000 tramcars running in the streets.

Institution Notes.

The annual smoking concert held in connection with the Informal Meetings Section of the Institution of Electrical Engineers will be held at Anderton's Hotel, on Monday, Feb. 28, at 7.30 p.m. Tickets 2s. 6d. each, may be obtained from the Secretary of the Institution, or from any member of the Informal Meetings Section Committee.

At a meeting of the Birmingham and District Electric Club, held on Feb. 12, a Paper, entitled "Reminiscences of the Test Bed," was read by Mr. C. G. A. Macdonald. The Paper was much more elaborate than was implied in its title. It gave an interesting and detailed account of the technique, methods and instruments used in testing motors, single-phase transformers and rotary converters, and gave rise to a lively discussion.

The general discussion on "The Failure of Metals under Internal or Prolonged Stress," which is being organised jointly by the Faraday Society, the Institution of Mechanical Engineers, the Institute of Metals and the Iron and Steel Institute, will take place on Wednesday, April 6 next. There will be afternoon and evening sessions. The North-East Coast Institution of Engineers and Shipbuilders, the Institution of Engineers and Shipbuilders in Scotland, and the West of Scotland Iron and Steel Institute, are also participating in the discussion. In the preliminary programme it is stated that the discussion will be opened by Dr. W. Rosenhain, F.R.S., who will give a general survey of the subject. Among other contributions on specific aspects of the subject which are expected is one on the "Failure of the Lead Sheathing of Telegraph Cables," by L. Archbutt. An exhibition of specimens will be held in connection with the meeting, and those desirous of lending specimens are asked to communicate with Mr. F. S. Spiers, secretary to the Joint Committee, 10, Essex-street, W.C. 2.

The North Eastern Centre of the Institution of Electrical Engineers held a conversazione on Friday last when the president and Mrs. Ll. B. Atkinson and the chairman and Mrs. J. R. Beard received the guests, of whom about 250 attended. During the evening a series of lantern lectures, exhibitions and demonstrations were arranged, whilst incidental music was also provided for those whose preference ran in this direction. A series of "Experiments with High Frequency Currents produced by the Tesla Coil" was given by Mr. J. H. Holmes. These included the production of various forms of spark and brush discharges, and an illustration of several forms of vapour or gas filled lamps. In addition, the various stages in the evolution of the electric vacuum lamp were exhibited. In another part of the college a series of demonstrations were given under the direction of Prof. W. M. Thornton. These included an illustration of the production of sparks under water, as used in under water signalling, the action of solenoids in weight lifting and the magnetic repulsion of discs. An exhibition of synchronising two machines by means of their wave forms as shown by the oscillograph, was of considerable interest. A complete exhibit of domestic electrical apparatus was given by Mr. W. F. T. Pinkney, including all conceivable forms of heating and cooking apparatus, electric combs, irons, hair dryers, sterilisers, mats, foot warmers, bed warmers, shaving pots, vacuum cleaners, immersion heaters and toasters. An electrically driven sewing machine was the centre of attraction for many of the ladies, whilst the demonstration of the many advantages of the electric oven for pastry cooking, &c., forcibly reminded one that refreshments were waiting to be partaken of. During the latter part of the evening dancing took place in the King's Hall.

Business Items, &c.

Messrs. H. W. Smith & Company (1920), Ltd., have engaged Mr. W. T. Rushton, late of the Fuller Electrical & Mfg. Company, as one of their representatives for the sale of cables and wires in London.

Messrs. Switchgear & Cowans, Ltd., have removed to their new works at Elsinore-road, Old Trafford, Manchester. The new telephone number is "Trafford Park 597," but the telegraphic address remains unaltered—viz., "Control, Manchester."

Mr. E. G. Lind, A.M.I.E.E., who for 14 years held the position of engineer and manager of the Tudor Accumulator Company's export department, has been appointed sole agent for the Accumulatoren-Fabrik A.G., of Hagen, and has opened an office at 48a, Buckingham Palace-road, Westminster, S.W.

Mr. Arthur W. Fithian, M.I.E.E., who for nearly 20 years has acted as engineer and branch manager for the North of England for the Tudor Accumulator Company, Ltd., has now joined Messrs. E. G. Lind & Company, 48a, Buckingham Palace-road, S.W., who have been appointed sole agents in Great Britain and Colonies for the "A.F.A." accumulators.

Mr. J. T. Baring has entered into partnership with Messrs. Williams & Pell, 5, Chancery-lane, London, W.C. 2, agents for the Electrical Alloy Company, the Industrial Filtration Corpn., La Metallurgique Electrique and the British Electric Plant Company, Ltd. The business will from now be carried on under the style of Williams, Pell & Baring, at the same address.

The Scottish Electric Lamp Repairing Company, Ltd., has leased business premises at the junction of Abercorn and Niddry-streets, Paisley, and expects to begin operations within the next two months. The premises will be sufficent for an output up to 15,000 lamps per week, and operations will be begun with a staff of about 25.

Messrs. Jones & Pordes, 8, Crawford-passage, Farringdon-road, E.C. 1, have placed on the market their best quality bell set, comprising 2½ in. iron cased bell, "Elba" dry cell, solid walnut fancy pear push, 30 ft. best vulcanised insulated flex, solid polished walnut dry cell box and heavy brass fittings. The set can also be supplied with mahogany bell, box and push at the same price. The sets are specially suitable for sick rooms, &c.

Miscellaneous.

The death is announced of Mr. Stanley J. Bessant, B.Sc., an electrical engineer, with the British Thomson-Houston Company, at Rugby. During the war he held a commission in the Hampshire Regiment., and served in Palestine.

A meeting of the British Empire Producers' Organisation will be held at their offices, 3-7, Old Queen-street, S.W.1, this (Friday) afternoon, when an address will be given by Mr. F. W. Field, H.M. Trade Commissioner in Toronto, on "Canadian Industrial Development and the Establishment of Branch Works in the Dominion." Persons interested in Canadian affairs will be admitted on presentation of their cards.

We regret that in our editorial note on the "Remodelling of the National Council," which appeared on page 167 of our issue of Feb. 4, we spoke of an alternative proposal having been put forward "by the employees' side of the National Joint Board of Employees and Staff Members of the electricity supply industry in No. 6 area." This should have read employers' side.

Catalogues, Price Lists, &c.

Messrs. Higgs Bros., Sand Pits, Birmingham, have issued their February list of alternating-current and direct-current stock motors and direct-current dynamos.

A leaflet and a four page pamphlet have been issued by Messrs Lamlok, Ltd., 36, Rusthall-avenue, Chiswick, W. 4, on the "Lamlok" electric lamp locking ring and the adjustable cord grip respectively. Illustrated particulars, with advantages, prices, &c., are clearly set out.

We have received an attractive catalogue from the Ironclad Switchgear Company, Ltd., Monton-lane, Eccles, Manchester, giving full details of their "Barton" and "Bonita" ironclad switches, "Bonitace" and "Bartace" combined switch and fuse, and the "Ace" ironclad fuse board and fuse components. They will be pleased to send copies to any of our readers who are interested.

Two new sections of their catalogue have been issued by the General Electric Company, Ltd., 67, Queen Victoria-street, E.C. 4, dealing with large and small transformers respectively. As usual, the company supply full technical information, with illustrations, dimensions, prices, &c. In section P. 6 there is a full description of single-phase and three-phase oil-cooled transformers of capacities between 30 and 1,000 k.v.a., and section E. 2 contains a technical and general description, including a discussion on the relative merits of auto-transformers and true transformers, and there is some valuable information on small transformers. Prices and dimensions are given for complete ranges of both types, air-cooled and oil-cooled, for single and three-phase circuits, whilst two pages are devoted to choking coils for use with arc lamps.

We have received from the British Electrical Development Association a series of advertising literature blazoning the advantages of using electricity, especially for domestic purposes. These range from the simple postcard, adhesive label or bookmark to an eight-page pamphlet on "The Power Behind the Home," and the still more extensive work entitled "Light in the Home." The last are frankly educational, and should do much to impress both the electrical engineer and the laity with what electricity can do for them both. "The Power Behind the Home" deals with the two housing schemes at Billington and Hammersmith respectively, where the "all-electric" idea is being worked out to the fullest extent. "Light in the Home" indicates what can be done with the use of electric light, and more especially what can be done with the proper use of electric light, giving some useful hints on things in general, especially on the abolition of dirt, a matter which, in these servantless days, is a problem that often assumes immense importance. Those in need of fresh and incisive literature to assist them in their propaganda have, therefore, no excuse for not knowing whether to go for it.

Bankruptcies.

John Vincent Bell, electrical engineer, 21, North Bar Within, Beverley, has been adjudicated bankrupt.

The first meeting of creditors of John Wm. Gladwin, electrical engineer, 81, Burcat-road, Meersbrook, Sheffield, was held on Friday last, and Mr. Chas. Turner, Norfolk-street, Sheffield, was appointed trustee.

A meeting to receive an account of the winding up of the Trafford Power & Light Supply (1902), Ltd. (in vol. liq.), will be held at the offices of Messrs. Cooper & Cooper, 60-62, Spring-gardens, Manchester' on March 7.

Albert Edward Dickinson, trading as the Crown Electrical Company, 157, Himslet-road, Leeds, has been adjudicated bankrupt. The first meeting of creditors will take place on Feb. 23 at 24, Bond-street, Leeds, and the public examination on March 8 at the County Court House, Albion-place, Leeds.

Personal and Appointments.

The following appointments have been made by the Council of Sheffield University: Dr. S. R. Milner, to be Professor of Physics; Mr. F. O. Hunt, assistant lecturer in electrical engineering; Mr. A. E. Beet, demonstrator in fuel technology; and Mr. Edwin Gregory, demonstrator in ferrous metallurgy.

Capt. G. D. Meynell, A.M.I.C.E., has been appointed assistant electrical engineer of the London County Council tramways dept., at a salary of £600, rising to £800 per annum. Mr. H. Underwood has also been promoted to the position of boiler house superintendent at Greenwich power station.

Tenders Invited.

Tenders are required by March 15 for the supply and erection of six electric cranes and coal handling plant at the Port of Boulogne.

Manchester Guardians require tenders by Feb. 23 for additional electric-light wiring and fitting at their Tame-street Institution. Particulars from Mr. Hargreaves, Union Offices, All Saints, Manchester.

Tenders are required by Feb. 28 for a 10-ton overhead hand power travelling crane for Manchester Electricity Department. Specification, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Dublin Electricity Supply Committee require tenders by Feb. 22 for supply and erection of seven truck-type switch cubicles for use on three-phase 5,000-volt network.

The Commissioners of H.M. Works, &c., invite tenders by Feb. 21 for supply of electric bell fittings for six months. Forms of tender from the Controller of Supplies, Charles-street, Westminster, S.W.1.

Southampton Harbour Board require tenders by Feb. 26 for six or 12 months' supply of electrical stores, oils, &c. Forms of tender can be obtained at the Board's offices, Town Quay, Southampton.

Tenders are wanted by March 1 for additional electric fittings for the County Sanatorium, Almeley, Herts. Specification can be seen at the office of the County Surveyor, High Town, Hereford.

The Commissioners of H.M. Works, &c., invite tenders by March 2 for the supply of electric lamps for six or 12 months. Forms of tender from the Controller of Supplies, King Charles-street, S.W. 1.

Belfast Tramways Committee want tenders by Feb. 26 for stores, including electrical accessories, copper strip, cable, lamps, insulating tapes, carbon brushes, &c. Forms of tender from the General Manager.

Bermondsey (London) Guardians require tenders by March 3 for six months' supply of stores, including electric lamps (item 71). Forms of tender from the Clerk, 283, Tooley-street, S.E.1.

Stockton-on-Tees Electricity Committee require tenders for six months' supply of stores. Forms of tender, &c., from the Electrical Engineer.

Larne Urban Council require tenders by March 3 for lighting the district by gas or electricity from Sept., 1921, to April, 1922, inclusive. Forms of tender from the Clerk, Town Hall, Larne.

Belfast Tramways Committee also want quotations from stock of two 500 kw. compound-wound converters, to give 500-550 volt continuous current. The a.c. supply is three-phase 50 ∿, 6,600 volts. Quotations are to be sent to the City Electrical Engineer.

Dublin Electricity Committee want tenders by Feb. 22 for repair of 1,200 amp-hour battery and for supply (or supply and laying) of e.h.p. and l.p. cables, and supply of troughing, section pillars and joint boxes. Forms of tender, &c., from the City Electrical Engineer.

Aberdare Urban Council require tenders by March 4 for supply of cable, meters, joint boxes, electric lamps, &c., for one year. Specifications, &c., from the General Manager of the Electricity and Tramways Department.

Pretoria (Transvaal) municipality require tenders by March 10 for one 20 ton overhead crane, six boilers to evaporate 18,000 lb. an hour each at 350 lb. pressure; three 3,000 kw. steam turbo-generators, condensing plants, five 750 kw. converters. Specification from Town Clerk.

Tenders are invited in connection with the electrification of the Cape Town–Simonstown and Durban–Pietermaritzburg Railways, for the supply of turbo-alternators, boilers, condensing plant, passenger and freight locomotives, motor coaches and underframes, motor bogies, electrical equipment of coaches, sub-station equipment and transformers. Specifications and forms of tender from the High Commissioner for the Union of South Africa, 32, Victoria-street, London, S.W., or the General Manager, Johannesburg. Further technical information can be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1. Tenders to the High Commissioner by May 3.

The Electricity Commissioners of Victoria (Australia) invite tenders for the supply of plant and material required for the Morwell Power Scheme, including 25,000–12,500 kw. turbo-alternators, 600 kw. turbo-alternators, transformers, switchgear, cables, transmission steel towers, steel telephone poles, &c.; also for telephone wire (specification 45) and pin type Insuators (46). Tender forms and specifications can be obtained from the Agent-General for Victoria, Victoria House, Melbourne-place, Strand, London, W.C.2, and drawings can be seen at the offices of Messrs. John Coates & Company, Ltd., consulting engineers, at the same address. Tenders by noon, March 31, to Mr. R. Liddelow, secretary, Electricity Commissioners, 673, Bourke-street West, Melbourne.

Tenders are invited up to March 21 for the supply and delivery to the Postmaster-General's Dept., State of New South Wales, of telephone and telegraph apparatus, testing instruments and switchgear parts (Schedule 814); up to March 29 for the supply to the Postmaster-General's Dept., State of Western Australia, of telegraph materials (Schedule 333), and to April 5 for the supply and erection of accumulators, &c., at the Telegraphic Office, Eucla (Schedule W. A., 647), and up to March 30 for supply of switchboard apparatus and parts (Schedule 515), to the Postmaster-General's Dept., State of Queensland; and also up to March 2 for the supply and delivery to the Australian Postmaster-General's Department, State of South Australia, of (a) telephone parts (Schedules 558 and 559); and (b) telegraph and telephone materials (Schedule 560). Forms from High Commissioner for Australia, 406, Australia House, Strand, W.C.2.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

7,700/14 Hochstadter. Electrical conductors. ([illegible]/14. Convention date not granted.)
18,042 Kienzle. Electrically-driven turret lathes and like machines. (1/8/13.)
126,629 Leblanc. Apparatus for indicating the operation of the ignition in internal-combustion engines. (5/2/18.)
132,265 Weismann. Electric control machanisms. (10/8/17.)
132,538 Buckley & Buckley. Starting rheostats for electric motors. (13/9/18.)
135,506 Sperry Gyroscope Co. Arc lamps. (20/11/18.)
138,604 Compagnie Française des Metaux. Electric induction furnaces. (7/2/19.)
138,929 Compagnie Generale d'Electricite. Portable electric lamps. (27/5/16.)
139,160 Rader & Aktieselskabet Zink. Electric furnaces for the production of zinc. (15/2/19.)
140,785 Landis & Gyr Akt. Ges. Means for measuring wattless [illegible] consumption in alternating current circuits. (25/3/19.) (Addition to 3,856/15.
142,432 Madsen. Electro-deposited metals. (26/4/19.)
142,494 Gallo & Villarboito. Electric switches. (29/4/19.)
143,830 Western Electric Co. & Deakin. Automatic telephone exchange systems. (26/5/19.)
145,507 Siemens-Schuckerwerke. Electrical switches or liquid starters. (30/8/18.)
145,690 Martinetto. Cut-out switch for electric polyphase alternating current circuits. (15/10/15.)
145,723 Krupp Akt. Ges. Distant control of apparatus in accordance with the electrically-transmitted movements of a pointer or the like. (30/9/16.)
145,729 Krupp Akt. Ges. Distant control of apparatus in accordance with the electrically-transmitted movements of a ponter or the like. (18/5/15.)
146,315 Krupp Akt. Ges. Distant control of apparatus in accordance with the electrically-transmitted movements of a pointer or the like. (6/11/16.) (Addition to 145,729.)
147,088 Munz. Voltage-regulator. (4/4/19.)
148,451 Optische Anstalt C. P. Goerz. Akt. Ges. Arc lamps for searchlights. (14/10/18.)
154,960 Hall. Coin-collecting means for telephone services. (30/7/19. Addition to 149,361.)
154,967 Haslam & Stretton & Stretton. Miners' electric safety lamps. (22/4/20.)
154,978 Craufurd & Doughty-Wylie. Method and apparatus for electric signalling through water—for example, between or with ships thereon. (1/9/19.)
154,982 Round. Valves used for wireless transmission. (3/9/19.)
154,985 B.T.-H. Co. (G.E. Co.) Electric-welding apparatus. (3/9/19.)
154,991 B.T.-H. Co. (G.E. Co.) Incandescent lamps and similar articles (4/9/19.)

Comprises a method of manufacturing incandescent electric lamps and similar articles, which consists in fusing the glass at a point where the end of an exhaust tube and the neck of a bulb are in juxtaposition with one or more wires extending these through, thereupon inserting a cool refractory body to maintain or form a passage from the bulb to the exhaust tube, and clamping the body of glass about the wire or wires and the refractory body.

155,017 B.T.-H. Co. (G.E. Co.) Cooling devices for electric transformers and the like apparatus. (8/9/19.)
155,038 B.T.-H. Co. & Carter. High-speed electric or other locomotives. (16/9/19. Addition to 128,106.)
155,061 B.T.-H. Co. (G.E. Co.) High-frequency alternators. (26/9/19.)
155,071 Oldham, Oldham & Oldham. Galvanic batteries. (9/10/19. Cognate application, 6,654/20.)
155,088 Automatic Telephone Mfg. Co. (Automatic Electric Co.) Coin-freed prepayment devices for telephone systems. (31/10/19.)
155,095 Hawkins, Hanstock, Higgs & Ferranti Ltd. Generation, transmission and distribution of electricity. (11/11/19.)
155,118 Levin. Electrolytic cells. (31/12/19.)
155,123 Sterling Telephone & Electric Co. & Bell. Indicators or annunciators. (2/1/20.)
155,136 Imray. (Bosch Akt.-Ges.) Electric starting devices for internal-combustion engines. (29/1/20.)
155,148 Hamilton. Insulating-protectors for the ends of electric conductors. (17/2/20.)
155,149 Simpson. Cross-arms for supporting electric insulators. (17/2/20.)
155,155 Douglas. Electric couplings. (2/3/20.)
155,317 Montgomery. Electric resistance for medical purposes. (28/6/19.)
155,328 General Electric Co. & Gossling. Circuits for amplifying electric currents. (14/8/19.)

Comprises a method of amplifying variations in electric potential in circuits subject to periodic or non-periodic changes of voltage, by the use of three electrode thermionic valves or the like connected in cascade, wherein a current limiting device, or devices, is, or are, used in the output circuit of each unit of the amplifier, whereby the point in the output circuit of one unit which is connected directly to the grid or input terminal of the succeeding unit can be maintained at any desired potential with respect to the output terminal of the first unit, whatever may be the position of the other direct connections between the terminals of the successive units.

155,330 Franklin. Aerial systems employed in wireless telegraphy and telephony. (14/8/19.)

APPLICATIONS FOR PATENTS

July 12, 1920.

20,963 Huth. Transmitting undamped electric vibrations. (21/7/17, Germany.)
20,964 Huth. Connection for obtaining a strengthening of wireless messages. (16/1/17 Germany.)
20,965 Loewe. Mode of putting in circuit of audion receivers. (18/4/18, Germany.)
20,992 Loewe. Apparatus for wireless transmission. (26/10/18, Germany.)
20,993 Huth. Wireless telegraphy and telephony. (18/8/17, Germany.)
20,994 Allgemeine Elek. Ges. Three-arm choking coil. (17/9/14, Germany.)
20,995 Loewe. Receivers with strengtheners. (18/4/18, Germany.)
20,996 Huth. Process for expelling gases from metal bodies, &c. (21/2/17, Germany.)
20,997 Huth. Arrangement for receiving electric oscillations. (26/4/19, Germany.)
21,003 Huth. Receiving connection with vacuum tube. (13/10/17, Germany.)
21,004 West & Page. Contacts for switches, &c.
21,023 Thorpe. Electrolytic devices for use with meters, switches, &c.
21,027 British Electric Transformer Co. & Roothaan. Coils for static transformers.
21,040 Tanaka. Armatures of electric rotating machines. (11/7/19, Japan.)
21,047 Luftfahrzengbau Schutte Lanz. Electromagnet for locking devices. (17/10/16 Germany.)
21,051 Sieurin. Carbon electrodes.
21,056 Allgemeine Elek. Ges. Driving system for a.c. motors. (31/12/18, Germany.)
21,060 Loewe. Vacuum tube. (20/4/18, Germany.)
21,077 Allgemeine Elek. Ges. Coin-freed meter for electricity. (19/9/14, Germany.)
21,078 Allgemeine Elek. Ges. Coin-freed meter for electricity. (4/7/17, Germany.)
21,092 Lipke. Heating running water by electricity. (25/4/14, Germany.)
21,094 Ebner. Talking machine with electric impulsion.

July 13, 1920.

21,103 Howard. Electrical transmission over wires or by wireless of pictures, &c.
21,106 Branson. Vehicle and starting.
21,113 Taylor. Long-distance electric power transmission.
21,139 Lye. Electrically bonding metallic circuits.
21,149 Wade. (Concordia Elek. A. G.). Portable electric lamps.
21,178 de Cossinck. Electric propulsion of ships. (15/7/19, France.)
21,179 Radio Communication Co. & Ree & Turner. Three-electrode ionic tubes.

Companies' Reports, &c.

YORKSHIRE ELECTRIC POWER COMPANY.

Mr. A. G. Lupton, who presided over the annual meeting on Tuesday, said the report and accounts showed the sound progress of the Company. Owing to the slump in every industry many customers were working short time, but the reduction in their demands for current had been more than taken up by new consumers and the increase of revenue had met the great increases of costs of fuel and labour and enabled the same dividend (8 per cent.) to be paid on the ordinary share capital, with a larger carry forward. The issue of £230,000 debentures, sanctioned in February last, had all been taken up and had strengthened their position. Since the inception of the Company it had been their policy to advance cautiously, increasing the plant and extending mains as the demand grew. The issue of shares last summer enabled extensions to be made which were beginning to bring a return and which would result in good increases in the sale of current during 1921 and following years. The Company had 446 miles of mains conveying current to 164 distributing sub-stations and was giving supply in the areas of 84 local authorities.

Bulk Supply.

In addition to direct supply to steel works, tramways, ship yards, collieries, textile factories and other industries, the Company was giving bulk supply to the holders of 40 provisional orders for distribution in their areas. Working agreements were in operation with Bradford, Sheffield, Rotherham, Dewsbury and Batley. Their mains were on the point of being coupled up with those of Sheffield at the Southern extremity of their area, whilst they were already giving supply in Otley on the northern boundary, Todmorden at the western extremity, and Pontefract on the east. They had a separate supply to Goole and Selby from the colliery station at Thorne, which they hoped would in a little time be coupled up to their Pontefract Mains. That was not a bad record for less than 20 years of existence, especially when one remembered that in spite of the long distance apart and scattered nature of the population served, the prices charged to the consumers for power and light were quite as low as those in the densely populated cities in the West Riding which had their own well equipped generating stations.

Statutory Restrictions.

They had tried in vain to get amended the restriction upon the use of their current for lighting purposes, which prevented the supply to householders in the more scattered portions of the area where it would not pay anyone to obtain a distributing order. Though they were not permitted to supply direct for lighting if the householder asked for current to run a sewing machine or a flat iron, or perhaps to light his after dinner cigar, in that case he could also use the current to light the premises in which he used the power. Their Company had always stood for the generation of electricity on a large scale upon the coal fields, utilising the waste heat from steel works and coke ovens wherever available and conveying the electric current by high tension mains to the cities and villages where it was required for driving factories and works and for public supply. Their record showed how much they had already accomplished, but it had been in the minds of some of them that another 20 years would see their Company joining its mains with those to the North, West and South, so that there might be an unbroken supply from Newcastle through Yorkshire down to Birmingham and Rugby and stretching out a hand on either side to Lancashire and Lincolnshire, not only for factories and householders, but also for the railways when they were ready.

Joint Authorities.

He expressed disappointment at the scheme put forward to cut off the collieries and iron works of the South Yorkshire coal field from the factories and other industries in the northern part of the West Riding. It was dangerous to prophesy, but it was possible that not many years would elapse before coal would cease to be burnt under boilers as at present, but would all be subjected to scientific treatment in coke ovens, the valuable bye-products extracted, and only the waste gases used for the generation of electricity. Municipal management might be necessary for many purposes, such as the control of the streets and even for local distribution of electricity within its area, but the scientific treatment of coal and its bye-products and the provision of capital for the purpose would be much better left in the hands of the industry itself. If the municipalities desired to assist in such undertakings outside their own areas by the provision of capital there was no reason why they should not apply for powers to invest their funds in the power Company and so get a share in its management. Their Company was to a large extent representative of the local industries; they had put up a considerable part of its capital and more than half of the Board were large consumers of its current. Unfortunately at present the Company was prevented from going forward with the station at Ferrybridge, which was urgently needed and would take two or three years to build. If the proposals for Nationalisation had not intervened the station would now be well on the way, and the first expenditure involved of a million or so on labour in the district and in British Engineering shops would have been some assistance towards solving the problem of unemployment. Mr. Lupton went on to criticise the proposals which will be submitted to the Electricity Commissioners. The production of electricity on a great scale and its distribution throughout a wide area could not be carried on with success by any petty parochial schemes which really did not even begin to realise the possibilities of the future, though to carry them out on the lines proposed would involve the expenditure of millions of capital, whilst there was nothing of any kind in them which was not already being adequately done by the Company without any charge upon either the taxes or rates.

The chairman concluded by paying a well-deserved tribute to the skill and capacity of Mr. Woodhouse and his staff. The development of the electricity supply industry would call more and more for well-trained engineers whose scientific knowledge, ability and character fitted them to bring to a solution the many problems of electricity supply on a large scale. It was a field for educated men which presented good prospects; it was one of the most progressive branches of engineering, and should prove not only an engrossing but a remunerative profession to many of the graduates in science of our principal Universities.

At the annual meeting of the Dublin United Tramways Company, Ltd., last week the chairman (Mr. L. Waldron) said the effects of curfew represented a loss of about 2,000,000 passengers per annum.

A dividend of 5 per cent. has been declared on the ordinary shares of the Smithfield Markets Electric Supply Company, Ltd., for the past year, the amount carried forward being £747.

The accounts of the Tyneside Tramways & Tramroads Company for the past half-year show a divisible balance of £3,097. A final dividend of 3 per cent. is proposed, making 4 per cent. for the year, and carrying forward £488.

The directors of the North London Railway Company have declared a final dividend of 3 per cent., making 5½ per cent. for the year 1920. The sum of £10,000 is placed to reserve and £14,565 (against £13,661) carried forward.

The net revenue of the City of Buenos Aires Tramways Company for 1920 was £68,940, and the directors recommend a final dividend of 1s. 3d. per share (making 5s. per share), placing £3,000 to general amortisation fund and carrying forward £3,940.

Subject to audit, the directors of W. T. Henley's Telegraph Works Company, Ltd., have decided to recommend a final dividend on the ordinary shares issued prior to the 1st Jan., 1921, of 2s. per share (less tax), making, with the interim dividend of 1s. per share paid in September last, 3s. per share for the past year.

The report of the Westminster Electric Supply Corpn. states that, after allowing for depreciation, sinking fund and other charges, the balance available is £70,381, less second half-year's dividend on preference shares (£12,375), leaving £58,006. The board recommends a dividend at rate of 12 per cent. per annum, less tax, making 10 per cent. for the year, carrying forward £12,698.

The accounts of the Cambridge Electric Supply Company, Ltd., for 1920 show a total profit of £9,584, which, added to £2,382, brought forward, makes £11,966. After deducting debenture and other interest (£2,096) and placing £3,000 to depreciation fund, the balance is £6,870. The directors recommend payment of a dividend of 5 per cent. for the year, absorbing £4,758, and leaving £2,112 to carry forward.

The Tyneside Tramways & Tramroads Company reports that the surplus of receipts over expenses for the half-year to Dec. 31 last was £3,340, and the balance brought forward was £1,011. It is proposed to pay a final dividend on the ordinary shares at rate of 3 per cent. per annum, making 4 per cent., carrying forward £488. Traffic receipts show an increase of £2,051, and for the year an increase of £6,579, but the increased costs of operation exceeded this.

The accounts of the Tottenham District Light, Heat and Power Company for 1920 show, after paying the full statutory dividend for the half-year ended June 30, and providing for interest and standing charges, an available balance (including £7,151 brought forward) of £26,347. It is proposed to pay a final statutory dividend at rate of 5 per cent. per annum on the preference stock, 3¾ per cent. on "A" stock, and 2⅝ per cent. per annum on "B" stock, carrying forward £13,174.

Mr. John Owen, who presided over the meeting of the Great Orme Tramway Company last week, said that for some time the directors had been convinced of the feasibility of converting the system of traction from steam to electric, but they could only obtain electric power through the Council, who were not now in a position to guarantee a supply. From outside sources the directors were aware that the Council were in negotiation with the North Wales Power & Traction Company with a view to getting power in bulk. The directors had no official information on the point, but what was going on between the Council and the company seemed more like a game of "hide and seek" than negotiations.

The traffic receipts of the London Electric Railway Company for 1920 were £1,716,476, and the miscellaneous receipts £134,936, a total of £1,851,412. The expenditure was £1,387,294; interest, rentals and other fixed charges required £286,266, the appropriation to reserve £45,000, and the dividend on the preference stock £126,947. The interim dividend paid in August last on the ordinary shares was ⅛ per cent., and absorbed £11,660, leaving £115,630 available, out of which the directors recommend payment of a final dividend for the year of 1 per cent., making, with the interim dividend, 1⅛ per cent. for the year, leaving £22,350 to be carried forward, compared with 1⅝ per cent. for 1919, and a balance of £20,942. The capital expenditure for the year was £88,404. A comprehensive scheme for the adjustment of and increase in the fares was put into operation on Sept. 26 last.

The total net income of the City & South London Railway Company for 1920 was £138,389, and after adding balance brought forward and deducting interest and fixed charges, placing £25,000 to reserve and paying the dividends on the preference stocks, the balance available is £41,020. The interim dividend paid in August last on the consolidated ordinary stock was ¼ per cent., and absorbed £3,700, leaving £37,320, out of which the directors recommend payment of a final dividend on the stock of 1¼ per cent., making 1½ per cent. for the year, leaving £18,820 to be carried forward. Owing to the financial stringency the directors have not been able to take any steps towards the reconstruction and re-equipment of the railway. This is a much needed improvement, and should be undertaken as soon as conditions will permit.

The traffic receipts of the Central London Railway Company for 1920 were £525,083, and the miscellaneous receipts £73,317, a total of £598,400. The expenditure amounted to £485,132; interest, rentals and other fixed charges absorbed £54,071, and after placing £20,000 to reserve and paying the dividend on the preference stock (£21,600), the balance is £82,660. The interim dividend of ¼ per cent. on the ordinary stock and of ½ per cent. on the preferred ordinary stock, which was paid in August last, absorbed £7,500, leaving £75,161, out of which the directors recommend a final dividend of 2 per cent. on the ordinary and of 3½ per cent. on the preferred ordinary stock, together with a dividend of ½ per cent. on the deferred ordinary stock, making 2¼ per cent. on the ordinary and 4 per cent. on the preferred ordinary stock for the year, leaving £15,160 to be carried forward. Until further experience of the increased fares introduced in September last has been obtained, it is not possible to say definitely that the present fares will provide a sufficient revenue for the working expenses, efficiently maintaining and renewing the undertaking, and a reasonable return on capital, although the results so far are up to expectations. The works in connection with the electrification of the Ealing and Shepherd's Bush line of the Great Western Railway have been completed, and the company's trains commenced running into Ealing Broadway on Aug. 3 last.

The revenue account of the South Metropolitan Electric Light and Power Company, Ltd., for 1920 shows a credit balance of £82,821, which, with £12,323 brought forward, and £1,001 14s. 0d., the dividend of 10 per cent. per annum on the Company's holding in the West Kent Electric Company, for the year 1919, makes a total of £96,146. After deducting £15,861 for interest on debenture stock and for other interest, and £7,912 for interim dividends on the preference shares, there remains £72,373, which the directors recommend be dealt with as follows:—In paying final dividends to Dec. 31, 1920, on the 7 per cent. cumulative first preference, £5,021; and on 6 per cent. cumulative second preference shares, £2,891; in placing to credit of depreciation fund, £23,000; to credit of reserve account, £10,000; in paying a dividend of 8 per cent. on the ordinary shares for the year, £13,200; leaving £18,260 to be carried forward. Despite the unfavourable conditions which prevailed during the year, the business shows a satisfactory improvement. The business of the West Kent Electric Company has also improved, and a dividend of 10 per cent. for 1920 is recommended. Lieut.-Col. Montagu Cradock, C.B., C.M.G., has been elected a director.

The directors of Messrs. Bruce Peebles & Company, Ltd., report that the profit for 1920, including interest on investments and transfer fees, and after deducting income tax, administration expenses and the amount required for debenture service, amounts to £74,714, to which must be added £5,461 from last year, making £80,176. There has been placed to reserve for excess profits duty and corporation profits tax £35,000, to depreciation reserve £8,000, and to general reserve account £10,000, leaving a balance of £27,176. The dividend at 7½ per cent. per annum paid on the preference shares for the half-year to June 30, 1920, required £1,915. The directors recommend payment of a dividend on the preference shares for the half-year ended Dec. 31 at 7½ per cent. per annum, and a further dividend at 2½ per cent. per annum for the year, making up the full dividend of 10 per cent., and a dividend on the ordinary shares for the year at 10 per cent. carrying forward £5,823.

The works have been fully employed during the year, and the result is satisfactory. The prospects for the current year are also good. It is proposed to issue the balance of the authorised share capital—36,469 in ordinary shares—and the ordinary shareholders will be invited to subscribe for same at par, less a commission of 10 per cent. In June last the directors appointed Mr. S. E. Bastow, formerly one of the joint managers, and subsequently chief engineer to the British Dyestuffs Corpn., Ltd., to be managing director of the company. The directors have also approached Mr. James Watt, W.S., with a view to his joining the board, and he has decided to act, if appointed.

The directors of the London Electric Supply Corporation, Ltd., report that the profit on the working for the year 1920 is £99,487, against £95,240 in 1919. Adding amount brought forward (£11,500) and deducting interest on temporary loan, &c. (£1,379) the total is £109,608. After meeting interest on debenture stock (£23,494) and providing for the sinking fund for redemption of debenture stock (£16,580), the balance is £69,534. The board propose to pay a dividend of 6 per cent. on the preference shares (of which an interim dividend of 3 per cent. was paid in September), absorbing £26,952 and a dividend of 2½ per cent. on the ordinary shares (£8,325), to place to reserve £15,000, to contingencies £5,000, leaving to carry forward £14,257.

The number of units sold amounted to 47,366,351, against 42,907,637; the total costs per unit sold being 1·38d. against 1·17d. The average receipt per unit sold (lighting and power) was 1·81d., compared with 1·60d. The directors regret to report the death during the year of Mr. R. Stewart Bain, the managing director. Mr. G. W. Partridge, the chief engineer and manager, has been appointed Managing Director in his place. The leading London companies, acting in association with the L.C.C. and the Conference of Local Authorities, are preparing a technical scheme for the London district, and the administrative and financial conditions which should govern the creation and powers of a Joint Electricity Authority are having the careful consideration of the Companies. It is hoped that the scheme ultimately adopted will be such as to secure the best use of existing resources and experience, with the object of producing and selling electricity as widely and as cheaply as possible.

The report of the directors of the St. James' & Pall Mall Electric Light Company, Ltd., for 1920 states that the connections which at the end of 1919 were 18,902 kw., increased during the year to 19,904 kw., and 13,510,297 units were supplied to consumers. The net profits applicable to dividends on shares amount to £28,309. 18s. 8d. Adding balance from 1919 (£8,576. 16s. 5d.), and deducting the interim dividends for the half-year ended June 30 at rate of 7 per cent. on the preference shares (£3,500) and on the ordinary shares (£7,000), an amount of £26,386. 15s. 1d. remains to be dealt with. The directors propose to pay a dividend at rate of 7 per cent. on the preference shares (£3,500), and a dividend on the ordinary shares for the second half-year of 8s. 6d. per share, making, with the interim dividend, a total of 12 per cent. for the year (£17,000), leaving to be carried forward to 1921 £5,886. 15s. 1d.

It is stated that a majority of the London companies (including the company), acting in association with the London County Council and the Conference of Local Authorities, have in preparation a technical scheme under the Electricity (Supply) Act which they propose to submit for consideration by the Electricity Commissioners. The important administrative and financial conditions which should govern the creation and powers of a Joint Electricity Authority are having the careful consideration of the Associated Companies, in view, especially, of the necessity of safeguarding the interests of the shareholders. It is hoped that the scheme ultimately put forward will be such as to secure the best use of existing resources and experience, with the object of producing and selling electricity as widely and as cheaply as possible. The directors regret the loss by death of their colleague, Mr. Marlborough R. Pryor, and Mr. Montague Gluckstein and Mr. Robert H. Benson have been appointed directors.

The gross receipts of the Metropolitan District Railway Company for 1920 were £1,767,267 (increase £201,698), and after adding Government compensation and deducting amount paid into the Common Fund, the total is £1,843,604, and the expenses were £1,509,272, leaving £334,332. With the miscellaneous receipts the total net income was £539,840, a decrease of £25,771. After adding balance from 1919, and deducting interest, reserve and dividends on guaranteed and first preference stocks, the balance is £64,637, a decrease of £16,261. The interim dividend of 1¼ per cent. paid on the second preference stock in August absorbed £18,375, leaving £46,262, out of which the directors recommend payment of a final dividend of 1¾ per cent., making 3 per cent. for the year, leaving £20,537 to be carried forward, compared with 4 per cent. and a balance of £22,098 in 1919. The capital expenditure for the year amounted to £46,595. Under the Fares Act of 1920 a comprehensive scheme for the adjustment of and increase in the fares charged on the railways of the four companies was put into operation on Sept. 26 last. Ordinary fares were increased by approximately 30 per cent., and workmen's fares and season ticket rates were also increased. The effect of these increases, and of the cancellation of the financial arrangement with the Government, was felt only during the last three months of the year. On the other hand, the increased working expenses prevailed throughout the year. Until further experience with the increased fares has been obtained, it is not possible to say definitely that the present fares will provide a sufficient revenue for the working expenses, efficiently maintaining and renewing the undertaking and a reasonable return on capital, although the directors say that the results so far are up to their expectations. The rolling-stock contractors have commenced to make delivery of the new cars of an improved type, and these are being put into service as quickly as possible. The construction of a new subway at Charing Cross Station was completed during the year, and proved to be a great public convenience.

New Companies.

The following list has been compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, Chancery-lane, London, W.C.2.:—

ELCO ELECTRIC MANUFACTURING COMPANY, LTD. (172,517.)—Private company. Reg. Jan. £10. Capital, £12,000 in £1 shares, to carry on the business of manufacturers, factors and repairers of switchboards and electrical appliances. Directors are: A. C. Wiley (chairman and managing), W. F. Cook and F. W. Fifield. Reg. office: 9, Denmark-street, Bristol.

FYFE WILSON & COMPANY, LTD. (172,959.)—Reg. Feb. 3. Capital £10,000 in 800 preference and 2,000 ordinary £1 shares. To acquire and carry on business of mechanical and electrical engineers. Directors: H. F. K. Dearlove, A. Hall and H. A. May. Reg. office: 31, Budge-row, Cannon-street, E.C.

GRAHAM & SONS, LTD. (172,842.)—Reg. Jan. 28. Capital £5,000 in £1 ordinary shares. To carry on business of electrical engineers. Directors: J. P. Graham, C. P. Graham and H. E. Graham. Reg. office: Sun Insurance-buildings, Collingwood-street, Newcastle-upon-Tyne.

PRACTICAL MACHINES COMPANY (A. T. GAISBY), LTD. (172,826)—Capital £10,000 in 1,000 preference and 9,000 ordinary £1 shares, to carry on business of electrical and general engineers. Directors: A. T. Gadsby (ch. and man. dir.) and H. Berry. Reg. office: 39, Avenue-chambers, 4, Vernon-place, Bloomsbury, W.C.

THOMAS DOWBIE, LTD. (172,974.)—Reg. Feb. 3. Capital £5,000 in £1 shares. To acquire and carry on business of marine, consulting, mechanical and electrical engineers. Directors: D. Brown, E. J. Walker and J. S. Chadwick. Reg. office: 5, Castle-street, Liverpool.

Forty Years Ago.

(THE ELECTRICIAN, FEBRUARY 19, 1881.)

THE SWAN LIGHT IN DUNDEE.—Mr. Swan's incandescent lamps were exhibited by the Naturalists' Society of Dundee at their annual conversazione last week.

REDUCTION IN PRICE OF GAS.—From all quarters of the kingdom we hear of a reduction in the price of gas, varying in amount, but decided in its tendency. What is the cause?

THE ELECTRIC LIGHT AT ALNWICK CASTLE.—The initiatory experiments in lighting the castle with the aid of steam power have, we learn, been abandoned, and water-power is to be applied, through the agency of the turbine wheel, from the water of the Aln at the Abbey Mills.

THE TELEPHONE IN DUBLIN.—The Secretary of the Dublin Post Office has intimated to the Corporation of that city that the proposed erection of wires in public streets by persons not authorised in the Act of 1863 is illegal. It is at the same time intimated that the Post Office is prepared to establish telephonic communication wherever this may be applied for.

RECENT TRIALS OF THE ELECTRIC LIGHT.—Last week the new Waterloo Station of the London & South-Western Railway and its approaches were illuminated for the first time with the electric light by means of fifteen lights. The experimental trial was made in the presence of the chairman, Colonel the Hon. H. W. Campbell, Captain Johnstone, Mr. Archibald Scott, the general manager, and other officials of the company.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics."—"Meteorology in the Service of Aviation," by Major G. Dobson; "Soaring Flight," by M. A. S. Riach; Annual Report of the Advisory Committee for Aeronautics.

"The Cabinet Maker."—"The Furnishing of Royal Workrooms at Olympia"; Annual Dinner of the National Federation of Bedding and Allied Trades, Ltd.; and "Yorkshire Industries of Interest to the Furnishing Trade."

"Chemical Age."—"Future of British Key Industries"; and Special Contributions by leading chemical and glass manufacturers.

"Farm and Home."—"Hackney Horse Show"; "Basic Slag and Agriculture"; and "National Farmers' Union and Wheat Prices."

"The Fruit-Grower."—"The Ministerial Changes"; "How Fruit is Grown at Hollesley Bay"; and "Current Work in the Nursery."

"Gardening Illustrated."—"Potatoes for Exhibition"; "Apple Lord Derby" (illustrated); and "Carpeting Plants for the Flower Garden."

"Gas World."—Carbon Monoxide in our Gas Supply; Analyses of Some Gas Companies' Accounts.

"Hardware Trade Journal."—"Domestic Labour Saving Appliances" "The Efficiency Exhibition": and "Seeing the Special Order through."

Prices of Metals, Chemicals, &c.

TUESDAY, Feb. 15.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£76 0 0	—	—
Electro Wirebars ...	,,	£79 0 0		—
H.C. wire, basis ...	per lb.	1s. 0$\frac{1}{16}$d.	-	—
Sheet	,,	1s. 1$\frac{5}{16}$d.	—	
Phosphor-bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. 4$\frac{1}{16}$d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 8$\frac{3}{4}$d.	—	$\frac{1}{4}$d.
Sheet, basis	,,	1s. 1$\frac{3}{4}$d.	—	—
Wire, basis	,,	1s. 1$\frac{1}{2}$d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£10 0 0	—	£0 5 0
Galvanised steel wire, basis 8 SWG	,,	£29 0 0	—	—
Lead Pig—				
English	,,	£23 0 0	—	£1 10 0
Foreign or Colonial	,,	£20 15 0	—	£1 17 6
Tin—				
Ingot	,,	£172 5 0	£5 5 0	—
Wire, basis	per lb.	2s. 4$\frac{1}{2}$d.	$\frac{3}{4}$d.	—

Salammoniac.—Per cwt. 100s.-95s.

Sulphur (Flowers).—Ton £14 10s.

,, (Roll-Brimstone).—Per ton £14 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £36.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 10d.

Sodium Chlorate.—Per lb. 4$\frac{1}{2}$d.

Rubber.—Para fine, 0s. 11$\frac{1}{4}$d.; plantation 1st latex, 1s. 1$\frac{3}{4}$d. to 1s. 2d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

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Arrangements for the Week.

FRIDAY, February 18th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At Storey's Gate, St. James's Park, London, S.W. Paper on "The Desirability of Standardisation in the Testing of Welds," by Mr. F. M. Farmer.

INSTITUTION OF ELECTRICAL ENGINEERS.—STUDENTS' SECTION.

6.30 p.m. At King's College, Strand, London, W.C. Presidential Address by Mr. L. B. Atkinson.

INSTITUTE OF METALS, SHEFFIELD LOCAL SECTION.

7.30 p.m. At The University, St. George's Square, Sheffield. Paper on "Cracking in Worked Brass and Other Metals," by Dr. F. Rogers.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper "On the Losses in Convergent Nozzles," by Prof. A. L. Mellanby, D.Sc.

SATURDAY, February 19th.

ROYAL INSTITUTION.

3 p.m. At Albemarle Street, London, W. Lecture on "Spectroscopy—Regularity in Spectra," by Mr. A. Fowler, F.R.S. (Lecture II.)

MONDAY, February 21st.

PHYSICAL SOCIETY OF SHEFFIELD.

7.30 p.m. At the University, Sheffield. Paper on "Valves and Wireless," by Mr. C. H. Hainsworth.

ROYAL SOCIETY OF ARTS.

8 p.m. At John Street, Adelphi, London, W.C. Cantor Lecture on "Applications of Catalysis to Industrial Chemistry," by Dr. E. K. Rideal, M.B.E. (Lecture II.).

TUESDAY, February 22nd

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. At Great George Street, London, S.W. Paper on "Port Improvements at Newcastle, N.S.W.," by Mr. P. Allan.

INSTITUTION OF ELECTRICAL ENGINEERS.

7 p.m. At the Engineers' Club, Albert Square, Manchester. Paper on "Magnetos for Ignition Purposes in Internal Combustion Engines," by Mr. E. A. Watson.

INSTITUTION OF ELECTRICAL ENGINEERS.—SOUTH MIDLAND CENTRE. STUDENTS' SECTION.

7.30 p.m. At the University, Edmund Street, Birmingham. Paper on "Turbo Alternators," by Mr. J. P. Ellis.

WEDNESDAY, February 23rd.

INSTITUTION OF CIVIL ENGINEERS.—STUDENTS' MEETING.

6 p.m. At Great George Street, London, S.W. Lecture on "Machinery Applied to Mass Production," by Mr. J. H. Barker.

INSTITUTION OF ELECTRICAL ENGINEERS.—SOUTH MIDLAND CENTRE.

7 p.m. At the University, Edmund Street, Birmingham. Discussion on "Electric Appliances for Domestic Purposes." To be introduced by a Paper on "Some Thermal Characteristics of Electric Ovens and Hot-plates," by Dr. E. Griffiths and Mr. F. H. Schofield.

INDUSTRIAL LEAGUE AND COUNCIL.

7.30 p.m. At Caxton Hall, Caxton Street, London, S.W. Lecture on "Health in Industry," by Dr. E. Halford Ross.

THURSDAY, February 24th.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Gt. George Street, London, S.W. Lecture on "Magnetic Susceptibility of Low Order." Lecture II. Results of Scientific Research, by Prof. E. Wilson

ILLUMINATING ENGINEERING SOCIETY.

8 p.m. At the Royal Society of Arts, John Street, Adelphi, London, W.C. Discussion on the Use of Light as an Aid to Publicity, including "Shop Window and Spectacular Lighting." Introduced by Capt. E. Stroud, and "Illuminated Signs," by Mr. E. C. Leachman.

FRIDAY, February 25th.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers on "A Note on the Hot-Wire Inclinometer," by Mr. R. H. Humphry; "On the Magnetic Susceptibility of Certain Natural and Artificial Oxides," by Prof. E. Wilson and Herroun; "On the Refractometry of Prisms," by Mr. J. Guild; and "On Tracing Rays through an Optical System," by Mr. T. Smith.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At 39, Victoria Street, London, S.W. Lecture on "Measurements of Precision in Engineering," by Mr. H. T. Davidge.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Offices on receipt of published price, plus postage.]

"The Thermionic Vacuum Tube and Its Applications," by H. J. Van der Bijl, M.A., Ph.D. (London: Hill Publishing Company). Pp. xix.+391, 30s.

"Winning the Public," by S. M. Kennedy. (London: Hill Publishing Company). Pp. 168, 15s.

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Notes.

The Dalmarnock Breakdown.

WE are glad that the disquieting rumours about the operation of the generating plant at the Dalmarnock station of the Glasgow Corporation are not to be allowed to go on circulating without some explanation. As it is, grave charges have been made against British design and engineering, and comparisons, as odious as they have eventually proved to be false, have been allowed full scope. For, as will be seen from a communication which we publish on another page of this issue, the cause of the several breakdowns is relatively simple, and as simply explained, being due to the fact that the core bolts employed on the alternators vibrated at a frequency which synchronised with the frequency of vibration of the whole set, corresponding to the speed of 1,500 revs. per min. As a result of the mechanical stresses thus set up the insulation between the bolts and the frame of the machines failed and trouble followed in the normal way. The Metropolitan-Vickers Electrical Company very rightly take full responsibility for what has occurred, but they equally correctly point out that the damage was purely mechanical, that it was not in the least due to any fault in the insulation and that the construction employed was a well-tried one. We dare prophesy, then, that these bolts will not again cause breakdowns either at Dalmarnock or elsewhere. In this particular instance the course has been adopted of replacing the faulty bolts by copper bolts of smaller diameter, and stressed to such a low value as to leave their natural frequency very far below the running frequency of the machine, an arrangement which should give satisfactory results. The worst phase of the whole matter, in our opinion, is the trouble and inconvenience the breakdown has caused to the electricity consumers in Glasgow, and the resulting stigma that may therefore attach to the good name of electricity supply. Apart from this, the occurrence may well be instanced as one of those to which we referred a week or two ago, where accidents place us in a position to learn useful lessons. On this score it should therefore be welcomed as an opportunity for discovering new facts rather than as an excuse for depression.

Relativity.

WE believe it was Dr. JOHNSON who said that the wonderful thing about a dog walking on its hind legs was not that it did it well, but that it did it at all. The same remark may, with some justice, be applied to the man who attempts to explain an essentially mathematical conception, such as relativity, in non-mathematical language, so that while congratulating Mr. L. BOLTON on his success in winning the prize of $5,000 offered by the "Scientific American" for a non-mathematical essay on the subject, we are not surprised that his article has not cleared away the doubts and obscurities which exist in the minds of both scientific and non-scientific persons on this matter. This criticism does not, however, apply to the articles published in last week's issue of "Nature," in which the whole field of our knowledge regarding relativity is explored by such authors as Prof. EINSTEIN himself, Sir FRANK DYSON, Dr. CROMMELIN, Prof. MATTHEWS, Mr. JEANS, Prof. LORENTZ, Sir OLIVER LODGE, Prof. WEYL, Prof. EDDINGTON, and Dr. NORMAN CAMPBELL, and we congratulate our contemporary on collecting such a wealth of influential information on a subject the importance of which cannot be over-estimated.

A Change of Foundation.

THE reasons for the interest taken in relativity are not far to seek. If we accept the principle of EINSTEIN we must give up the theory of an all-pervading stationary æther upon which so much of the work of FARADAY, CLERK-MAXWELL and other physicists was based. The æther was conceived as stationary, yet all tests failed to detect the movement of the earth through it, so that FITZGERALD suggested that the dimensions of the apparatus were affected by the movement and, on the theory of the electro-magnetic constitution of matter, LARMOR and LORENTZ reached the conclusion that no experiments could ever reveal absolute motion. EINSTEIN's work, however, showed that remarkable consequences as to time and space followed from this proposition; so remarkable, that they necessitated a new mental picture of the physical universe. It would, in fact, not be going too far to say that acceptance of the principle of EINSTEIN would necessitate a complete change in our views of one of the foundations of physical science. It is not surprising to find, therefore, that many physicists do not think it necessary to go "the whole hog," and that while most agree that there is something in it, not by any means all are agreed that Prof. Einstein's theory is without its weak points. Perhaps, however, the most interesting thing from the electrical point of view about this controversy is the way in which the idea, as "Nature" points out, has proceeded by logical steps from hypothesis to theory. In two cases predicted phenomena for which no other alternative explanation is forthcoming, have been observed, and a third is still the subject of inquiry. This makes it a true victory for scientific method, which in its highest conception proceeds carefully from stepping stone to stepping stone, and allows no weight to be given to a new idea until that idea has first been carefully tested.

Electric Supply Reorganisation.

During the past week the Electricity Commissioners have been engaged in investigating proposals for the reorganisation of electricity supply in the North Wales and Chester Electricity District, and, as will be seen from the report of the proceedings on another page of this issue, all the parties interested have been given a patient, almost a too patient, hearing. A great deal of time was spent on points of detail raised by urban and rural councils which might well have been postponed until questions of general principle had been settled, while the subject of riparian and fishery rights might also have been reserved, as well as the application by a representative of the organising committee for the North West Midlands Electricity District to transfer a portion of that area to either the Mersey or the North Wales District. In connection with the last point it must be remembered that the electricity districts have only been provisionally determined and the Commissioners can at any time readjust the areas so as to make them fit in with public requirements. If, however, the same amount of time is spent on each of the other districts it will be some years before the work of reorganising the industry is complete.

The Chester and North Wales Schemes.

There were only two schemes from the North Wales district before the Commissioners, but some of the witnesses were cross-examined at great length. One scheme was submitted by Chester Corporation and involved the creation of a Joint Electricity Authority upon which all interests, both municipal and company, would be represented; the other was put forward by the North Wales Power & Traction Company. The latter has two large hydro-electric stations and has already got bulk supply powers over the greater part of the proposed area. It now wishes to develop further the water power available and in this way to supply in bulk to local authorities and existing undertakers, the latter distributing energy in their respective areas. Under the Chester scheme there would be big steam-driven works on the lower Dee and there would also be hydro-electric stations on the Upper Dee. The relative claims and advantages of the two schemes were well put by Mr. S. E. Britton, of Chester, and Mr. H. J. Jack, of the North Wales Power & Traction Company, and we await the decision of the Commissioners with interest.

The International Cable Dispute.

For over a quarter of a century there have been spasmodic demands for an all-British submarine cable system, but it was only during the war that any attempt was made to give effect to the views of those idealists who propounded the advantages of this arrangement. The reason for this is simple. The system of cables owned or controlled by the Eastern Telegraph and its associated Companies was so extensive, and their operation was so satisfactory in every respect, that it was only during the progress of hostilities and the strain thereby imposed on our resources that it was discovered that it was necessary to have independent cable communication with Canada. This was provided temporarily by the diversion of one of the German Atlantic cables, and more recently the position has been strengthened by the purchase of the Direct United States Telegraph Company's cable by the Government. The movement for "all-British" communication has apparently led to a very strong demand by commercial men and certain political interests in the United States for an "all-American" chain of independent submarine cables, so as to give them direct means of communication with all other countries. This seems the main reason for the deadlock in the negotiations as to the disposal of the cables lately owned by German companies in the Atlantic and the Pacific. In our issue of November 26 last we gave an outline of the situation on the adjournment of the International Communications Conference in November last. The Ambassadors of the countries interested have now resumed consideration of this delicate subject, and we trust that an amicable arrangement will soon be evolved. If this country were alone concerned we believe there would be no difficulty in finding a solution, but the attitude of our Allies, France and Japan has also to be taken into consideration.

International Radio-Telegraphy.

Apparently the United States Government is equally solicitous about her means of radio-telegraph communication with the outside world, for she has taken up with the utmost seriousness the withdrawal of a Chinese concession recently granted to the American Federal Wireless Company. This concession is said to be a breach of a previous exclusive concession granted to the Marconi Wireless Telegraph Company. Though radio-telegraphy has made great advances during the last six or seven years, and is likely to make equally good progress in future, still no one seriously contends that it will altogether displace submarine telegraphy, or seriously affect its development. The first link in the Imperial Chain of wireless communication, that from England to Egypt, is expected to be in operation by May, and the other portions of the chain will be supplied in due course. Wireless communication will also be provided with practically the whole of the countries in Europe and this will be supplemented by the expanding Marconi services. This activity is well-known in the United States, but the main reason for the present American attitude is said to be due to the desire to maintain the open door in China, though no doubt the present demand for independent means of communication, coupled with the patriotic endeavours to support one of its own nationals, may have also had considerable weight. It might be added that the development of radio-telegraphy has been so rapid that there is now a general desire for a revision of the International Regulations laid down by the International Radio-Telegraph Convention of 1912. No doubt some of these regulations are not in conformity with modern practice and the present needs of nations. The position of radio-telegraphic companies' and private commercial stations and many other points require to be more clearly defined. The Preliminary Communications Conference is, therefore, considering the steps to be taken to bring these matters up to date.

The High Cost of Poor Lighting.

The case for good industrial lighting is put in a very effective form by Mr. R. E. Simpson, of the Travellers Insurance Company, in a paper read recently before the American Illuminating Engineering Society. That a considerable proportion of accidents are due to faulty lighting is freely admitted. Ten years ago statistics collected in the United States put the proportion as high as 25 per cent., and though in the interval conditions have improved Mr. Simpson's view is that even now at least 15 per cent. of industrial accidents are attributable to this cause. From an analysis of accident returns he estimates the value of the annual time lost through accidents at 200 million dollars. Fifteen per cent. of this, *i.e.*, 30 million dollars, is probably chargeable to inadequate lighting. Taking a typical case, Mr. Simpson shows that a firm expending 375 dollars per month on lighting is probably paying an extra 866 dollars per month on insurance owing to the lighting being inadequate. This sum, be it noted, does not serve any productive purpose, and it would therefore be much better economic policy to spend some of the money on improving the illumination. These are the type of arguments that "get home" with commercial men. We wish that officials of insurance companies in this country were as well aware of the prejudicial influence of bad lighting in causing accidents and impairing efficiency as Mr. Simpson is.

Electric Power in Industry.

The ground covered by the lecture delivered by Mr. J. C. Wigham at the Efficiency Exhibition last week was of a width that is hardly indicated by its title of "Electric Power in Industry." In comparing the costs of driving machines by steam, gas and electricity he made a point most appropriate at an efficiency exhibition, that cost is not the only thing that matters. He showed how true this is by indicating the great part the electric drive plays in our industrial life, so great that it may truly be said that no manufacturing process is now complete without it. But true as all this is, there is virtually general agreement about it, certainly among electrical engineers, so that the main effect of Mr. Wigham's remarks was that of preaching to the converted. On the other hand, he skimmed too quickly over present and future conditions in the electric vehicle, electric traction, electric furnace and especially in the domestic electric fields, in all of which there is still a great deal to be done, and where for that reason ample and well-thought-out propaganda is eminently necessary.

The Public View.

It is only fair to add that Mr. Wigham's survey was of a kind likely to appeal to a popular audience, and we hope that it left in the minds of those present some realisation of what the electrical industry is doing for them, and of what they can do for themselves by the use of electrical equipment. But once again, as Mr. Leevers rightly said in the discussion, the principal link that is required to join the public and electricity together is education, and this point we are glad to see was emphasised by other speakers. For while the unobtrusiveness of the electric drive is an advantage, the unobtrusiveness of the electrical engineer is of no advantage at all to himself or to anyone else, but is a handicap to progress, and we hope trade will attend the industry. And while as a driving agent the electric motor is so well established, and its advantages so well known that it is now almost its own advertisement, the same does not apply to other spheres of usefulness. No effort should therefore be spared to develop well-thought-out schemes for bringing the advantages of electricity for the purposes we have indicated to the public notice. Such a lecture as that given by Mr. Wigham last week is one of the best ways in which this can be done if the subject is well chosen, and the subject matter adapted to the audience to whom it is delivered. But when other lectures of this kind are inaugurated we should like to see the discussion so stage-managed that speakers from among the public are encouraged to have their say. For the more electrical engineers know of what the non-electrical user thinks about our equipment the better it will ultimately be for all parties.

Foresight and the Domestic Load.

It is human nature that when some course a little out of the ordinary is suggested there is widespread opposition even from those who would benefit most from the new policy being adopted. An example of this sort of attitude is to be found among those station engineers who view the approaching development of the domestic-electric load with something approaching dismay, being fearful of the effect which the development is likely to have on their networks. Some, indeed, go so far as to protest that they cannot connect a single extra domestic consumer until their "copper" has been increased, and that the necessary increase is at present impossible for financial and other reasons. Calm consideration will, however, show that this is not the way in which the problem should be tackled. The domestic-electric load is for the moment a very tender plant, but we hope—indeed, we feel sure—that it will gradually increase in sturdiness, and that before long there will be a large and steady demand from the general public for the facilities it can provide. Unhappy those who in such case cannot supply the demand! Supply engineers would therefore be well advised to prepare for that demand in their own time rather than be forced to deal in haste with the situation when it arises, as it will undoubtedly arise.

Future Methods of Distribution.

We are glad to learn that the advantages of foresight in this matter are being realised in certain districts, and that steps are being taken to deal with the present and prospective increased demands in a number of ingenious ways and with a minimum of expenditure. In one city, for instance, where three-phase generation and direct-current distribution is the rule, a new three-phase feeder-distributor is being laid right across the central area of supply. This cable will be tapped at convenient points to supply large blocks of shops and offices with their lighting and domestic requirements., the necessary static transformer stations being located at convenient positions on the consumers' premises or elsewhere. Power requirements will, of course, be met as at present. This arrangement will relieve the existing direct-current network, and so enable more consumers to be supplied. The idea, of course, is not capable of infinite expansion, but is at least an ingenious method of dealing with present difficulties. In another instance, where alternating current distribution is already employed, it has been suggested that, where possible, a higher distributing voltage should be used and transforming stations installed in convenient positions for feeding blocks of houses at the present supply voltage. Either policy is, at any rate, better than saying that nothing can be done until prices go down, and we hope that all supply engineers will consider what means can be adopted in their own areas to meet the steadily increasing demands for a domestic-electric supply. Were that demand to be checked ever so slightly by refusal or discouragement, it would be disastrous.

The Telephone Agitation.

The agitators for an improved telephone system have won a victory which may turn out to be something very like a defeat. For while there is to be yet another inquiry into the administration of the telephone by the Post Office, the coming into force of the new rates is not to be postponed. The only result will therefore probably be a more or less well-balanced report, and an expenditure of a certain sum of public money in hearing evidence and collecting data. And this is really only the first short step, for when the evils of the system or of the administration have been pointed out, there yet remains the more difficult step of killing those evils. But we understand that the agitation which has been enlivening the columns of the daily press for the past few weeks has not been undertaken with the idea of returning the telephone system to private management or with avoiding any increase in charges which may be necessary, but has solely been undertaken with a view to dissecting the present administrative methods of the Post Office and of discovering whether economies cannot be introduced which would render the increased charges unnecessary. The one hope of improvement, therefore, lies in teaching the Post Office business methods, and it will take more than a committee, or even a Press agitation, to do this.

An Important Work.

Having animadverted in a recent issue on the shortcomings of many present-day engineering text-books, it is only right that we should draw attention to the other side of the picture. For among a number of very poor productions we occasionally receive a book which is in every sense of the word literature, and as such is not only worthy of study but of retention. An example of this latter class is "Properties of Steam and Thermodynamic Theory of Turbines," by Prof. H. L. Callendar, a review of which will be found on another page of this issue. It will be agreed that thermo-dynamic theory is not a very easy subject either to write about or to interest the reader in, yet Prof. Callendar has so well succeeded in both parts of the task that every sentence in the book is full of information. Also there is no padding of any kind, and without any sense of incongruity it may be said that interest is held from beginning to end. This is not surprising when it is realised that the book is an epitome of Prof. Callendar's researches extending over many years into this important subject. And this being so it is hardly possible to exaggerate the value of what he has written. The importance of the right use of steam is likely to increase rather than to diminish in the future, and it is evident that the more we know about its properties the better we are likely to be able to make use of it. To do so it is evident that not only must correct deductions be made but the premises from which they are made must also be as accurate as humanly possible. As Mr. Selvey points out this is only a question of expense, and it is therefore to be hoped that before long it will be possible for Prof. Callendar or some other worker to bring our present knowledge up to date from figures obtained with modern turbine plant. We agree with Mr. Selvey that the Turbine Committee of the B.E.A.M.A. is the proper body to assist in this matter, and we feel sure that the large amount of time and money which would necessarily have to be expended on the investigation would be amply repaid by the results obtained.

A Novel Strike.

Owing to the greatly increased cost of printing and the very high price of paper all books, publications and printed matter have, as we know to our cost, had to be increased in price since pre-war days. This upward movement, which is not confined to any particular country, is one of the worst legacies hostilities have bequeathed us, as it is really a tax upon the acquirement of knowledge. But while we have great sympathy with all those, and they must be very numerous, who suffer from the high price of printed matter, we doubt if the steps taken by the students of Naples will have the desired effect of bringing about a reduction. As a protest against the high cost of educational books, and particularly of those on scientific subjects, they not only went out on strike, but also demanded a reduction of 50 per cent., and where this was refused by publishers and booksellers, adopted the medieval policy of commandeering the books in stock and tearing them to pieces. The effect of this action, though doubtless a relief to the overcharged Southern temperament, can only be to make scientific works scarce as well as dear, and the position of the serious student in Naples will only be more difficult than it was before. It would be much wiser, though less spectacular, to form book clubs or to establish co-operative societies for buying and lending expensive scientific and educational works. We believe it was Adam Smith who pointed out that the breaking of windows by rioters is not really good for the glaziers, and it is certain, *a fortiori*, that burning books is no advantage to either booksellers or publishers and is likely to be harmful for students.

Understudies on Councils.

A proposal made at a recent meeting of the South African Institute of Electrical Engineers will interest those who sit upon the councils of scientific and technical institutions. It having been found that members of the Council of that Society were often away on either business or leave for months at a time and that this absence threw undue work on those who remained, the suggestion was made of providing each member of the Council with an understudy, who in the absence of his principal should take his place and perform his duties, as is, we believe, the custom in less scientific circles. We are hardly surprised to learn that the proposal found no great support. The constitution of the South African Institute of Electrical Engineers, like that of most other such societies, provides means for filling any vacancies which occur on the Council. Moreover, if a member either before or after election to the Council finds that other work will prevent him performing these duties satisfactorily, the best thing he can do is to resign and let his place be filled by some one more fortunately situated. The proposal, indeed, is a good example of trying to do the right thing in the wrong way.

The Prize Tramcar.

A search of certain dusty files in the Patent Office Library will convince anyone who cares to undertake the task that there is no limit to the lengths to which the ingenious inventor will go in devising apparatus from the hairpin that cannot be lost to the machine which will do all the household chores and end up by taking the children for their daily constitutional. It is true that some of these machines will not work except on paper, and that few of them ever do much towards making the world fit for ordinary people to live in. Nevertheless, it is a sorry commentary on the intellects of this band of much misunderstood creatures that the prize of £1,000 offered last May by the London County Council for a new design of electric tramcar has not been awarded, owing to the fact that according to the assessors nothing really practical was suggested. Surprised as we are at the result, we hope that we shall not be bombarded with letters from inventors, pointing out that only jealousy and political rancour have prevented their particular ideas from being adopted. We agree with all that may be said in advance on this question, and to prevent the influx of callers we will add that probably the reason why no prize was awarded is that the present tramcar cannot be improved.

Our real opinion is that the result indicates a sanity on the part of the Highways Committee of the London County Council which we had not thought it possessed, at any rate it has resisted the temptation to adopt the design of the ingenious person who suggested a car with sloping sides against the sides of which tightly packed passengers could lean.

Unemployment.

We have so far refrained from commenting on the unemployment question in the hope that either the Government or the trade unions, or better still both in conjunction, would find some solution of the present serious difficulties which did not include doles, the inauguration of more or less useless relief work, panic legislation, or the adoption of other panaceas which will eventually make the remedy worse than the disease. Unfortunately, this consummation has not yet been reached, nor does there seem much prospect of it ever being reached. On the other hand, every day unemployment is increasing, trade seems ever to be getting worse, and nothing constructive is being done to improve matters. Now bad as this state of affairs is for those most intimately concerned and for the trade and industry of the country, psychologically it is worse still. For it gives to those who desire nothing better than an overthrow of our present system of government, finance and industry a lever to advance their own mad-brained schemes, of which they are not slow to take advantage. It makes the timid fear that matters are really very much worse than they are, and they are bad enough in all conscience, and, therefore, to throw their weight on what they consider to be the winning side. It further handicaps those who see clearly what the true solution of the problem is, and necessitates time being taken up in arguing against false doctrines rather than in putting forward every effort to improve the situation. This would be bad enough were the matter not so urgent, but unless the situation is realised and dealt with without delay we may well be faced with political and commercial disaster, not because there is logically any real reason why such disaster should occur, but because fright and timidity will be steering the ship when only clear sightedness and boldness can adequately control it.

The Diagnosis of a Platitude.

It is a platitude that present unemployment is caused not by the usual factors which are conveniently grouped under the heading of bad trade, but by the position of the foreign exchanges, by the burden of excessive taxation (especially the Excess Profits Duty, now happily moribund), by the high cost of production and by the general disorganisation and war weariness caused by the recent hostilities. The diagnosis thus being clear it would seem at first sight an easy matter to proceed to treatment and cure, but such is not the case. Indeed, we are provided with yet another example of physicians disagreeing, for we have on the one side those who suggest that the only practical way to restore normal conditions is to reduce the cost of production by immediately reducing the wages throughout all industries, and, on the other side, the definite statement by Labour that reduction of wages will be resisted by all means in their power, and that the real cause of high prices and the present unemployment is the enormous profits which have been made in recent years. And between the employers and the employed, whose cases we have just represented and who both have a certain amount of justice on their side, stands the ordinary consumer, who is almost silent but who seems to be the first to be placed in any disadvantageous position there is going, so far as wages and trade are concerned, and who is certainly the last to obtain the least benefit from any alleviation in the industrial situation.

Cause of Present Discontents.

If we examine the causes of the present unemployment it appears that though the foreign-exchanges question might be dealt with by agreement the complications and the time necessary to arrive even at a compromise that would be accepted by all parties would be so long as to render it probable that these particulars matters would adjust themselves before any remedy is likely to be obtained in that way. With the effects of an excessive taxation we are all familiar enough. And we hope with the removal of the Excess Profits Duty an attempt will be made to raise the necessary revenue for carrying on the country without resource to methods which, whatever their advantages, are primarily notable for the bad effect that they have upon trade. In considering this question it must, however, be realised that the revenue required by the country is very much larger than it was in pre-war days and is likely to continue, however economically our Government operates, at a high figure for some time to come. So that while relief from excessive taxation would doubtless be of assistance in solving the unemployment problem it is a solution that cannot be pushed further than a certain point. The wholesale reduction of wages is a solution which, though it at first sight seems to fulfil every condition, is in too many cases put forward in a spirit of vindictiveness, though this is one reason only why it is outside true practical politics.

No Reduction in Wages Necessary.

In our view unemployment at present, is, to a large extent, both unnecessary and unwise. For, except in a few cases where wages have risen to a very high point, they need not be reduced at all if (and there is much virtue in that if) production is increased as a result. The whole question is indeed an economic one, and, provided that what we have just said is admitted, it will be agreed the trade unions are quite right in standing out for what they consider their just claims ; but any policy they adopt in this respect will have to be very carefully considered and carried out, as when it comes to a question of lower wages *versus* no wages there will not be found many who do not accept the reduction, especially as the reduced prices, which will we hope soon be realised, will bring home the truth of the fact that money is of no benefit in itself.

On the other hand, the policy which has been followed by many capitalists and employers of labour must also be changed. There are black sheep on this side of the industrial fence as well as on the labour side, and though employers and financiers have been impeded in a way that has not been the lot of any trades organisation, many of them have not made the best of a bad situation, but have gone as far as to adopt a policy which has been very harmful. One result of this is to be seen in a watering down of enterprise and the acquiring of a habit of sloth out of which it seems to be difficult to emerge. And to attempt to keep wages, profits, or prices above their economical level will simply lead to a continuance of the present or even worse conditions and to ultimate disaster.

Parliament and the Situation.

The only real remedy for unemployment then, and, indeed, for all other illnesses which are affecting our prosperity at the present time, is the resumption of trade and industrial activity. While it is only fair to say that in theory this is realised, very little effort seems to be being made to give the theory any practical effect. The debate which took place in Parliament on this subject is a good epitome of the national state of mind on the subject, though it is becoming increasingly evident that improvement will come through action and not through inaction. It is, therefore, the duty of all parties to come together and by the help of real co-operation find a way out of present difficulties.

Distortion in Thermionic Tube Circuits.

BY L. C. POCOCK, A.M.I.E.E., B.Sc.

Although for some purposes thermionic tubes are used primarily as amplifiers with but little concern for faithful reproduction of the input waveform, there is a large and rapidly extending field of use wherein fidelity to the input wave form is required in the output current. Examples are, the employment of tubes as generators of high frequency current for testing purposes, telephonic applications, and a variety of laboratory applications to quantitative work.

It is therefore not without interest to inquire to what extent a vacuum tube causes distortion, and what conditions must be met in order to reduce the distortion to a minimum.

TWO FORMS OF DISTORTION.

There are two forms of distortion possible. First, that in which the various components of a complex wave form are differently amplified or attenuated to an extent depending on their frequencies; distortion of this type is continually encountered in telephone circuits owing to the varying value with frequency of any complex impedance.

The second type of distortion is that in which an impressed pure sine wave is reproduced as a sine wave of the same frequency with added harmonics; this case also occurs in telephony, notably in a transmitter circuit where sinusoidal variation of the transmitter resistance does not cause a pure sine wave current to be formed.

DISTORTION ARISING IN THE GRID CIRCUIT.

If the grid potential is to vary in exact accord with the impressed voltage when the source of E.M.F. has appreciable impedance, the grid filament circuit must have a constant resistance independent of the frequency and amplitude. To secure this condition the grid is generally given a negative polarity with regard to the filament, such that the instantaneous P.D. is never sufficient to cause a current between the grid and filament. Under these conditions the input impedance is infinite and no distortion of the peaks of positive waves occurs. If the peak of the positive wave were able to send current through the tube there would in general be a drop of grid potential depending on the magnitude and frequency of the current, and distortion would result . This effect is readily understood, but is not amenable to calculation so long as the functional form of the grid current is unknown.

Unfortunately the input circuit cannot be dismissed as free from distortion by merely securing a sufficiently negative polarisation; the grid must necessarily have a capacity to both the filament and the plate, and it will be shown that the effective impedance of the grid circuit (even when there is no ordinary conduction current from grid to filament) is a function of the ratio of grid-filament and grid-plate capacities.

Dr. H. W. Nichols has shown (see "Physical Review," June, 1919) that for calculation purposes a vacuum tube may be conveniently considered as a network (Fig. 1). If the favourable assumptions be made that the current variations are small and that the filament-plate capacity is negligible, the network equations are

$$\left.\begin{aligned} &\left(Z_1+\frac{1}{c_1p}\right)x_1-\frac{1}{c_1p}x_2=e \\ -&\left(\frac{1+\mu}{c_1p}\right)x_1+\left(\frac{1+\mu}{c_1p}+\frac{1}{c_3p}+R\right)x_2-Rx_3=O \\ &\frac{\mu}{c_1p}x_1-\left(R+\frac{\mu}{c_1p}\right)x_2+(R+Z_2)x_3=O \end{aligned}\right\} \quad . \quad . \quad . \quad (1)$$

where p is the operator d/dt,

μ is the amplification constant,
e is the input voltage (instantaneous),
R represents the plate filament resistance of the tube.

If equation (1) is solved for x_1, and Z is put for the tube input impedance, then when the external impedance $Z_1=O$, $Z=e/x_1$ and

$$Z=\frac{1}{c_1p}\cdot\frac{1+\frac{RZ_2}{R+Z_2}c_3p}{1+\frac{RZ_2}{R+Z_2}c_3p+\frac{c_3}{c_1}\left(1+\mu-\frac{\mu R}{R+Z_2}\right)} \quad . \quad . \quad . \quad . \quad (2)$$

The operator p is, of course, understood to introduce frequency terms which tend towards zero as the frequency is reduced, but the denominator also contains a term independent of frequency, and, therefore, unless the frequency is zero, so that $1/c_1p$ bcomes infinite, the input impedance will have neither the magnitude nor the angle of the pure capacity impedance represented by $1/c_1p$. If, therefore, Z_1 is comparable with or greater than Z there will be a variation of input voltage on the grid with frequency.

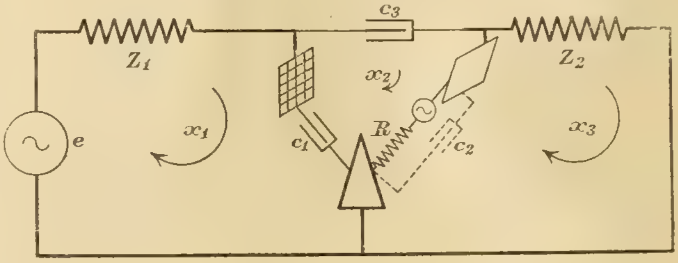

FIG. 1.

If the term in the denominator of equation (2) involving the ratio c_3/c_1 is large, the input impedance can be rendered independent of frequency by the application of a non-inductive grid leak S. Thus, if the frequency is low enough to allow of neglecting the terms directly involving it, and if c_3/c_1 is large, the approximate value of Z is

$$\frac{1}{c_3p\left(1+\mu-\mu\frac{R}{R+Z_2}\right)}.$$

Now, let S be a leak resistance small compared with the capacity reactance $1/c_1p$. The value of Z is then approximately

$$\frac{S}{1+Sc_3p\left(1+\mu-\mu\frac{R}{R+Z_2}\right)}.$$

If S is sufficiently small, the term involving frequency can be neglected, and the input impedance is the non-inductive resistance S. In order that the voltage impressed on the grid may be independent of frequency it is now only necessary to see that Z_1 is either non-reactive, or small compared with S. It is by no means always convenient fully to secure this condition in low frequency (telephonic) circuits.

DISTORTION IN THE PLATE CIRCUIT.

Distortion of the kind that depends on frequency is not limited to the grid circuit. If equations (1) be solved for x_3 the plate circuit current, it is found that

$$x_3=\frac{e\left(R-\frac{\mu}{c_3p}\right)}{\frac{c_1}{c_3}Z_1(R+Z_2)+(RZ_2+RZ_1+Z_1Z_2+\mu Z_1Z_2)+\frac{R+Z_2}{c_3p}+RZ_1Z_2c_1p} \quad . \quad . \quad . \quad . \quad (3)$$

from which for low frequencies

$$x_3=\frac{-e\mu}{R+Z_2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

And there is no distortion other than that due to Z_2. This last step shows how essentially the operation of the tube depends on the grid-filament capacity, although in the ideal limiting case this capacity cancels out, and does not appear in the expression for x_3.

Expression (3) is derived from the general approximate linear equations (1), and therefore includes any grid distortion that may occur in accordance with the last section. In the assumed absence of appreciable filament-plate capacity it can be shown that the plate circuit does not introduce further distortion under the same conditions of low frequency as for negligible distortion in the grid circuit; for if, without making any other assumption, we make the applied grid voltage independent of the grid current by putting $Z_1 = O$ in (3),

$$x_3 = \frac{e\left\{R - \frac{\mu}{c_3 p}\right\}}{RZ_2 + \frac{R+Z_2}{c_3 p}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which involves frequency, but becomes independent of frequency when the capacity reactance $1/c_3p$ becomes large. For those high frequencies which make the reactance $1/c_3p$ commensurate with the other impedances it is evident that the amplification is reduced, tending in the limit towards unity. Under such conditions it would be necessary to introduce the filament-plate capacity reactance in parallel with R.

DISTORTION OF WAVE FORM.

Distortion of wave form, or non-sinusoidal reproduction of a sine wave input voltage arises from the non-linearity of the characteristics of the tube, and is met with under such conditions of current amplitude as render the approximate linear equations (1) invalid.

Let I be the steady plate current.
E_B be the plate battery E.M.F.
E_c be the normal grid voltage.
ε be a constant for the tube.
μ be the maximum amplification factor.
Z be the external impedance in the plate circuit $R+iLn$.
a be a constant.

It is known that

$$I = a\{E_B + \mu E_c + \varepsilon\}^r \quad . \quad . \quad . \quad . \quad . \quad (6)$$

(E_B in this expression standing for the voltage on the plate), where the exponent r is to be determined empirically. Analytically the simplest case actually occuring is when $r=2$.

Suppose an alternating voltage E_0e^{int} acts on the grid, and suppose that the output current is also of pure sine form I_2e^{int}; it is necessary to find the conditions that the above equation will lead to this result.

The characteristic equation becomes

$$I + I_0e^{int} = a\{E_B - RI + \mu(E_c + E_0e^{int}) + \varepsilon - ZI_0e^{int}\}^2. \quad . \quad (7)$$

On multiplying out it is found that the right-hand side contains constant terms, and terms of frequency n and $2n$. Constants and terms of like frequency must form simultaneous identities with the terms on the left and the double frequency terms must obviously and accordingly be zero.

Thus the conditions that there shall be no distortion of wave form are .

$$\left.\begin{aligned} I &= a\{E_B - RI + \mu E_c + \varepsilon\}^2 \\ I_0 &= \frac{2E_c\mu\{E_B - RI + \mu E_c + \varepsilon\}}{1/a + 2Z\{E_B - RI + \mu E_c + \varepsilon\}} \\ \text{and} \qquad (E_0\mu &- zI_0)^2 = 0 \end{aligned}\right\} \quad . \quad . \quad . \quad (8)$$

The first of these conditions shows that the direct current as read on a direct current milli-ammeter should be the same when the tube is carrying alternating currents as when only steady E.M.F.s are acting. A milli-ammeter in the plate circuit gives in fact a good indication of the presence of distortion.

The third condition is evidently that the alternating current in the plate circuit shall be equal to the effective alternating-current voltage divided by the external impedance—in other words, that the apparent tube resistance shall be negligible in comparison with the external impedance.

The second condition can be written

$$I_0 = \frac{2E_c\mu\sqrt{I/a}}{1/a + 2Z\sqrt{I/a}};$$

and becomes reconcilable with the third condition when $1/a$ is small compared with $2Z\sqrt{I/a}$, that is, when Z is great compared with $\frac{1}{2\sqrt{aI}}$. But $\frac{1}{2\sqrt{aI}}$ is equal to $\partial E/\partial I$, which is the mean effective resistance between the plate and filament.

The second and third conditions are therefore the same, as is necessary (since both contain Z) if the equation assumed is to hold good.

For telephone work it has been shown that for all practical purposes Z need only be of the same order as the tube resistance, but for greater freedom from distortion as well as when it is desired to secure high voltage amplification Z should be as large as possible.

The Analytical Determination of the Steps in the Starter of a Series Motor.*

By STANLEY PARKER SMITH, D.Sc.

In this Paper an analytical method for calculating the resistance steps in the starter of a series motor is given. When metallic starters are used, it is usual to arrange the resistance steps so that the current varies between given limits. The solution of the problem entails a knowledge of the magnetisation curve, or of the speed curve, of the motor.

By the method described a given number of steps can be obtained analytically with the same accuracy and practically with the same ease as for a shunt motor, without trial and error or the construction of a diagram.

THEORY.

From the equation for the E.M.F. induced in a direct-current machine we can write for the speed

$$N = kE/\varphi \text{ revs. per min.,} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where k is a constant for any given motor, and φ = useful flux per pole.

Now the E.M.F. induced in the motor is

$$E = V - RI, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where V = pressure at supply terminals, R = total resistance in armature circuit between supply terminals, I = current in the field and armature of motor. Hence equation (1) may be written

$$N = k(V - RI)/\varphi. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

V is assumed to be constant, whilst I at starting is kept within the requisite limits by varying the resistance R; also, with series-parallel control, by varying the pressure applied to each motor.

In order to calculate the resistance steps in a metallic starter, we proceed as follows: Let I_1 = upper limit of current during starting; I_2 = lower limit of current during starting; φ_1 = flux corresponding to I_1; φ_2 = flux corresponding to I_2. The fluxes φ_1 and φ_2 are obtained from the magnetisation curve of the motor, or, alternatively, from the speed curve of the motor. In the series motor the flux is a function of the armature current; whereas, in a shunt motor, the flux is constant, so that the magnetisation curve is not needed.

Further, let $\lambda = I_1/I_2$; $\beta = \varphi_1/\varphi_2$; $\alpha = \beta/\lambda$. . . . . (4)

In general, λ and β are >1, and α is <1. (In a shunt motor, $\beta = 1$, and therefore $\alpha = 1/\lambda$.)

The conditions during starting are represented in Fig. 1, where R_m = resistance between terminals of motor; R_a, R_b . . . R_n and

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* Abstract of a Paper in the "Journal" of the Institution of Electrical Engineers.

R_m=resistances between supply terminals during starting; r_1, r_2, ... r_n=resistance steps.

Then, $R_a-R_b=r_1$, $R_b-R_c=r_2$, &c.

and in general, $R_{x-1}-R_x=r_{x-1}$. . . . . (5)

At the instant when R_{x-1} is in circuit and the current has fallen to I_2, the induced E.M.F. will then be

$$E'=V-R_{x-1}\,I_2=N\varphi_2/k.$$

At this instant, the resistance step r_{x-1} will be cut out; the current will immediately rise to the upper limit I_1, thereby increasing the induced E.M.F. to $E''=V-R_xI_1=N\varphi_1/k$, the speed N not having changed during this transition.

Therefore $$\frac{E''}{E'}=\frac{V-R_xI_1}{V-R_{x-1}I_2}=\frac{\varphi_1}{\varphi_2}=\beta, \quad . \; . \; . \; . \; . \; . \; . \quad (6)$$

whence $$R_x=\alpha R_{x-1}-V(\beta-1)/I_1. \quad . \; . \; . \; . \; . \; . \; . \quad (7)$$

This is the general expression for the total resistances in the starter for a series motor. The corresponding expression for the resistance in the starter for a shunt motor (where $\varphi_1=\varphi_2$, *i.e.*, $\beta=1$) is $R_x=\alpha R_{x-1}$; *i.e.*, the total resistances for a shunt motor form a geometric series. With the series motor, however, the constant term $(\beta-1)V/I_1$ has to be deducted from αR_{x-1} in each case.

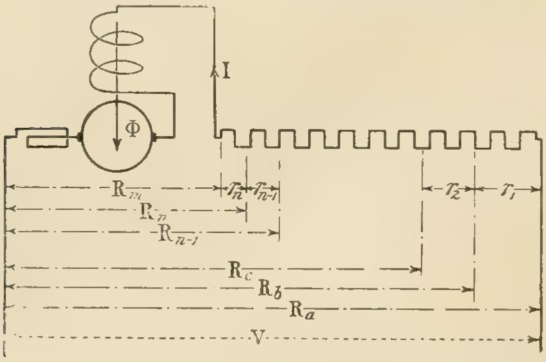

FIG. 1.—DIAGRAMMATIC ARRANGEMENT OF STARTING RESISTANCE FOR SERIES MOTOR.

Coming to the resistance steps, however, a geometrical progression is met with in the starter for the series motor as well as for the shunt motor.

For $r_x=R_x-R_{x-1}=\alpha(R_{x-1}-R_x)=\alpha r_{x-1}$.

Hence $$r_x/(r_{x-1})=\alpha. \quad . \; . \; . \; . \; . \; . \; . \; . \quad (8)$$

That is $r_2=\alpha r_1$, $r_3=\alpha r_2=\alpha^2r_1$ . . . . $r_n=\alpha r_{n-1}=\alpha^{n-1}r_1$. From equation (7) $$r_x=R_x(1-\alpha)+V(\beta-1)/I_1. \quad . \; . \; . \; . \; . \; . \quad (9)$$

For the first step r_1 this becomes

$$r_1=R_a(1-\alpha)+V(\beta-1)/I_1. \quad . \; . \; . \; . \; . \; . \; . \; . \; . \quad (10)$$

Now the sum of the n steps (*cf.* equation 8) is

$$\Sigma_1^n r=r_1+r_2+ \; . \; . \; . \; . \; +r_n=r_1(1-\alpha^n)/1-\alpha.$$

Further, $$\Sigma_1^n r=R_a-R_m.$$

Therefore, $$\Sigma_1^n r=R_a-R_m=r_1(1-\alpha^n)/1-\alpha). \quad . \; . \; . \; . \quad (11)$$

Combining this with equation (10) in order to introduce the condition contained in equation (7), developed for the current changes, we have

$$R_a-R_m=\left\{R_a(1-\alpha)+\frac{V}{I_1}(\beta-1)\right\}\frac{1-\alpha^n}{1-\alpha}, \quad . \; . \; . \; . \; . \; . \quad (12)$$

or, $$f=\frac{V}{I_1}(\beta-1)\,\frac{1-\alpha^n}{1-\alpha}+R_m-R_a\alpha^n=0. \quad . \; . \; . \; . \; . \quad (13)$$

This is the general expression which must be satisfied in order that the n steps may give the correct current changes when the switching in current is I_1. A knowledge of the magnetisation curve is necessary in order to find the relation between β and α. When this curve is given, together with the number of steps, n, and the motor resistance R_m, as is usual, equation (13) can be solved by fixing either I_1 or I_2, but not both. (This latter condition also applies to the calculation of a starter for a shunt motor when n and R_m are given.)

CALCULATION OF RESISTANCE STEPS FOR A SERIES MOTOR.

Consider the case when the motor starts from rest and the current rises to the upper limit I_1 on switching in. Under these conditions, $R_a=V/I_1$, so that the general expression in equation (12) becomes

$$f=(\beta-\alpha)\frac{1-\alpha^n}{1-\alpha}+\frac{I_1}{V}R_m-1=0, \quad . \; . \; . \; . \; . \; . \; . \; . \; . \quad (14)$$

while equation (10) for the first step becomes

$$r_1=R_a(\beta-\alpha). \quad . \; . \; . \; . \; . \; . \; . \; . \quad (15)$$

In the original Paper the author works out an example—namely a 5 H.P. crane motor—in which the upper current limit is given. The same method applies when the lower limit is given.

CALCULATION OF RESISTANCE STEPS FOR A SERIES MOTOR WHEN THE CURRENT ON SWITCHING IN IS TO BE LESS THAN THE UPPER LIMIT.

It is sometimes stipulated that the current on switching in shall not rise to the upper limit I_1, but to some value I_3 intermediate between I_1 and I_2.

The total resistance on switching in is then $R_a=V/I_3$, and the first step r_1 is cut out, either automatically or by hand, when the current has fallen to I_2. Let R'_a denote the total resistance when the first step r_1 is cut out, that is

$$r_1=R_a-R'_a.$$

Further. $$R_a-R_m=r_1+r_2+ \; . \; . \; . \; . \; +r_n=\Sigma^n{}_1r,$$

and $$R'_a-R_m=r_2+ \; . \; . \; . \; . \; +r_n=\Sigma^n{}_2r$$

$$=r_2(1-\alpha^{n-1})/1-\alpha$$

From equation (9) we have

$$r_2=R'_a(1-\alpha)+V(\beta-1)/I_1.$$

Hence the general expression in equation (12) now takes the form

$$R'_a-R_m=\left\{R'_a(1-\alpha)+\frac{V}{I_1}(\beta-1)\right\}\frac{1-\alpha^{n-1}}{1-\alpha}. \quad . \quad . \quad (16)$$

We must now express R'_a in terms of R_a. Just before r_1 is cut out $E'=V-R_aI_2$, and just after r_1 is cut out $E''=V-R'_aI_1$; whence, as in equation (7)—

$$R'_a=\alpha R_a-V(\beta-1)/I_1. \quad . \; . \; . \; . \; . \; . \; . \; . \quad (17)$$

Substituting for R'_a in equation (16), the general expression that must be satisfied when the current on switching in is I_3 is obtained, namely

$$f=\frac{V}{I_1}(\beta-1)\,\frac{1-\alpha^n}{1-\alpha}-R_a\alpha^n+R_m=0. \quad . \; . \; . \; . \; . \; . \quad (18)$$

This problem the author also illustrates in the original Paper by a worked example—namely, a 250 H.P. traction motor.

CALCULATION OF RESISTANCE STEPS FOR TWO SERIES MOTORS WITH SERIES-PARALLEL CONTROL.

This is the case commonly met with in direct-current traction. For the parallel positions the conditions before and after changing-over must be taken into account (Fig. 2). Let I_1 and I_2 again denote the current limits in the parallel position. *These limits are not the same as in the series position.* We may have either I_1 or I_2 the same in both positions, but it will be quite accidental if the two limits are the same in the parallel as in the series positions.

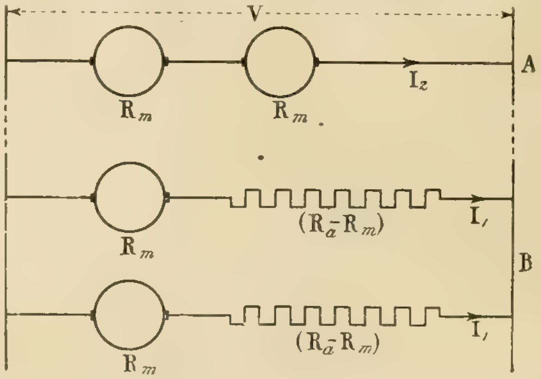

FIG. 2.

A. Connection *before* paralleling. *B.* Connection *after* paralleling.

Before paralleling, let the current fall to the value corresponding to I_2 in the parallel positions, then from Fig. 2 it is seen that

$$V-2E'-2R_mI_2=0.$$

After parallelling, let current rise to upper limit I_1, then

$$V-E''-R_aI_1=0.$$

Since the speed has not altered during the transition, we have (*cf.* equation (7)) $$R_a=\frac{V}{I_1}\left(1-\frac{\beta}{2}\right)+\alpha R_m. \quad . \; . \; . \; . \; . \; . \; . \; . \quad (19)$$

Thus in addition to equation (12), equation (19) must be satisfied in the parallel position. Equating then (12) and (19), we get

$$f=\frac{V}{I_1}\left\{\frac{1-\alpha^n}{1-\alpha}\cdot\frac{\beta-1}{\alpha^n}+\frac{\beta}{2}-1\right\}+R_m\left(\frac{1}{\alpha^n}-\alpha\right)=0. \quad . \; . \; . \; . \quad (20)$$

In the original Paper the author works out an example of series-parallel control, in which the upper current limit I_1 is chosen the same for both conditions. In the case when the lower limit I_2 is to be the same for both conditions (automatic control with minimum current relay), the problem is solved in a similar way.

Measurement of the Electromagnetic Field of Transoceanic Radiographic Waves.*

By Prof. G. VALLAURI.

At the beginning of August, 1919, the wireless station of Annapolis (N.S.S.) carried out some experimental transmission tests lasting for 24 hours continuously. The Italian Royal Naval Electrotechnical and Radiotelegraphic Institute took the opportunity to make a quantitative measurement of the electromagnetic field at the receiving station. The method employed was one of simple substitution, facilitated by the fact that the aerial at the Institute, used for direction finding, consists of two identical 2-wire circuits oriented with regard to true north at angles 36 deg. to 216 deg. (approximately N.E.-S.W.) and 126 deg. to 306 deg. (approximately N.W.-S.E.). The area enclosed by each aerial is about 1,404 sq. meters.

The distance from the wireless station at Annapolis to Leghorn measured on a great circle is 6,917 km. and its bearing from Leghorn is 298 deg. 47 min. It follows that the N.W. aerial is almost exactly oriented for receiving from Annapolis, while the N.E. aerial is so placed as to be almost uninfluenced by such signals.

For receiving, an 8-valve amplifier was used, with six stages of resistance amplification and two with telephone transformers. The amplifiers were connected to a secondary circuit inductively coupled to the aerial.

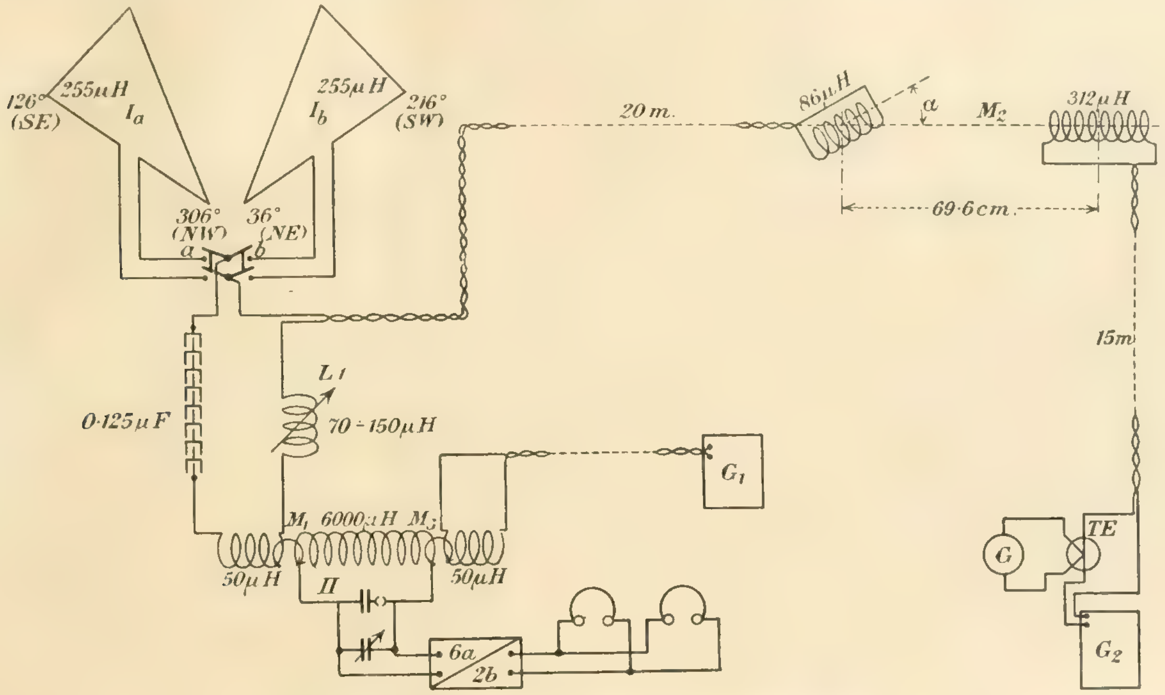

DIAGRAM OF CONNECTIONS USED ON ANNAPOLIS TESTS.

PRINCIPLE OF THE MEASUREMENTS.

The principle of the measurement, which will be understood by reference to the diagram, consisted in receiving the signal to be measured on the N.W. aerial and then switching over to the N.E., inducing in the second circuit a local E.M.F. of adjustable frequency and amplitude which were arranged to give signals identical with those received from N.S.S.

The circuit of the aerial consists of one or other of the aerials proper, according to the position of the 2-way switch a, b, a capacity consisting of eight paper condensers of 1 mfd. connected in series, the primary of the mutual inductance M_1, the variable inductance L_1 and the secondary of the mutual inductance M_2 for coupling to the local generator G_2. The secondary circuit II includes the secondary of the mutual inductance M_1, with some fixed condensers and a variable air-condenser across which is connected the amplifier.

The local generator G_1 is employed through the mutual inductance M_3 to produce beats in the receiver. The local generator G_2, by means of the mutual inductance M_2, is made to induce in the aerial N.E. signals identical with those produced in N.W. by N.S.S. The oscillating current produced by G_2 is measured by the thermo-electric couple T, E, and the galvanometer G. Both the generators G_1 and G_2 are of the ionic-valve type with magnetic coupling. The value of M_2 for $\alpha=o$, that is, the position in which the two coils of the inductance are coaxial has been calculated by Havelock's formula and is equal to 0·049 microhenries. In view of the small dimensions of the coils compared with their distance, M_2 for other positions may be taken as 0·049 cos α.

DETAILS OF THE TESTS.

The measurement is effected as follows. With the 2-way switch in position a and with generator G_1 and not G_2 working, the values of L_1, M_1, M_3 and the wave-length of G_1 are adjusted to receive the signals. Then, leaving everything else unchanged, the 2-way switch is thrown over to b and G_2 started. M_2 is regulated roughly to give about the same strength of signal as in the first position, and then the wave-length of G_2 is adjusted to give the same musical note as in the first position. This is verified by throwing over the 2-way switch from one position to the other. Finally, the fine adjustment of the intensity of the signals is effected by varying the angle α of the mutual inductance M_2. As $M_2=o$ for $\alpha=90$ deg., there is a certain range on either side to 90 deg. in which the signals are inaudible, and balance may be effected on either side of this range.

COUPLING RELATIONS.

If the coupling between the circuit I and that of G_2 were made entirely by the mutual inductance M_2 the readings α and α_1 would be symmetrically placed on each side of 90 deg. In practice, however, there is a certain amount of mutual inductance between the circuits in spite of the distance between them. Putting M_0 for this constant and unknown coupling and $M_2'=0·049 \cos \alpha_1$, $M_2''=0·049 \cos \alpha_2$ for the two values of M_2 corresponding to the two readings α_1 and α_2, the total induction M is given by

$$M=M'_2+M_0=-(M''_2+M_0),$$

whence

$$M_0=-\frac{M'_2+M''_2}{2}$$

and

$$M=\frac{M'_2-M''_2}{2}=\frac{0·049}{2}(\cos \alpha_1-\cos \alpha_2).$$

That the value of M so obtained is actually independent of M_0 is proved by the substantial agreement of the readings in any group, in spite of the orientation of the circuit of G_2 and consequently the value of M_0 being changed.

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* Abstract of an article in "L'Elettrotecnica."

The results would, however, have been invalidated if there had been sensible mutual inductance between the circuit of G_2 and the secondary circuit *II*, and it was to avoid this that the two sets of apparatus were placed far apart. As a test of the absence of such inductance, the orientation of the apparatus forming the inductance M_1M_3 was changed and was found to have no effect on the readings α_1, α_2.

THE INFLUENCE OF THE GENERATOR.

It might also be feared that the circuit of the generator G_1 might influence, not only the mutual inductance M_3 on the secondary *II*, but also the primary, and that this influence might be different according to the two positions. In practice the coupling M_3 is relatively close, as it was found that the signals were best received when the E.M.F. induced in the secondary by G_1 considerably exceeded in amplitude that due to the signals. Any doubt on this score was removed by taking advantage of pauses in the transmission from Annapolis and noting that, the oscillations in G_1 and G_2 remaining the same while the two aerials were interchanged, the readings α_1 and α_2 were altered, but the difference, $\cos\alpha_1-\cos\alpha_2$, remained constant.

Finally, it might be thought necessary to take account of the E.M.F. induced by the signals in the N.E. aerial, depending on the fact that it is not exactly at right angles to the bearing of Annapolis. This was found to be unnecessary since, by varying slightly the wave-length of G_2, no beats could be detected and, also, since no trace of the signals could be heard even with maximum amplification and with G_2 out of action.

From the current I in the circuit of G_2 and the readings α_1 and α_3 the E.M.F. is given by the equation

$$E=\omega MI=2{\cdot}67+10^{-3}\,(\cos\alpha_1-\cos\alpha_2)\,I,$$

where $\lambda=17{,}300$ metres $\omega=109{,}000$

$$M=49\times10^{-9}\,\frac{\cos\alpha_1-\cos\alpha_2}{2}.$$

It should be noted here that the identity of notes in the signals from *NSS* in the first position and those from G_2 in the second position may be obtained with a frequency f_2 differing from that of the signals f so long as the frequency f_1 of G_1 satisfies the condition $f-f_1=f_1-f_2$. It is easy to avoid this error by noting the variation of the note with variation of λ_1 in the first position and of λ_2 in the second. In all the measurements it was arranged to have $\lambda_1<\lambda$ and $\lambda_2>\lambda_1$ so that $\lambda=\lambda_2$.

From the value of E given above the magnetic field of the wave from *NSS* is given by

$$H=\frac{10^8E}{\omega\,S\cos\beta}=6{\cdot}58\times10^{-5}E,$$

where $S=14{,}040{,}000$ cm² is the area of the receiving aerial and $\beta=7°$ is the angle between its plane and the direction of the incoming waves. The effective value H of the magnetic field is given in C.G.S. units. Thence the electric field is given by $F=uH$ where u is the velocity of light, or

$$F=3\times10^7H\ \text{volt/km.}=1{\cdot}97\times10^3E\ \text{volt/km.}$$

ACCURACY OBTAINABLE.

The results of the observations and calculations made as above are given in the subjoined table. As all observations are given, the variations give an idea of the order of accuracy as regards accidental errors. As was to be expected it was found greatly preferable to work while the transmitting station was sending a continuous signal than when sending messages.

The results are not sufficiently numerous to justify conclusions as to the diurnal variation in the intensity of signals for which, moreover, it would be necessary to know the variation of current in the aerial of *NSS* during the experiments. The measurements in Group 4 seem to confirm the weakening of signals during the morning which is noticed by all the Italian stations receiving from North America.

The results may be employed to check the formulæ which have been put forward for the range of wireless stations and to give a rough guide to the strength of electro-magnetic field necessary, with a certain type of aerial, to receive satisfactorily. Thus, with an induced E.M.F. of 40 microvolts and consequently a magnetic field of $2{\cdot}6\times10^{-9}$ C.G.S. units and electric field of 0·078 volt/km. the reception of telegrams with an 8-valve amplifier was good, except in periods of maximum atmospheric disturbance.

Regarding the formulæ for the range of wireless stations that of Austin* may be put in the form

$$Ir=377\,\frac{h_rhI}{\lambda dR}\sqrt{\frac{\theta}{\sin\theta}}\,e^{-0{\cdot}0015\frac{d}{\sqrt{\lambda}}},$$

whence,

$$F=\frac{RI_r}{h_r}=377\,\frac{hI}{\lambda d}\sqrt{\frac{\theta}{\sin\theta}}\,e^{-0{\cdot}0015\frac{d}{\sqrt{\lambda}}},$$

where R is the resistance of the receiving aerial, h_r its effective height and I_r the current obtained in it, h and I are the height and current in the transmitting aerial, λ the wave length, d the great circle distance between the stations, θ the angle subtended at the centre of the earth by that distance. R is expressed in ohms, I and I_r in amperes, h, h_r, λ, d in km., then the electric field F is expressed in volt/km

Solving for the unknown hI and putting $\lambda=17{\cdot}3$, $d=6917$, $\theta=62°\ 18'{\cdot}5$, we have

$$hI=\frac{\lambda d}{377}F\sqrt{\frac{\sin\theta}{\theta}}\,e^{-0{\cdot}0015\frac{d}{\sqrt{\lambda}}}=3{,}500\,F\ \text{amp./km.}$$

The values of hI thus obtained from Austin's formula as shown in the table are far too high. This shows that at such great distances Austin's formula gives values for the electro-magnetic field sensibly lower than those found, that is that the propagation takes place in a more favourable manner than would be given by the formula.

Much better figures are obtained from the formula of L. F. Fuller†.

$$Ir=377\,\frac{h_rhI}{\lambda dR}\sqrt{\frac{\theta}{\sin\theta}}\,e^{-0{\cdot}0045\frac{d}{\lambda\sqrt{2}}},$$

whence

$$hI=\frac{\lambda d}{377}F\sqrt{\frac{\sin\theta}{\theta}}\,e^{0{\cdot}0045\frac{d}{\lambda\sqrt{2}}},$$

or with the constants as given above

$$hI=500F\ \text{amp./km.}$$

Prof. L. W. Austin has kindly informed the author that the transmission from Annapolis is normally made with

$$hI=0{\cdot}107\times280=30\ \text{amp./km.},$$

which agrees very well with the values calculated by Fuller's formula.

It is to be hoped that opportunities will occur for other measurements of this sort executed at different stations and at different distances and wave lengths.

Group.	Date.	G.M.T.	*E* Micro-volts		*H* C.G.S.	*F* volt/km.	*hI* amp./km. Austin	*hI* amp./km. Fuller	Signal.
1.	6/8/19	14· 6	83	77	$5{\cdot}0\times10^{-9}$	0·151	530	75	L.
		0· 9	74						
		0·12	75						
2.	,,	21·38	62	53	$3{\cdot}5\times10^{-9}$	0·104	360	52	*L.*
		0·42	50						
		0·47	47						
		0·51	52						
		0·57	55						
3.	7/8/19	5·50	29	34	$2{\cdot}2\times10^{-9}$	0·067	230	33	*T.*
		0·59	39						
		6· 3	35						
		0· 6	29						
		0· 8	32						*L.*
		0·11	42						,,
4.	,,	7·24	24	25	$1{\cdot}6\times10^{-9}$	0·049	170	24	L.
		0·26	18						
		0·28	33						
		0·30	24						
5.	,,	9· 8	34	36	$2{\cdot}4\times10^{-9}$	0·071	250	35	L.
		0·10	42						
		0·13	33						
		0·16	34						
6.	,,	11·51	46	42	$2{\cdot}7\times10^{-9}$	0 082	280	41	L.
		0·53	37						
		0·57	41						
		12· 1	43						
		0· 4	43						
7.	,,	16·23	36	39	$2{\cdot}5\times10^{-9}$	0·076	260	38	L.
		0·26	36						
		0·30	41						
		0·32	45						

L.—Long Line Transmission.
T.—Signals.

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*Proc. Radio. Eng., Feb., 1917, Vol. 5, No. 1, p. 25.

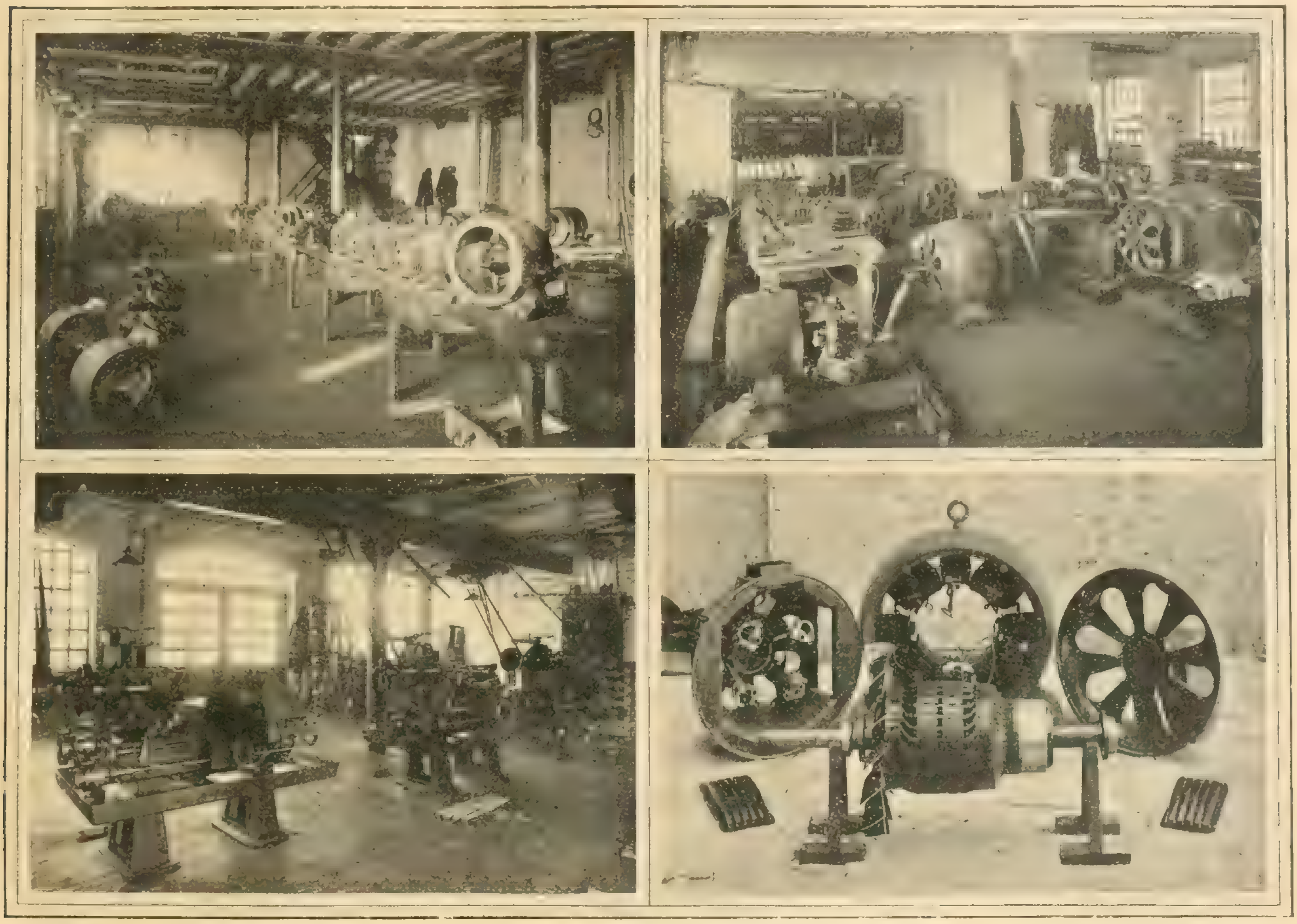
†Proc. A.I.E.E., April, 1915, Vol. 34, p. 567.

Standardised Electric Motor Manufacture.

Electrical manufacturers now-a-days are generally of two kinds, those who, so to speak, have the whole world as their parish in that they make everything that can by any stretch of imagination be called electrical, from wall plugs to turbo-alternators, and those who confine themselves to the specialised production of one particular piece of apparatus. While the former class are doubtless more imposing to the outward eye, the latter are not without their successes, both in the financial and in the more purely engineering field. This text may be elaborated by a short reference to the works of Messrs. Higgs Brothers, of Sand Pits, Birmingham, a firm that was established some nine years ago for the specialised production of small electric motors.

Some idea of the growth of the firm, and therefore of the success of the firm since that time, may be given by saying that at the time of its foundation in premises at Balsall Heath, near Birmingham, an area of only 1,500 sq. ft. was occupied, and the staff's combined wages amounted to the magnificent sum of £4 12s. a week, and the charges for rent, electricity and gas were equally meagre, being £7 10s. a quarter, £8 a quarter, and £3 a quarter respectively. At this time Mr. W. F. Higgs confined himself to the manufacture of motors not exceeding 5 h.p., but in spite of this restricted activity he succeeded in obtaining a 100 per cent. return on the capital employed at the end of the first year. This result, under what it will be agreed were somewhat arduous conditions, was obtained not only as the result of business acumen, a quality which is considered in some circles to be the sole qualification of the successful electrical engineer, but was the fruit of considerable technical knowledge, skilful planning, perseverance and the clearing of both the minds and the operations of the firm of a good deal of unnecessary and hampering detail. Since 1912 the business of the firm has developed on the technical side in that motors of the direct, two-phase and three-phase types in the protected and enclosed ventilated patterns are now made up to 50 h.p. or, as Mr. Higgs would sooner express it, the maximum armature diameter has been increased from 8 in. to 12 in. or, more accurately still, the equivalent of these two figures in the metric system. The motors built by Messrs. Higgs Brothers, however, comply in every respect with the British Engineering Standards, but under no circumstances is any departure made for customers' convenience from the standard designs employed by the firm.

As regards the question of temperature rating, which has recently been receiving a good deal of ventilation so far as turbo-alternators are concerned, a maximum temperature of 200°F. in any part of the machine is fixed, as this is considered to be the upper limit at which reliable operation can be obtained, a condition which is rightly thought to be of such supreme importance that all others must give way to it. The actual measurement of the temperature is made on a selected machine of each new design, which is equipped with thermocouples so that thorough acquaintance with its behaviour may be obtained.



Views of the Works and Products of Messrs. Higgs Brothers.
1. Assembly Shop. 2. Experimental Test Shop. 3. Single Purpose Machine Shop. 4. Assembled Components of a Higgs D.C. Motor.

The Use of the Metric System.

Parallel with this technical development the business of the firm increased to such an extent that, in 1917, a removal was made to the present works in Sand Pits. At the same time the interesting step was taken of changing the whole of the operations over to the metric system. This policy will, of course, be criticised from two points of view, its financial disadvantages and the general undesirability and unadaptability of the metric system to British conditions. We may, therefore, point out that on both these scores no disaster has occurred. Nor is this surprising. Jigs, tools, &c., have in any event to be changed every few years, and opportunity was taken of renewing on the new system rather than on the old. As regards the second point no trouble has been experienced in any way, except that the steel makers insist that the steel required for making the shafts shall be purchased on the British system. This, however, does not interfere with anything inside the works, as the change over to the metric system is made as soon as the raw material enters the doors.

While the works at Sand Pits, which were originally used for cycle manufacture, are not ideal for carrying out the production of electric motors on a large scale, owing to their obsolete arrangement, every opportunity is taken of so organising the various operations that the highest efficiency is obtained, and as little possible time is lost.

Works Organisation.

As regards works organisation, machines are not manufactured directly for customers but for stock, the practice being to keep about 500 finished motors available for delivery, while at any one time about 1,000 are in course of manufacture. The progress of each machine part, and assembled component, up to the time that they become combined into a finished machine, is kept careful track of by a well-thought-out system of stock cards. These cards are divided into three classes which deal respectively with single component parts, assembled components and complete machines. Orders for these articles are put through in batches, the card being marked with particulars of the order, the number of the operations, and the time allowed for each operation. The result of the inspections which take place at various stages is also recorded, and the batch is not taken into store unless the card is complete in every respect, and every item to which it refers is also present. This applies especially to spoilt work, which has to be returned to store along with the completed parts, so that not only is a check kept on the way each workman is carrying out his duties but no scrap is allowed to accumulate in the shops.

Jigs are used for every operation, and the pattern number is cast on every casting, while only the dimensions which concern the machinist are placed on the shop drawings, these being examples of those small points of detail which make for simple and easy production. Materials and sizes are standardised as far as possible, and this is carried to such an extent that in the manufacture of all types of motor, 32 in number, only 17 different sorts of screw are used. Automatic machinery is used as far as possible, and spraying equipment is employed for insulating the stampings. Die stamping is also largely used.

It may be mentioned that piece work is in operation throughout the works, more because it seems to be the most adaptable of systems of payment in use at the present time than because Mr. Higgs sees in it any particular advantage. In fact he hopes in due course to adopt the conveyor system with high but fixed wages.

The welfare of those working for the firm is looked after by the provision of a light and airy canteen in which meals are supplied at a low cost, or food is cooked at the firm's expense. There are also the usual run of football and other sporting clubs which are so much a feature of Midland industrial operations.

Details of the Motors Turned Out.

Turning to the motors themselves, one of our illustrations shows the assembled components of a direct-current motor. These motors, as are those of the alternating-current type, are fitted with ball bearings, an arrangement which means less attention from the user, though it necessitates careful fitting by the manufacturer. A proper system of lubrication is also of importance, and Messrs. Higgs Brothers therefore adopt the wise practice of despatching with each of their machines sufficient grease to last for a year.

All machines are fitted with a ventilating fan, and the direct-current motors are designed as variable speed machines, with 100 per cent. speed variation. Direct-current machines are also designed to be reversible without any alteration of the brush rockers, commutation being arranged to always take place at the neutral point. The brush gear used on direct-current machines is interesting from the fact that the arms are fixed to the brush rocker by an ingenious cone joint being held in place by a taper collet which makes a very tight fit. The brush holder box itself is a die stamping of material with a tensile strength of 33 tons per square inch, and an elongation of 15 per cent. The spring arm is also a die stamping. All direct-current motors with an output exceeding ½ H.P. are fitted with interpoles, these being of mild steel cast into cast-iron yokes. Laminated pole shoes are used.

No Loose Connections.

A special point is made of the elimination of loose wire connections inside the machine, soldered joints being used everywhere, all ends being brought out to special terminal box on the top of the yoke. The poles are provided with laminated shoes, the coils being wound with enamel wire served with black tape. Each coil is given a number so that its history can be noted, and an exact duplicate supplied in case of need. Additional ventilation in the alternating-current motor is obtained by exposing the outside of the stator laminations to the air. The stator coils are wound with direct-current cotton wire in the larger sizes, and with enamelled single cotton covered wire in the smaller sizes of machine, the latter being capable of withstanding a pressure of 2,800 volts between adjacent layers of wire. The interior of the stator and the exterior of the rotor are ground so that a very fine clearance is practicable. The rotors of alternating-current machines, whether for two or three-phase circuits, are always wound three-phase, in the case of slip-ring motion the ends being led out to vertical rings. The short-circuiting device used on the motors consists of a central plunger which engages with a plug on the shaft and with arms connected to the slip rings. At the same time the side rods come into play and lift the brushes.

Cooling is effected by means of a centrifugal fan revolving above the windings which draws air into one end of the rotor core, and passes it out at the other end.

Every machine, whether direct-current or alternating-current, is tested on load for three hours, is flashed five times at least 2,000 volts in a special testing department, which is equipped with a means for carrying out tests at any frequency from 25 to 60 cycles, and any pressure up to 3,000 volts. In addition to this all winding coils are flashed at every operation during manufacture, as are also commutators.

We are indebted to the "Electrical Review" for supplying the photographs from which the block illustrating this article was made.

The Reason Why:

The Foreman is Selected from Outside the Department.

By W. J. HISCOX.

¶ It is a standing grievance in some factories that operators are never promoted to positions of trust in their own departments, or, in other words, the foremen and charge hands are selected from outside. It is contended by many that this has a bad effect upon the workers, as it stifles initiative and develops the "no use trying" attitude, and as it is a matter which intimately concerns the well-being of the factory, a few words on the subject, with a view to ascertaining the reason why this course is favoured by the management, may be of interest.

Jealousy of the New Broom.

When the news gets abroad of the impending departure of a departmental foreman the operators begin to speculate as to what his successor will be like. It is quite understood that he will not be selected from amongst their fellows, and many bitter comments as a consequence follow. Yet, such is the perversity of human nature, that were one of their number appointed, bitter comments would still be made, in this case against their fortunate colleague.¶ His capabilities (or lack of them) would be discussed with refreshing candour, and it would be found that, out of the one hundred men in the department, 99 of them had, in their own opinion, better qualifications for the position.

Jealousy is really at the bottom of this trouble. When a man rises above his fellows, and particularly when he is appointed to control them, they hate having to submit to his authority, and will make him as uncomfortable as possible. They will refer to episodes of the past, and, should he resent this and stand on his dignity, he is labelled "stuck up" and "too big for his boots," and every opportunity is seized to annoy him.

If, on the other hand, he remains upon familiar terms with them, and treats the epithets lightly, his authority suffers considerably, and he cannot perform his duties efficiently, because he is afraid of hurting an old friend. It becomes, therefore, apparent to the management that, although a good workman, he is a poor foreman.

The Troubles of Authority.

A man in such circumstances is handicapped, and is rarely a success in his new position. No matter what attitude he adopts, he does not give satisfaction. On the one hand is heard, "Look at him strutting about giving orders. Why, I knew him when he hadn't a change of overalls"; and, on the other, "Oh! we can lark about all right. He can't say anything to us, for he was at the same tricks himself only a few months ago."

The management is aware of this, and is naturally loth to put a man in authority under such conditions; therefore an outsider is brought in. If he is a newcomer to the factory, he may experience difficulties; but he has the decided advantage of being personally unknown to the men he is called upon to control, and as a consequence his authority is respected, and he has a fair chance of making good.

Sometimes a workman in one department is promoted to the position of foreman in another department. In the large factory, where the possibilities of previous intercourse with the workers over whom he must exercise control are remote, this has every chance of success. At all events, the personal element is one of the reasons why the management looks outside the department for the man to occupy the position of foreman.

Apart from the personal element, however, the question of working policy must be considered, for it may be observed that, no matter how good the retiring foreman may be, he does not know all there is to be known, and the management feels that outside experience could be brought in with advantage. The policy of the foreman dominates the department, his methods are copied, and the whole working of the department is in accordance with his ideas. This being so, is it too much to suggest that those ideas are imbibed to a greater or a lesser extent by all working in that department?

A Chance for Reform.

So when the foreman retires, and one of the men working in his department is appointed his successor, this latter individual rarely strikes out a line for himself, but carries on as before. A man from another factory, however, is not imbued with the ideas of his predecessor, but has ideas of his own, gained under different conditions, and he naturally wishes to apply these to his new surroundings. He, no doubt, realises that the department is in a flourishing condition, but he will not believe that it cannot be further improved.

An infusion of new blood is therefore always an advantage, and in saying this no reflection is cast upon the capabilities of the retiring foreman, or of any of the workers in the department. Any one of the latter may make a very good foreman—elsewhere. But in the progressive factory new ideas are really necessary. These ideas are not forthcoming from the man already working in the department, for reasons before stated, and so they must be imported.

A man may have the business at his finger tips, but, after all, the methods he employs are the methods he has been taught, and assuming that his teaching is confined to the department in which he is now working, it seems fairly obvious that, in the event of promotion, he will not be able to apply many original ideas. He may improve somewhat upon the methods of his predecessor, but substantially they are the same.

Fitting Himself for Promotion.

There is no doubt, however, that many men feel sore at the lack of opportunities for promotion, for they argue that it is not every man (even though he possesses the necessary qualifications) who can afford to seek promotion in another factory. Whilst this may be correct, there appears to be one way of imbibing new ideas, and that is by a systematic study of the technical journals. It is to be feared that, in the main, the operator does not give this the consideration it deserves, he being inclined to think that the articles contained therein are of interest only to managers and foremen. He must, however, appreciate that they are of interest also to potential managers and foremen, and if his aspirations are in that direction then surely they should be of interest to him.

The ambitious operator, then, should take steps to fit himself for promotion, with a view to convincing the management that he is the man for the job. He must get rid of that jealous feeling, and let the management see that, should one of his fellows be appointed, his authority will be respected. On the other hand, he must imbibe new ideas, and for the man who is not prepared to travel, the technical journals will at least advise him as to what is being done elsewhere.

The Cambridge University Press hope to publish by next October the first of a series of MONOGRAPHS ON RECENT DEVELOPMENTS OF PHYSICS, which shall serve as supplements to Dr. N. R. Campbell's "Modern Electrical Theory." Each monograph, which will correspond roughly to a chapter of the book, will be edited by Dr. Campbell, but he will not write all of them. The first three monographs will deal with Spectra, the Quantum Theory of Energy, and the Constitution of Atoms and Molecules.

Breakdown of Plant at Glasgow.

We have received the following communication from the Metropolitan-Vickers Electrical Company regarding the recent breakdown of the turbo-alternator plant at the Dalmarnock station of the Glasgow Corporation.

On the morning of December 8th, one of the new 15,000 kw. turbo-alternators at Dalmarnock station, Glasgow broke down after having been in commercial operation for about 2½ months. The insulation on the windings at one end of the machine took fire, and as the turbine could not be stopped for some 20 minutes, the whole of the insulation on this end of the machine was destroyed. No evidence could be found at the time as to the cause of the breakdown. The machine was very heavily insulated, and every precaution had been taken with regard to winding and testing.

As another generator was almost ready for service, it was substituted for the first machine, and although the breakdown occurred on Wednesday morning, the new machine was in position, dried out and put on load the following Wednesday. After operating on commercial load for about a week, sparks were seen issuing from the top of the stator frame, and the machine was shut down. The windings were found to be in perfect condition, and the machine was run up again with field on, when sparks were again noticed, and further examination showed that one of the insulated bolts through the core had broken down near the endplate. These bolts pass through the core in an axial direction, and serve to hold the endplates tightly against the laminations. The bolt was removed, and it was found that it had vibrated violently, and the insulation had broken down near the centre of the core as well as near one end. The windings were found to be in perfect condition, but an inspection of other bolts which had not given trouble showed that more or less serious vibration had occurred on several of them.

A series of tests and investigations were at once undertaken, and it was found that for the particular length and diameter of bolt used, a relatively slight tension was sufficient to bring the frequency of the bolts to such a value as to synchronise with the frequency of vibration of the whole set, corresponding to the speed of 1,500 revs. per min. A further and more careful inspection of the first machine showed that one of the bolts had broken down to the core and molten metal had come into contact with the insulation at one end of the machine, thus setting it on fire.

Introduction of Copper Bolts.

A third generator was practically ready for running at the time the first breakdown occurred, and it was decided to remove the steel core bolts and replace them with copper bolts of smaller diameter which would carry heavier insulation. These bolts are stressed to such a low value as to leave their natural frequency very far below the running frequency of the machine. A considerable amount of work was required in order to replace the bolts, but this was done in an exceptionally short time, and before the end of the month the work had been completed, and the machine was under load. Since this time it has carried peak loads up to 21,000 kw. The two machines which broke down are being rewound, and will shortly be in commission.

The use of core bolts has been standard practice on the part of many companies in this country, America and on the Continent. Machines have been in operation for 15 years in which this construction has been used, and the Westinghouse Company of America has a very large number of machines in operation in which the same construction is used. This is the first case on record where trouble has resulted due to the use of the core bolts, and it is very remarkable that it should have occurred on two machines in such rapid succession, though the fact that they are duplicates and built by the same workmen may explain this.

The trouble was due to the fact that a peculiar combination of conditions resulted in the bolt having a frequency equal to that of the machine, and vibration once having been set up, the insulation on the bolts was more or less rapidly disintegrated. While the Metropolitan-Vickers Company assumes full responsibility for the trouble which has occurred, the following points might be emphasised:—

(1) The insulation on the windings of the machines has been in no way responsible for the breakdowns. (2) The voltage between the volts and core was approximately 100, and while the damage was due finally to the breakdown of the insulation on the bolt the cause of the breakdown was purely mechanical. (3) The construction which was responsible for the trouble is not a new or experimental one, the breakdowns being due to a particular combination of conditions, the existence of which could not reasonably have been anticipated.

Reviews.

Properties of Steam and Thermodynamic Theory of Turbines. By H. L. Callendar, M.A., LL.D., F.R.S. (London: Edward Arnold). Pp. xi.+531. 40s. net.

Prof. Callendar has produced a notable contribution to engineering literature in his new treatise "The Properties of Steam and the Thermodynamic Theory of Turbines." Engineers engaged in electric power station operations have become familiar to some extent with Callendar's work through the enterprise of the Turbine Committee of the B.E.A.M.A., who arranged for the publication of steam tables based on his researches and calculated in a suitable form for engineers' ready use. It is fitting, therefore, that this larger work should now be made generally available. The book is intended, as Prof. Callendar states, to supplement engineering treatises which deal largely with the mechanism of prime movers. Prof. Callendar gives a graceful acknowledgment to Mr. Martin's classical work on turbines, and he produces a welcome further contribution to our knowledge of the behaviour of steam under rapid expansion, which has been to some extent dealt with by Martin in recent articles in the technical press. Prof. Callendar apologises for writing in a personal manner, but considering he is giving the results of a life's work this is surely as allowable as it must be unavoidable. All is not yet known about the behaviour of steam, and it is fitting, therefore, that work on the theory of turbines should be, as the author states, still somewhat of a tentative character.

THE ARRANGEMENT OF THE BOOK.

The book, which is well presented, has 16 chapters. In the first is happily given a description of all the symbols used, many of which have now an International significance. Fortunately no new symbols involving the Greek alphabet are introduced, other than those with generalised application. This chapter is followed by a discussion on the specific heat of water, and of the units and data selected, which is of great importance in the work which follows. In Chapter II. we have echoes of the Callendar-Gray controversy as to the total heat, *H*, where the reasons are given which led the author to adopt his particular formulæ. An account of later experimental work is given with a discussion, a matter only within the purview of a few experts. Chapter III. deals with the further knowledge that has been attained as to the nature of steam by repeating the equivalent of the well-known porous plug experiment of Joule & Thompson. Chapter IV. goes on to deal more particularly with the experimental evidence derived from a porous plug apparatus based on the differential method so often used and elaborated by the author. The observations were taken at the McGill University in 1897. These are compared with results of other experimenters who used apparatus not altogether free from objections. The author also discusses whether *C*, the cooling effect, depends on the temperature or on the total heat, and details the logical conclusions of either assumption. The point is very important, as whatever set of equations is adopted finally, these have to be taken as defining the behaviour of steam outside the range covered by experimental evidence. The author's conclusion is that it is better to take *C* as a function of *T* at moderate temperatures, but that it cannot be said to hold at high temperatures and pressures. Chapter V. deals with the specific volume of steam, and analyses the notable experiments of Knoblauch, Linde and Klebe at Munich. These experiments with certain allowances are well fitted by the author's equations which are thermodynamically sound, but the empirical equations derived from the same source by Linde are not so correct.

THE KEYNOTE OF CALLENDAR'S WORK.

Chapter VI. deals with the specific heat of steam, and contains the keynote to much of Callendar's work: "*The application of the laws of thermodynamics to test the consistency of the various empirical expressions which have . . . been proposed.*" All the experiments of importance are discussed, and the author has to take exception to much that has been said by other workers. Chapter VII. deals with entropy, the fundamental work of Carnot and Clapeyron, and subsequently gives examples of the author's formula for finding entropy and the saturation pressure for any temperature, and generally indicates the way in which his steam tables were prepared. Chapter VIII. deals with the critical state, and on account of the difficulties of experimenting with steam owing to its high critical temperature and pressure, a study is first made of CO_2, so much used in refrigeration processes. This necessitates a discussion of the famous Van der Waal's equation, which in the author's hands suffers the fate of most of the other expressions he has analysed when used thermodynamically. Finally, he falls back on an empirical type of formula for tabulating the properties of saturated steam from 200°C. up to the critical temperature of 374°C., using the somewhat scanty experimental evidence available. Chapter IX. brings the formulæ into contact with practical conditions, and applies them to find the ideal efficiencies with Rankine and air standard cycles. Much useful information on the use of the tables is given. The adiabatics of wet steam, and of steam becoming wet during expansion are discussed. A note on the refrigeration cycle is given.

Chapter X. deals with the theoretical flow in nozzles. This is of the greatest interest as it discusses the application of the theory of supersaturation to existing experimental evidence. The existence of supersaturation would explain the experimental value of superheat in turbine practice. This is nearly twice as great as the theoretical gain based on the ordinary theory of expansion in which the steam becomes wet with the water so formed in thermal equilibrium with the steam. A formula and table for flow through a throttling gland is given and compared with Martin's. Chapter XI. is called "Flow through a Turbine," and is of general interest. Chapter XII. is entitled the "Reaction Turbine," but deals principally with what is known as the reheat factor. The methods of Martin are discussed and refinements and variations from them given. The most interesting portion is that which deals with the probability of supersaturation in ordinary working, and the value of superheat is to some extent thereby explained. The engineering statements are perhaps not very convincing, and the use of centrigrade units gives an air of unreality to the chapter to engineers in close touch with modern turbine design. Of the types of turbines to-day it may be said with considerable truth "The more they change the more they are the same."

IMPULSE TURBINE CALCULATIONS.

Chapter XIII. deals with impulse turbine calculations in a similar way to the previous chapter. Both these chapters will be of interest to designers who are using similar but probably more empirical methods every day, and who have much of the data which has apparently not been available to the author. The questions of the day all turn on efficiencies (F) lying between 73 and 80 per cent. and with highly superheated steam. Chapter XIV. deals with reaction turbine analysis somewhat on the lines set out by Martin, but in a different series of equations. The author draws attention to the necessity of considering a variation in the effective percentage "carry in" with blade angle, a point which has not escaped designers. He indicates the imperative necessity for further published results. Chapter XV. continues this analysis for a complete turbine, and deals with corrections for pressure and vacuum. The formulæ which have been developed give a rational basis for these corrections. Chapter XVI. is a long and careful analysis of the performance of the Mauretania's turbines, mainly with the object of showing that under circumstances unfavourable to supersaturation, a certain amount must occur in order to explain the pressure distribution. The author arrives at a new conclusion, namely, that rapid condensation and recovery from the supersaturated condition sets in when the steam would contain 3 per cent. wetness on complete recovery.

PHYSICAL ENGINEERING.

The book ends with a number of appendices, the first being on the fundamental thermodynamical relations, the second on the use of the diagram, the third on the well known steam tables, which are afterwards included. The book as a whole will make a powerful appeal to physicists who are interested in engineering, and also to designers, who, while perfectly familiar with their own work, have leanings towards theoretical analysis. It does, however, seem a matter for regret that such careful analysis has had to be bestowed on what are data which, while right enough for verifying the ordinary formula used by designers are quite inadequate if required for the purpose of deciding such points as the degree of supersaturation. It would not be difficult to get the data the author requires, certainly much more accurately than at present. It is only a question of expense. On the other hand, the main result of having such data would be to demonstrate an increase in the supposed efficiency of the turbine and diminish the reputed efficiency of the cycle. Their possession would also give greater confidence in settling the areas down a turbine to give an equipartition of work or of efficiency as may be desired. These areas have however, been settled by experience and can easily be adjusted if on trial the overall result is defective. Fortunately or unfortunately, such variations as occur are not serious in their consequences. All the author's investigations are made on data from inefficient turbines. Modern turbines with few stages and very high peripheral velocities are being made and run with projected efficiencies of 75 to 80 per cent., and with such, the margin of inefficiency having become much smaller, the matter of supersaturation assumes greater theoretical importance. The turbine Committee of the B.E.A.M.A. is the best body to deal with such a question, but it is rather doubtful whether they would be inclined to take it up, although one or two individual members might. W. M. Selvey.

Induction Coil Design. By M.A. Codd. (London: E. & F. N. Spon.) Pp. 238. 21s. net.

This book deals with induction coil design more from the constructor's point of view than from the theoretical standpoint. The design is mainly based on empirical formulæ derived from practical experience, and while this is good as far as it goes, the book leaves one rather disappointed that the author has not welded theory and practice more closely together. On p. 5 the statement is made in discussing the spark at the contact-maker at break that the current causing the spark is in the opposite direction to the magnetising current. One would have thought that the effect of the primary self-induction would have been to retard the fall of the current.

In discussing the magnetisation of the core, the so-called iron filing curve on p. 61 is very misleading. Between the poles of the magnet, and inside it, the lines of force are shown as closed flat ellipses, indicating that one side of a section is oppositely magnetised to the other side.

The question of design is summed up on pp. 236 and 237 in 14 empirical rules. These rules will apparently produce a coil giving a certain spark length, but the question of design with respect to output, heating and efficiently is hardly dealt with. The efficiency of a coil is defined as the product of the spark length and the current (plates 8 and 9), and the efficiency unit is given as the milliampere-inch. As this appears to be a new unit, it is suggested that it be called " The Codd."

The book contains a great deal that is interesting to the induction-coil constructor, but from the theoretical standpoint it leaves much to be desired.

The Organisation of Industrial Scientific Research. By C. E. K. Mees. (London: Hill Publishing Company.) Pp. ix.+175. Price 12s.

The war provided innumerable instances of the advantages of applied research, and it was inevitable that the widespread interest aroused would result in a demand for guidance as to ways and means through which the resources of scientific method and investigation may be placed at the disposal of industry. Dr. Mees, who directs the Research Department of the Eastman Kodak Company, U.S.A., has written this book as a guide to manufacturers and others who desire enlightenment in these directions.

The plan of co-operative research is considered, and the association of users or consumers of a product is advanced as a more appropriate body for undertaking research financed co-operatively than the association of manufacturers or producers formed with State aid in a number of British industries. It is probable that no rigid ruling can be given to cover all cases, and both methods deserve thorough trial. The electrical industry presents an admirable illustration of the difficulty involved. Many electrical products, the result of extended and complex researches in pure science, such as incandescent lamps or domestic appliances, are purchased regularly by the general public, which could only be expected to undertake research through action by some representative body, such as the State. But the State has chosen to encourage manufacturers rather than users to associate. Other products, such as large electrical machines, are purchased by technical men, such as supply and consulting engineers, who are sufficiently closely in touch with the industry as to recognise the difficulty of uniting to investigate matters about which the manufacturer has already considerable knowledge and experience. This applies no less to such component parts of apparatus as electrical steel, textile fabrics, insulating paper, and so on.

The larger part of the book comprises a full discussion of the scope and function of a works research department, its relation to other departments of the works and its internal organisation. The problems presented by the staffing and administration of the department are considered and an illustrative design for a laboratory attached to a textile dyeing works is worked out on a basis of the provision which can reasonably be made for a given expenditure. While nor specifically applicable to electrical manufacture the book will doubtless be welcomed by many who are furthering research in industry. A. P. M. F

Correspondence.

THE PASSING OF THE B.O.T. UNIT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the above appearing in the current issue of The Electrician, and the name of a new unit, I have an idea that the name kelvin was applied to a measurement unit years ago, but whether this is the case to-day, perhaps some of your other readers can inform us.—Yours, &c.

London, February 21. D. R. Broadbent.

DANGERS OF STATIC ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I read with interest the case of static electricity, caused by a belt driven by an electric motor mounted on wood beams. Neither motor nor the machine seems to have been earthed, at which I am greatly surprised, as it is asking for trouble. I had a similar experience some years ago. I think if the firm had efficiently earthed the motor and the machine and used a noiseless Coventry chain, the difficulty would have been overcome.—Yours, &c., Common Electrician.

Fused Silica Valves for Wireless Work.

We understand that considerable progress is being made in the construction of radio valves for handling large outputs by H.M. Signal School, Portsmouth. Patents have been taken out by the Admiralty for the construction of valves in fused silica which has made possible the handling of larger outputs. We believe that considerable ranges have already been effected with silica valves, and that there seems no doubt that if the present progress is maintained the silica valve may ultimately supply the best solution to high power stations such as those demanded for the Imperial Wireless Chain. We are pleased to be able to say that the manufacture of these valves is in British hands, namely, the Mullard Radio Valve Company, Ltd., who have been appointed sole licensees and manufacturers for their production.

Heating and Cooking Notes.

Bed Warmers.

The copper bed warming pans of olden times served a twofold purpose. They warmed the bed, and their well-polished surfaces indicated the presence of damp. The modern stone or rubber hot-water bottle fails in this respect, and possibly many a sufferer from rheumatism to-day owes his or her affliction to sleeping between damp sheets.

The Photector Company, Ltd., of Southall, are hoping by producing an electrically-heated bed warmer, which will serve the twofold purpose of the old warming pan, to change all this. Essentially it consists of a 20-watt element mounted in a polished nickel-plated reflector measuring 11 in. by 3½ in.

This Company is also making a speciality of domestic electric heating appliances, the range of apparatus which they manufacture comprising electric heating pads, foot warmers, boiling plates (radiant table type), curling tongs heater, saucepans, immersion heaters, irons, and electric fires.

The immersion heater is of novel design, in that the element is contained in a cylindrical ring, and the water circulates around this ring, thus all sides of the element are active. The case of the heater is made of copper nickel plated, and polished. The consumption is 300 watts.

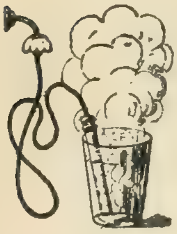


Fig. 1.—"Thermo-Fox" Immersion Heater.

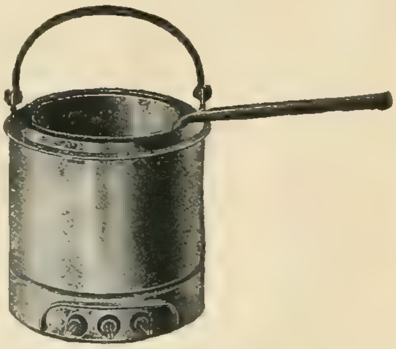


Fig. 2.—"Sunco" Electric Glue Pot.

Another immersion heater produced by this firm is the "Thermo-Fox," which consumes 250 watts, and is intended for heating small quantities of liquids. It is intended for use on A.C. circuits, and can be used for voltages from 70 to 350. The element is contained in a porcelain tube, and a special feature of the apparatus is that the current is switched off immediately the tube is removed from the liquid. This heater is shown in Fig. 1.

Electric Glue Pot.

The Sun Electrical Company, Ltd., have recently sent us a copy of their latest heating and cooking list, which contains particulars of a number of lines of interest to the contractor and supply authority. We notice in particular an electric glue pot (*see* Fig. 2), which is a thoroughly sound job, designed to withstand the hard wear and tear of industrial conditions. Both the glue pot and the water jacket container are made of solid copper. The capacity is 2 pints of glue, and the consumption 100 watts. Three-heat regulation is provided by means of three terminal pins and connectors.

Another useful industrial appliance is an electric soldering iron which is made in two sizes, of one and two pounds weight respectively. Specially-shaped copper soldering bits can be supplied if required. The list also contains particulars of the new "Sunco" vacuum cleaner, electric hair dryers, and vibrator sets, together with "Xcel" irons and "Universal" table accessories.

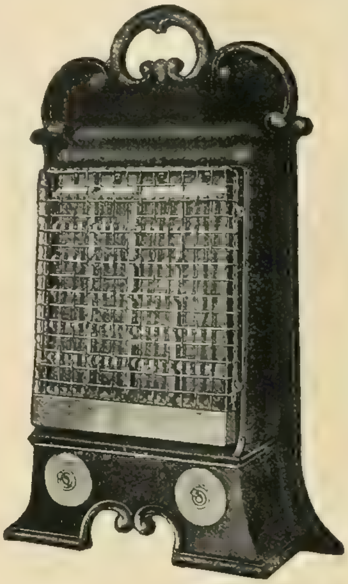


Fig. 3.—New Pattern Ediswan Fire.

Ediswan Electric Fires.

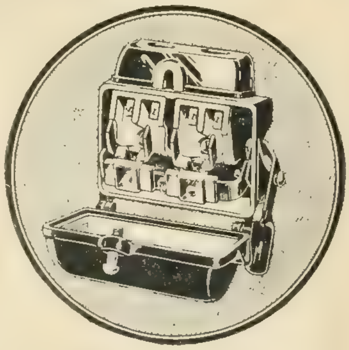
The new pattern Ediswan fire, illustrated in Fig. 3, has a cast-iron frame, and is made in three sizes, viz., one, two and four-bars, having a consumption of 750 watts, 1·5 kw., and 3 kw. respectively. If desired the four-bar fire can be supplied with elements designed to consume 2·5 kw. instead of 3 kw. The frame is substantially made, providing a fire which will stand steadily. A strong wire guard protects the elements from accidental contact with inflammable materials. In addition to the standard stove enamelled black finish, these fires are stocked in vitreous enamel finish in a variety of colours.

Increased Output Reduces Price.

The Cooper-Stewart Engineering Company, Ltd., inform us that by extending their factories and increasing production they are able to reduce the retail price of the "Princess" electric iron from 30s. to 25s., including 2 yds. of flex, connector, and adaptor. One size only is manufactured, 6 lbs., rated at 500 watts. Taking into account the finish and general design of the iron the new price seems to be distinctly reasonable.

A New Note in Ironclad Switches.

The Midland Electric Mfg. Company have recently made a new departure in switchgear production by placing on the market an ironclad switch for circuits whose capacity is between 10 and 15 amperes. This switch, which is illustrated herewith, is known as the "Baby Paragon," and has been designed to provide the electrical trade with a small, strong and reliable switch for circuits where something more robust than a tumbler switch is required, and where cost is a consideration, which is, of course, practically everywhere. We hasten to add that the switch is an engineering job. Each pole is mounted on a separate base of best English porcelain, while the blades are assembled on a mica insulated metal bar. This, it is claimed, is much superior to the use of a fibre bar, which stands a risk of being distorted, and gives only a poor dielectric and mechanical strength. Detachable glands which enable the switch to be adapted for conduit installation are fitted, and it may be said without exaggeration that the whole is not only a neat production, but is an excellent example of the value which it is possible to obtain by adopting methods of scientific standardised production. The "Baby Paragon" is illustrated herewith.



View of the "Baby Paragon."

Standardised production is, in fact, a strong point with the Midland Electric Mfg. Company, for they manufacture only a small but complete range of ironclad switch, switch fuse and fuse gear on standardised and mass production lines, as will be gathered by a perusal of an interesting booklet they have recently issued entitled the "M.E.M. Message." The booklet is illustrated by photographs of the company's works, offices and productions, and copies will be sent on application. It is worth reading.

New District Railway Rolling Stock

In our issue for Jan. 7 last we gave a description of the first instalment of the new trailer cars which had been designed for use in eight-car trains during the busy services, and in five-car trains during the slack services on the Metropolitan District Railway. Some of the new motor cars are now ready, and the technical Press were invited to inspect and take a trial trip on an eight-car train of the new type on Monday last. The motor cars weigh 44½ tons. Each motor car is equipped with 190 h.p. G.E. 260 tapped-field motors, rated at 198 h.p. for one hour and 182 amperes continuously. These are hung on the axles and supported by brackets extending from housing plates. The contact tips in the control gear are provided with arcing horns. The interlocks are of the disc type and mounted on the back of the contactor. The reverser connected to the motor fields is of a drum type, and is operated by a pair of solenoid coils. Other apparatus is substantially the same as that previously used. The new eight-car train has an acceleration of 1¼ miles per hour per second, and a balancing speed of 45 miles per hour attained after one mile on the level, compared with 35 miles in the case of the old rolling stock. The new cars were built by the Metropolitan Carriage, Wagon & Finance Company, and the internal arrangement is the same as that in the trailer cars recently dealt with in The Electrician.

Electricity Districts.

The Ministry of Transport announce that, in view of the time necessary for obtaining the further information required for dealing with the scheme submitted for the Lower Severn District, the resumption of the local inquiry at Bristol, provisionally arranged by the Electricity Commissioners for the 1st prox., has been postponed.

The Commissioners have definitely arranged to resume the adjourned inquiry into the Mersey and West Lancashire Electricity District at Liverpool on Tuesday, March 8, and following days.

The Electricity Commissioners (Sir John Snell, Mr. Harry Booth, Sir H. Haward and Mr. A. Page) continued their investigation of the schemes for the reorganisation of electricity supply in the North Wales and Chester District. The first witness in support of the Chester scheme was Mr. E. Noel Humphreys, ex-chairman of the Chester Electricity Committee and a former managing director of the North Wales Power and Traction Company. He estimated that the proposed Joint Electricity Authority would at first comprise 74 members. He did not consider that the financial clauses need alarm any of the authorities. Their object was to secure a good reception for any loans which it might be desired to obtain in the money market. There would be a specific obligation upon the authority to apply any surplus there might be in reduction of the charges for electricity to consumers.

Sir John Snell said he assumed that it was contemplated by the Chester scheme that the North Wales Power Company would be a constituent authority represented on the Joint Electricity Authority, whilst continuing to develop their district in the western portion of the area.

Mr. Humphreys.—With that in mind the North Wales Power Company has been invited to all the conferences that have been held. There was power under the scheme for them to come in.

He said there was a very serious fall in the rainfall in 1915, and that drought would have been disastrous to the eastern portion of the district had it then relied upon a supply from hydro-generating stations. A committee representing Chester Corporation and other authorities had been negotiating with the Government to take over the steam generating station at Queensferry, and an arrangement might be expected to be concluded without delay.

In cross-examination by Mr. Harper (for the North Wales Company) he said he would prefer private supply, assuming there were permanent guarantees of quantity and price. He saw no reason why a publicly-controlled authority should not provide power as cheaply as the Company. The supply was not expected to be as cheap in the eastern area as many consumers in the west were already getting it. The North Wales Company's scheme disclosed capital outlay, valuation figures and estimates of expenditure, which—particularly the valuation figures—were considered by the promoters of the Chester scheme as inflated. It was not contemplated to purchase any other generating stations. Witness denied that the proposed weirs on the upper Dee, nine in number, would ruin the salmon fishery of the river. He concurred in the suggestion of Mr. W. O. Jones, clerk of the Anglesey County Council, that if the county joined the proposed electricity authority it could not expect a better supply than was available from the Company. He could not agree to priority of supply being given to areas not already provided for.

Mr. Humphreys denied that the financial basis of the Chester scheme was fallacious. The Northwich Urban District would be included in the area in which the supply of electricity would be developed within five years. A full and cheap supply of electricity was essential for the Weaver area and it was important that it should be given at the earliest possible date. The area of the Northwich Electricity Supply Company adjoined that of the Mersey Power Company, but as to the exclusion of Northwich from the North Wales and Chester area, Mr. Humphreys pointed out that it was provided in the scheme for the joint authority to take a supply from an adjoining district if desired. It would not be conducive to good working if Northwich urban area were transferred to another district and the rural area around it were to remain in the North Wales and Chester area.

In reply to a question as to whether it was proposed to carry out any works or extensions in the western part of the district, where the slate quarries were situated (a number of which are already large consumers from the Power Company), Mr. Humphreys replied that it was not proposed to interfere with the company. Rhyl and the Vale of Clwyd to Denbigh were not in the area to be developed in the first instance. The Joint Authority, when set up, would consider when, and in what way, a supply for that part of the district could be obtained.

The Chairman pointed out that Rhyl and the Vale of Clwyd could not get any benefit from anybody unless it became affiliated with some electricity district.

Mr. Amos Jones said that if Rhyl Council could have authority to supply current in the Vale of Clwyd they would have a market for the surplus energy generated at their works.

The Chairman said the Commissioners would have due regard to that themselves, and he imagined so would the joint electricity authority.

Mr. H. A. Mothersole, Connah's Quay, said his council intended to support the scheme of the North Wales Power Company.

Questioned as to the method in which the Chester scheme proposed to make up any deficiency of revenue, Mr. Humphreys said there were reasons why the promoters proposed to make any deficiency a charge upon rates and not upon the consumers. The method would give the scheme a better basis on which to approach the money market for one thing, and that would be for the benefit of all concerned.

For Nantwich Rural District, Mr. Cartwright objected to any rating of rural areas which could not benefit from the supply of electricity. It was true that a rural district council could join the electricity authority on condition that only specified parts of the district would be included, but he contended that even in parts of a district included there should be no rate levied upon anyone who could not be supplied with current if he wished to be.

In re-examination, Mr. Humphreys stated that the North Wales Power Company was not authorised to distribute electricity. The first duty of the proposed electricity authority would be to encourage local authorities to extend their areas as distributors, and if after a reasonable time they failed, the electricity authority itself would be expected to take electricity in bulk from the Power Company and distribute it in areas not otherwise provided for.

In reply to Sir H. Haward witness said that, with the exception of Chester, no local authorities had actually passed resolutions agreeing to come into the scheme. A number had approved of the principle, and would probably pass the resolutions when the complete scheme was laid before them.

As to whether the county councils should be accepted as constituent authorities, Mr. Humphreys said he did not think they would add much rateable value to the authority in view of the clause permitting them to exclude unaffected areas, but they would be useful in an advisory way and they could assist in obtaining wayleaves for transmission lines. It was intended to make the undertaking of the authority self-supporting, but it was essential that constituent authorities should make themselves liable to a deficiency rate. The capital required up to 1926 for the generating stations and transmission lines was £914,000, but it would not all be required at once. He adhered to the belief that complete reliance upon power coming over a long transmission line was inadvisable. A steam plant, in addition, was desirable. As the undertaking of the North Wales Power Company was not purchaseable by the proposed authority, the relationship between the authority and the Company would, he hoped, be one of friendly co-operation for the service of the whole district.

Mr. S. E. Britton, city electrical engineer of Chester and the engineer responsible for the technical details of the Chester scheme, said he estimated that 11,000,000 units, practically the output of the Government factory at Queens' Ferry, would suffice for Chester, Wrexham and the surrounding area for the next two years, but if the Power Company immediately erected a transmission line into that area, the demand might be much larger. It was proposed that distributing authorities should be set up in convenient areas; Chester, Hawarden and other adjacent places would form one distributing authority. The joint authority would generate and transmit power to distributing authorities, who would deliver to the consumers. The charge for current to the distributing authorities would probably be 1½d. per unit. The existing undertakers would not be in a position at present to reduce their charges to consumers owing to having no meet capital charges, but the areas not now supplied, and having no loans to pay off, might reasonably be expected to pay more than 1½d. per unit for current in bulk.

In cross-examination, Mr. Britton admitted that in summer steam plant would mainly be relied upon. He had had charge, since its erection of the hydro-electric station at Chester, and he based his conclusions to some extent upon his experience of the generation of current at the station. He proposed to erect a steam station on a site on the banks of the Dee, three miles below Chester Weir, and he submitted estimates of the cost of generation, &c. With regard to the proposed hydro-electric stations on the Dee, Mr. Britton held that in the summer the power produced would be a fourth of the winter quantity. The surplus energy of the West would be available for use in the East if it could be supplied at a proper rate.

Replying to Mr. Tyldesley Jones, K.C., for the railway companies, Mr. Britton said the statement in the scheme that exceptional circumstances existing in the North Wales district for generating electricity rendered the district suitable for the electrification of the railways, was based on the fact that there was a coal field in the area adjacent to a river, enabling electricity to be produced at a very low rate, and that there was the water power provided by the Power Company in the west. No powers had yet been obtained to construct the dams across the Dee required for the development of power from that river, but there was provision in the Act of 1919 for the development of water power, under which propositions such as that could be dealt with. Something in the Fishery Acts enabled dams to be erected under certain conditions. His estimates included substantial sums for obtaining leave to erect the dams. His experience at Chester was that the summer load was only half the winter load, and, therefore, the fluctautuion in the power from the river would be much less important. He had made no provision for deepening and improving the flow of the River Dee, where eight dams were proposed. The Vale of Clwyd hydro-electric installation would be on the River Elwy, near St. Asaph. There a dam would submerge 28 acres of land, the price of which he knew. His estimate of the cost of land and rights was £4,600, out of £47,000, the estimated total cost for the works. Fish passes for salmon to go up river would be provided in all cases. The raising of the Chester dam had not lessened the fishing value of the river.

On Saturday the case for the North Wales Power Company was opened. Mr. H. J. Jack, managing director of the Company, Sir Philip Dawson, Mr. R. Freeman and others gave evidence in support.

An abstract of the evidence of the later witnesses will be given in our next issue.

The inquiry closed on Wednesday last.

The British Industries Fair.

BIRMINGHAM SECTION.

In 1920 the originators of the movement to establish a section of the British Industries Fair in the metropolis of the Midlands successfully accomplished their object, and the importance of the project as a prominent factor in the development of British trade is emphasised by the second great fair which is now being held in Birmingham as well as in London and Glasgow. The 1921 Fair promises to be a still greater success than its forerunner as a demonstration of the producing qualities of the British manufacturer. As in 1920, the venue of the Birmingham section of the Fair is the great aerodrome at Castle Bromwich, and here are displayed a number of representative exhibits.

A Purely Business Proposition.

As on the last occasion, the Fair is purely a business proposition, in other words, a place where buyers and sellers can meet, and where buyers can in a very short time examine the lines of commodities produced, not by one, but by many manufacturers. Although the same three permanent buildings are in use as last year, the area covered is considerably greater by reason of the fact that the buildings are now connected together with passages which themselves contain exhibitors' stands, while some of the exhibitors have generally taken larger stands.

G.E.C. Specialities.

The General Electric Company, Ltd., Birmingham, have a special display of electrical plant and apparatus, which cannot fail to appeal to visitors interested in the electrical industry. The exhibits include such apparatus as generators, motors, switchgear, fans, arc lamps, portable electrical tools, &c. Being quite impossible to exhibit samples of the larger machinery manufactured at their Witton Works, the Company extend an invitation to those interested, to visit the works, where the larger equipment for which the firm is so well known, may be seen in the course of construction. This invitation also applies to the works of Fraser & Chalmers, Erith, Kent, where may be seen in the course of construction steam turbines, conveying and mining machinery, winders and dry gas cleaning plant. At their High-street showrooms, Birmingham, there is a representative collection of telephones and telephonic gear, bells and batteries, while the exhibit of electric lighting fittings, heating and cooking and general domestic electrical apparatus is most comprehensive.

Other apparatus for which the Company are renowned, and which can be seen include Chamberlain & Hookham meters, samples of cable made at the Pirelli-General cable works, Southampton, "Kinarko" carbons, electrical instruments, circuit breakers, Osram and Robertson lamps, magnetos and electric lift gear.

Among the many electrical exhibitors we may mention Messrs. **Siemens Bros. & Company, Ltd.**, London, the first and perhaps most interesting exhibit on whose stand is the "Siemens' Autophone Outfit," with its large sign above it proclaiming, "No operations, no delays and no increased charges." The system is in full automatic operation and is connected to about 30 stands and offices in the exhibition. It is attracting considerable attention by reason of its perfect automatic action. It is rather interesting to note that nine systems are working in Birmingham with complete success.

The firm are also showing their "Mine Shaft Signalling Apparatus" for use in mines with intermediate levels. A complete system is fixed up on the stand, in full working order for the benefit of visitors. Alongside of this apparatus is shown Siemens' telephone equipment for mines. These instruments are of very robust construction and are intended for use in mines, engine-rooms, railway sidings, docks, factories, explosive works, and other places where they will be exposed to atmospheric or other conditions detrimental to apparatus of the ordinary type.

Siemens' Britannia lamps, dry cells and batteries, cables, and Purlite fittings are among the other interesting exhibits on this stand.

Messrs. **J. H. Tucker & Company, Ltd.**, Birmingham, show a very comprehensive range of samples of their various manufactures. A complete accumulator switchboard for country-house and similar lighting plant, besides numerous examples of fuse and distribution boards of varying capacities, and many types both in teak and iron cases, are shown as samples of their switchboard and switchgear department. They also show a very complete range of switchgear components, such as switches, fuses, &c., of various types, sizes and forms as used in their switchboard manufacture. Ironclad switch and fusegear complying with Home Office regulations are also displayed.

As pioneers of the tumbler switch, it is not surprising that they make a very special exhibit of tumbler switches in a variety of patterns, forms and finishes, for all purposes. A special feature is a choice selection of switch plates for use with sunk-type switches. General lighting accessories are also shown, such as lamp holders, ceiling roses, cutouts, wall plugs and sockets, &c.

Artistic Electric Fittings.

Messrs. **David Shanks & Company, Ltd.**, Birmingham, show a number of really excellent and artistically designed electric light fittings. Examples of fittings for churches, country houses, public buildings, theatres, cinemas and marine work, are also shown, including a wide range of various designs of electroliers and the now very popular indirect type of lighting fitting.

Messrs. **Donovan & Company**, Birmingham, are again showing their Safuse and Donlok Ironclad Gear, and visitors interested in this class of manufacture will be well repaid by a visit to their stand. Many improvements have been made in their manufactures since last year, the quality of their ironclad switch and fuse gear still maintaining a very high standard of excellence consistent with the firm's reputation. One of the most interesting exhibits is their Home Office combined switch and wall plug. It has been greatly improved by being made more robust, certain and quicker in action. There is also a double break on each pole of the switch portion, and no matter how careless the operator, he cannot come into contact with live metal. A most comprehensive range of distribution boards, switch and fuse boxes, in iron and teak cases are also shown.

(To be continued.)

The Plexsim Royal Electric Cleaner.

With the disappearance of the domestic servant comes an ever increasing demand for the vacuum cleaner, not only because it saves time and labour, but because it prevents back-aches and also cleans carpets and other articles much more efficiently than was possible by the older methods. We are therefore not surprised to learn that **Simplex Conduits, Ltd.**, have been devoting their attention to the subject, and in connection with the British Industries Fair at Birmingham are pressing the advantages of the Plexsim Royal electric cleaner manufactured by them.

View of the "Plexsim" Vacuum Cleaner.

Taking the various parts of the cleaner in detail, the handle is made of high grade steel tubing finished in nickel-plate, the grip being shaped to fit the hand, with the switch at the finger-tips, so that the cleaner can easily be started and stopped. The nozzle is so designed to give the most efficient suction, while its shape enables it to reach under pieces of furniture which are close to the floor, and to clean close up to skirting boards. Being 14 in. wide, it cleans a wide area in the shortest possible time. Adjustment to allow for efficient working on different grades of carpet is effected by an adjusting screw.

The motor driving the cleaner is designed to develop high speed and power with lowest current consumption. It runs at a speed of 9,500 revs. per min., producing through the fan an air current having a velocity of 120 miles per hour, high air velocity being essential to efficient cleaning. The motor is mounted horizontally, thus equally distributing the weight on two extra large phosphor-bronze bearings. The fan is a solid aluminium casting, whose design and high speed cause a very large volume of air to be displaced. Each armature and fan is individually balanced before being placed in the cleaner, thus ensuring perfectly smooth, true running units. The revolving parts and bearings are constantly immersed in oil, but it is impossible for the oil to flood the motor. It is only necessary to fill the oil-cups about once in three months.

Commercial Topics.

Industrial Electric Power in New Brunswick.

Like other countries, there is a demand for cheap electric power for industrial purposes in New Brunswick, and the Government are taking steps to make hydro-electric power available to manufacturers and others throughout a large part of that province. The water power at Musquash, N.B., is being developed by a special commission appointed for the purpose. The initial cost is estimated at £250,000, and the Commission will supply current at actual cost to the Halifax Municipal Council, which will distribute it either direct, after erecting its own distribution system, or sell energy in bulk to an existing company, safeguarding the community as to the rates to be charged. In the case of St. John, where the New Brunswick Power Company operates the street railway and lighting and power systems, it will have to be decided whether that company, using steam plant, shall receive power or meet the competition of the municipality with hydro-electric power.

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Electrical Supplies for South Africa.

Recent advices from South Africa were to the effect that many public authorities and companies were short of electrical plant and supplies, and complaints were frequently made that machinery which had been on order for long periods had not been delivered. According to our contemporary, the "South African Engineer and Electrical Review," most of the leading municipal councils were not only unable to give extended supplies of electricity, but were only able to meet the existing demand with no reserve for emergencies. A similar condition of affairs applies in this country, where many stations are without adequate reserves of plant. Only in the supply of electric lamps, which were over-imported in 1918 by speculators, has the South African demand been adequately met. In most lines of electrical goods, such as heating and cooking apparatus, telephones, conduits, &c., supplies have been at times unprocurable at any price.

Apart from the difficulty of getting delivery of machinery it has been found almost impossible during the year to place orders in the United Kingdom. In spite of the adverse rate of exchange, America has taken practically every important order for large plant owing to the apparent inability of British manufacturers to quote firm either for delivery or price. At present public bodies are faced with the choice between paying what seems prohibitive prices and turning down all schemes of extension. This is a serious matter, and should receive careful attention from our manufacturers and exporters. Now that the General Election is over trade and business should expand, and as tenders are being invited for the electrification of two lengths of railway line some important orders for generating plant, rolling stock and material should be secured for this country.

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New Industries in Australia.

The movement for the establishment of new industries in Australia is extending rapidly, especially in New South Wales and Victoria. According to statistics compiled by the Minister for Trade and Customs, the total amount of new capital for industrial extension sanctioned by the Federal Government during the past 12 months was £20,000,000. Though all parts of Australia benefit, more than half of the new industries will be established in New South Wales, the most favoured centres being Newcastle and Port Kembla. The biggest issues of new capital were £3,500,000 for the Broken Hill Proprietary Company, and £2,000,000 for the Electrolytic Zinc Company of Tasmania.

These new industries must mean an increased demand for electric motors and other plant, and also an increased demand for skilled workers. For instance, we notice that the Springvale Foundry Company, of Victoria, is equipping its foundry on the most modern lines. Electric power is to be employed, and an overhead electric crane, fitted with steel magnets, will be used to fill and empty the railway trucks at the siding. It is understood that several companies contemplate the establishment of industries in the vicinity of Springvale, one reason being that the district will be in a favourable position when the Morwell electricity scheme is in operation. Not only will firms in the vicinity of the railway be in the line of progress from Morwell, from whence they can obtain a cheap and abundant supply of electric power, but they will also be able to obtain cheap supplies of brown coal from Morwell.

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German Industrial Amalgamation.

H.M. Commercial Secretary at Cologne has forwarded to the Department of Overseas Trade lists containing the most recent information on the various combinations in the German iron and steel industry. We have already given particulars of some of these, but in commenting upon the subject the Commercial Secretary states that coal, ore iron and steel, raw and semi-manufactured materials form the bases of the fusions, and upon them the group of finishing industries, embracing a large variety of products, depends. The financial strength and organisation of the various groups will be utilised in order to secure concessions and deliveries of the necessary foreign raw materials to make up deficiencies in home supplies. In Lorraine and the Saar there is already an overproduction of raw steel and iron products, and French industry is placed in a somewhat embarrassed position in getting rid of its surplus, so that a closer co-operation between the German and French industry may be expected in the future.

The formation of efficient cartels of industrial groups will make itself felt as a competitive factor in foreign trade, as the Germans have shown themselves capable of handling undertakings of these magnitudes with considerable success. The facilities which the grouping of interest give to the individual firms in the favourable purchase and delivery of raw materials, the interchange of experience, and in the development and exploitation of foreign markets, cannot be over-rated, and there is little doubt but that the activity in regrouping is directed towards the assimilation of foreign markets. The interests which some of the groups have in the shipbuilding industry will enable Germany to concentrate upon the rebuilding of her mercantile marine, and possibly also (aided by rate of exchange conditions) to develop a building programme for foreign markets should her yards not be called upon by the Reparation Commission for their full output. The Siemens & Halske Company, by becoming allied to the Deutsch-Luxemburg and Gelsenkirchen group, will enjoy the advantages of a reliable source of raw materials, and will thus gain facilities in the development of her foreign trade, which the severance of her former outside connections has done much to hold in check. The lists can be seen at 35, Old Queen-street, S.W.1.

Revival of the Motor Industry.

The revival of this vast and important section of British engineering activity is not only coming; it simply cannot be stopped unless we, as a nation, purposely stop it. Two cardinal facts exist, one is the gigantic world-wide demand for motor vehicles in general, and the other, of greater significance from our view point, is the marked preference of the British made car throughout the home and overseas markets. The experienced and discerning motorist is open to pay £100 more for the British product. Conservative calculation estimated the world demand for British cars at the beginning of 1920 at 50,000, two-thirds being from overseas markets. At an average of £1,000 per car this would represent a total of £50,000,000, of which £37,000,000 worth would go overseas. Quantity production schemes launched by several of the leading British manufacturers aimed at securing this trade for Britain. Increased production presented the only possible means which could do it. The desired output was not reached, the hampering element in the majority of instances being the fetters around capital.

Of the British manufacturers which launched out upon quantity production of a standardised model upon an economic basis one name, the Austin Motor Company, stands out prominently as having achieved a really tangible success. This firm has proved indisputably its capacity for producing a type of car which the whole world wants in considerable numbers; a car the design of which caters for the requirements of all motorists and is particularly suited to overseas conditions. The Austin "Twenty" has been exported to practically every part of the world, from the Malay States to Buenos Ayres. One of the splendid facilities of the Austin Company is its complete network of world trade representation. As to the product itself, the Austin "Twenty" is undoubtedly an achievement and one of a national nature. It is the British master-stroke to the American principle of mass production, which has made a better car for the same money. Definitely, there is not another car in the world presenting its equivalent in sheer value. The Austin "Twenty" is above the average British car, and when one considers its remarkably moderate price it is not difficult to see the reason for its huge demand. Actual contracts have been placed totalling 5,000 cars for this country alone during the current year, and the brightest aspect of all is that the great Austin factory at Longbridge is equipped and organised for an output of anything from 200 cars a week upwards. Production costs have been reduced to a scientific minimum by the application of the most modern plant and methods, rendering it possible for the Austin Company to market the "Twenty" at the astonishingly low price of £695 and leave a reasonable margin of profit.

The famous Austin tractor is another engineering achievement of supreme importance and a further example of the Austin policy of standardising one type of machine—the design of which is the result of the most careful analysis, of experiment and tests, and once the design was defined, to set about its quantity production upon strictly economic lines, thus keeping its selling price down to a popular figure. Since its first appearance as the Austin tractor a consistent chain of successes to its credit, gaining highest awards at Agricultural shows tests and matches. 3,500 of these machines are already contracted for during the current year, while manufacturing facilities are capable of increasing output to 200 a week. There is a vast export trade possible in this article, and India alone can, it is estimated, absorb at least 10,000 Austin farm tractors a year in future.

The other Austin products consist of the 1½-ton lorry chassis, plans for the quantity production of which are now complete. An indication of the Austin method of truly economic production may be judged from the fact that for the "Twenty" car, the farm tractor, and the 1½-ton lorry, one power unit of standardised pattern is produced in quantities sufficient to supply all three products. The Austin Works are the largest works devoted to automobile manufacture in the British Empire, covering 53 acres of factories, foundries and machine shops. The machinery, the finest in the world, is driven by power plant of a total of 6,000 H.P. The foregoing facts convey their own message; the moral needs no labouring. The British motor industry, represented by those firms whose products have such world-wide demand, needs, and what is more, merits, every facility, help and encouragement. It needs the support of the Government, the co-operation of the banks, and the backing of the financial element. Such joint effort would do much towards establishing Britain firmly as the world's leading producers of motor vehicles in all markets in the world.

Electricity Supply.

BARNSLEY Corporation has been authorised to borrow £14,200 for electric supply purposes.

Sanction to a loan of £11,674 for electricity extensions has been received by DARWEN Corporation.

The WALSALL Corporation have authorised the extension of the electric supply mains to Rushall village.

HARROGATE Corporation has applied for sanction to borrow a further sum of £40,000 for extensions of their electric supply undertaking.

An additional loan of £10,000 is required by DERBY Corporation for cable extensions, and application has been made for authority to borrow this sum.

ESSEX County Council have made an agreement with the G. E. Railway Company for the supply of electric current to the Harwich County High School.

It is hoped to inaugurate the ROTHERHAM electricity works in July next, when the Prince of Wales will be invited to attend and perform the inaugural ceremony.

ENNISKILLEN Urban Council has appointed Mr. Thos. Tomlinson, of Dublin, consulting engineer, to prepare a report upon the possibility of electric supply works.

PAISLEY Corporation has authorised an additional capital expenditure of £34,450 on mains and sub-station plant by the electricity department, and the Electricity Commissioners have been asked for authority to borrow the necessary money.

HAMMERSMITH (London) Council is recommended by the Finance Committee to take up a loan of £25,000, at 7 per cent. interest, from the London County Council, for extensions of mains and services, purchase of transformers, &c.

Messrs. J. & P. Coats, of Paisley, have applied to the GREENOCK Electricity Committee for a supply of electricity to Ferguslie Mill, and Mr. F. H. Whysall, the burgh electrical engineer, has been instructed to submit a scale of charges proposed to be made.

NOTTINGHAM Electricity Committee is losing no time in proceeding with the erection of a temporary power station on the Clifton site, for the electrical engineer (Mr. H. Talbot) has been instructed to obtain the necessary plant. Two 2,000 turbine sets are to be purchased from Liverpool, and it is hoped that extra current can be supplied in about six months' time.

All the NEW MUNICIPAL HOUSES at EALING are wired, but a few of the tenants refused to use electric current, on the grounds that they could not afford to use it except on the slot-meter system, and that they could not afford to pay the deposit of £1 which was required before supply was commenced. To meet these cases the Electricity Supply Committee will allow tenants to pay the deposit by eight weekly instalments of 2s. 6d., but the Council has made a regulation rendering it compulsory for tenants to make use of electricity for lighting purposes in all dwellings in which electric wiring is installed.

Provisional arrangements have been made whereby Preston Corporation propose to take over the local electricity supply works of the National Electric Supply Company, but the arrangements are subject to the sanction of the Town Council and the shareholders of the Company. The agreement includes a payment to the company of a sum equal to the capital expenditure at the date of sale, and the taking over of the debenture and loan liabilities of the Company. The Corporation will pay 25 per cent. in cash (less the amount of the loan capital), the remaining 75 per cent. to be paid in Corporation 6 per cent. mortgage bonds, for five, ten or fifteen years. The Corporation is to pay £8,400 compensation for loss of office to the directors, and the usual statutory compensation to officials and servants.

GLASGOW Corporation have sanctioned, by 40 votes to 35, the erection of a 10,000-kw. turbo-alternator at the tramway power house. The proposal of the Tramway Committee was challenged by Mr. Denny, who wanted the matter referred to a joint sub-committee of the Tramways and Electricity Committees. The tendency was towards centralisation in the generating and supply of electricity, and he thought the tramways department should be supplied with energy by the Electricity Committee. He urged delay until full inquiry was made.

Mr. W. B. Smith gave figures to show that by the time the additional plant would be ready the Electricity Department at Dalmarnock would have sufficient spare current to meet the tramway demands.

Treasurer Kelly said the Electricity Commissioners had approved of the plant being put in. If they had thought the Electricity Department would be able very soon to link up with the tramways they probably would not have given their sanction. Pinkston was a splendidly equipped station; they had been working on a full load for a long time and the tramways could not be at the mercy of a supply that might fail. When the Electricity Department could offer power at a lower price than the Tramways Department could generate it, the day would come for having one authority.

Mr. Kennedy, convener of the Electricity Department, said it had been their misfortune that there had been a breakdown recently at Dalmarnock, but the large works which drew their power from the undertaking had not lost confidence in them. The Electricity and Tramways Committees should meet and see if they could not come to some understanding.

On the plea of urgency, as the tramways had no reserve power, the proposal to install the machinery was approved.

Electric Traction.

On account of economy, BATH City Council has authorised the Surveying Committee to purchase four 2-ton electric vehicles for refuse collection.

For the nine months ended 31st December last, there was a deficit on the BELFAST tramways of £22,007, and the Ministry of Transport is being urged to authorise an increase in fares at once.

The employés of the DUBLIN UNITED TRAMWAYS COMPANY will not press their claim for an increase of wages until a decision is arrived at in the case of the English tramwaymen, who have submitted a similar demand.

The Ilford Tramways Committee desire to introduce trolley omnibuses in the district, and a deputation from the Council is to wait upon the Ministry of Transport to lay before them a scheme for the adoption of the system of 'buses, to be eventually followed by tramways, from the terminus at Chadwell Heath through the area now being built upon, to the other tramway terminus at Barking.

On Tuesday the LONDON COUNTY COUNCIL approved an estimate of £240,000 for three additional boilers, a new 8,000 turbo-generator and other plant for the Greenwich power station, and an estimate of £160,000 for the rearrangement of the plant at the Holborn and Streatham sub-stations, including the purchase of seven 1,000 kw. rotary converters, new switchgear and h.t. cables.

It has been decided not to proceed with the electrification of the old horse tramways in Southwark Park-road, Grange-road and Rotherhithe New-road at present, owing to the heavy capital cost involved. The conversion of the lines was postponed in 1915 owing to the war, and it is impossible to carry out the work now without incurring an annual loss on their working.

After considering a report on the railless trolley cars in use at BRADFORD, the Birmingham Tramways Committee think the system eminently suitable for some of the Birmingham routes on which the traffic is not very heavy. Further investigations are being made with a view to a modification of the Bradford system, which will add to its usefulness in Birmingham. The City Council's sanction will be asked for adopting the system on a route running from the centre of the city to one of the industrial districts.

The work of reconstruction and repair of tramway tracks, which is proceeding in many parts of the city, will involve an outlay of about £70,000.

Imperial and Foreign Notes.

The UNIVERSITY OF HONG KONG has organised a scheme for commercial training, and now confers the Degree of Bachelor of Commerce. The course of study includes lectures on industry, trade and transport, and the University desires to receive from British manufacturers for exhibition purposes lantern slides and, if possible, cinematograph films illustrative of the processes used in various industries, including the textiles, clothing, leather industries, tools and machines, smelting and manufacturing of heavy iron and steel, ships, bridges and railways. Illustrated catalogues and large sized photographs of works would also be welcomed. Communications to Prof. W. J. Hinton, The University, Hong Kong. Sir Robert Hotung has made a gift of 100,000 dollars to the UNIVERSITY for the endowment of workshops for the Faculty of Engineering.

The net profit of the SIEMENS & HALSKE ELEKTRICITATS GESELLSCHAFT for the past year was 16,000,000 marks, and a dividend of 12 per cent. has been declared. The SIEMENS-SCHUCKERT COMPANY had a net profit of 12,750,000 marks, and a dividend of 10 per cent. is being paid.

At the EXHIBITION OF IMPLEMENTS AND AGRICULTURAL MACHINERY, which will be held at Reykjavik (Iceland) from July 5 to 12 next, there will be sections for electrical articles for lighting, heating, cooking and other domestic purposes, motor-driven agricultural machinery, automobiles, wiring, netting, tools, &c.

At an extraordinary general meeting of the PAULISTA RAILWAY COMPANY (BRAZIL), in December last, a resolution was passed to increase the capital of the company from 100,000 to 132,000 contos of reis by the issue of 160,000 shares of Rs.200 each, in order to meet the expenditure to be incurred in the electrification of the system.

The report of the COMPANIA HIDRO-ELECTRICA DE TUCUMAN for the year ended June, 1919, states that receipts were $322,570 (paper), compared with $324,048 in previous year, and the gross profit was $182,824 (about £15,898 at pre-war rate). Interest on debentures and charges in connection with new debentures issue amounted to $224,360, and the difference between that amount and the gross profit had to be made up by the Tucuman Tramways, Light & Power Company, Ltd.

According to the Norwegian Press, a proposition is to be put before the Storting recommending the purchase by Buskerud County from the NORWEGIAN STATE, at kr. 75,000, of the HALLI WATERFALL, for generating power. H.M. Charge d'Affaires, Christiania, in his report to the Department of Overseas Trade, states that the conditions of transfer contain a proviso to the effect that, as far as possible, the work of harnessing the fall shall be carried out by Norwegian workpeople, and that the material to be used shall be Norweigian in all cases where quality and delivery are as satisfactory as can be obtained from foreign manufacturers, and when the price is not over 10 per cent. dearer than that of the foreign material.

Institution Notes.

Lord Moulton has been elected a honorary member of the Instutition of Civil Engineers.

The tenth annual dinner of the Birmingham and District Electric Club will be held at the Grand Hotel, Colmore-row, Birmingham, on Friday, March 4, at 6.45 p.m.

At the annual meeting of the Institution of Mechanical Engineers last Friday a memorial was unveiled by the President, Capt. H. Riall Sankey, to 87 members and one member of the staff of the Institution who were killed in the war.

Commencing on Saturday, March 5, at 3 p.m., Sir Ernest Rutherford will deliver the first of a course of three lectures at the Royal Institution on "Electricity and Matter." A discourse will be delivered on March 4 by Mr. W. A. Tait on "Severn Crossings and Tidal Power."

The Manchester Wireless Society has arranged for a new meeting place at the Albion Hotel. Members will meet as usual on Wednesday nights. Some of the members made special preparations last week to pick up wireless test messages sent from America, but no appreciable result was obtained.

The annual public meeting of the University College, London, Engineering Society will take place on Friday, March 4, 1921, at 5.30 p.m., in the Botanical Theatre, University College, Gower-street, when Sir Dugald Clerk, K.B.E., F.R.S., will read a Paper on "Joule and the Mechanical Theory of Heat." Visitors are cordially invited.

The Department of Scientific and Industrial Research has approved the Research Association for the Cast Iron and Allied Industries, and as it is to be registered as a non-profit sharing company, the promoters have applied for a licence under sec. 20 of the Companies' (Consolidation) Act of 1908. The secretary of the committee is Mr. Thomas Vickers, 174, Corporation-street, Birmingham.

At a meeting of the Chelmsford Engineering Society last week a lecture on "Electric Wiring" was given by Mr. J. H Johnson, M.I.E.E. He described the different systems in commercial use and the various uses for which they could be employed. He said that the spot butt and seam welding had revolutionised many of the light-metal industries in eliminating the older methods of drilling, riveting and soldering. Samples of butt welding were exhibited. A discussion followed.

Those interested in the perennial contest of gas and electricity will be interested to learn that a discussion on the relative advantages of these two commodities for heating, lighting, power and cooking is to be held at a meeting of the National Association of Supervising Electricians at St. Bride's Institute, Bride-lane, London, E.C., on Wednesday, March 9, at 6.30 p.m., when Mr. F. W. Goodenough, the nominee of the British Commercial Gas Association, and Mr. W. A. Gillott, the nominee of the British Electrical Development Association, will lead the opposing forces.

At the Annual General Meeting of the Physical Society, held on Feb. 11, the following were elected as Officers and Council for the ensuing year:—

President: Prof. Sir W. H. Bragg, C.B.E., M.A., F.R.S. *Vice-Presidents*: C. Chree, Sc.D., LL.D., F.R.S.; Prof. H. L. Callendar, M.A., LL.D., F.R.S.; Prof. R. B. Clifton, M.A., F.R.S.; Sir Richard Glazebrook, K.C.B., D.Sc., F.R.S.; Sir Oliver J. Lodge, D.Sc., F.R.S.; Prof. C. H. Lees, D.Sc., F.R.S.; Prof. A. W. Reinold, M.A., F.R.S.; Sir Arthur Schuster, Ph.D., Sc.D., F.R.S.; Sir J. J. Thomson, O.M., D.Sc., F.R.S.; Prof. C. Vernon Boys, F.R.S. *Vice-Presidents*: Prof. W. Eccles, D.Sc.; Prof. A. S. Eddington, M.A., M.Sc., F.R.S.; The Rt. Hon. Lord Rayleigh, F.R.S.; Prof. Sir Ernest Rutherford, D.Sc., F.R.S. *Secretaries*: F. E. Smith, O.B.E., F.R.S.; D. Owen, B.A., D.Sc. *Foreign Secretary*: Sir Arthur Schuster, Ph.D., Sc.D., F.R.S. *Treasurer*: W. R. Cooper, M.A., B.Sc. *Librarian*: Prof. A. O. Rankine, D.Sc. *Other Members of Council*: G. B. Bryan, D.Sc.; C. R. Darling, F.I.C.; Prof. C. L. Fortescue, O.B.E.; E. Griffiths, D.Sc.; F. L. Hopwood, D.Sc.; E. H. Rayner, M.A., D.Sc.; A. Russell, M.A., D.Sc.; T. Smith, B.A.; J. H. Vincent, D.Sc., M.A.; Prof. W. B. Morton, M.A.

Liquidations and Bankruptcies.

Claims against Bernard Edmond Thomas, electrical engineer, 12, Castle Meadow, Norwich, must be sent by March 2 to Mr. H. P. Gould, 8, Upper King-street, Norwich.

The Leeds Alliance Electrical Mfg. Company, Ltd., is being wound up voluntarily, and Mr. S. S. Tadman, 1, Albion-street, Leeds, has been appointed liquidator. Claims to Mr. Tadman by March 16.

The first meeting of creditors of Albert Lord, electrical contractor, 33, Westgate, Burnley, will take place on Feb. 25 at 13, Winckley-street, Preston, and the public examination on March 10 at the County Court House, Bankhouse-street, Burnley.

John and John Richard Jones, trading as J. Jones & Son, electrical engineers, 7, Chapel-street, Penzance, have been adjudicated bankrupt. The first meeting of creditors will take place on March 4, at 12, Prince's-street, Truro, and the public examination on March 15, at the Town Hall, Truro.

A first and final dividend of 4s. 8¾d. is payable at the Official Receiver's Office, 26, Baldwin-street, Bristol, to creditors of Albert Edward Channon, Humphrey Stanton Nadin and Cyril Geo. Channon, trading as A. E. Channon & Company, electrical engineers, 8, Orrisdale-terrace, and 425, High-street, Cheltenham, and a first and final dividend of 20s. is payable at the same place in respect of the separate estate of Albert Edward Channon.

Miscellaneous.

We are asked to say that the Callender-Benson Yardometer described in our article on the Physical and Optical Societies' Exhibition is made by Mr. H. W. Sullivan from whom all particulars can be obtained.

The Athletic and Recreation Club of Messrs. J. H. Tucker Company, Ltd., held their annual fancy dress dance on Feb. 12, about 120 members of the works being present. Prizes were given for the best fancy costumes, which were of an extremely original and tasteful character.

Messrs. Benn Brothers, Ltd., have a very complete and interesting exhibit of their publications at the British Industries Fair, at Shepherd's Bush, which opened on Monday, February 21. We hope to deal with such other exhibits as are of electrical interest at this Fair in a later issue of The Electrician.

The Strike of 22 Electricians engaged on the new London County Hall, which arose out of the employment of a foreman who was not a member of the E.T.U. (though he belonged to the Foreman's and Supervisors' Union), has been settled by the foreman joining the union.

The annual dinner of No. 5 Company, London Electrical Engineers, will be held on March 9. The secretary, Mr. G. Pressey, 3, Rugby-road, Bedford Park, London, W. 4, is still without the addresses of a number of members of the company, and it is therefore hoped that everyone who has not received a notice of the dinner will communicate with him without delay in order that the function may be a success.

At Bedford on the 10th inst. the members of the Igranic Electric Company and their friends held a Fancy Dress Carnival at the Café Dansant, Bedford, when a most enjoyable evening was spent by about 350, fully two-thirds of whom were in fancy costumes. After supper there was a grand parade which was spectacular in the extreme. The judges experienced difficulty in making their choice for the six prizes, but their selection met with vociferous approbation. Dancing continued into the small hours and concluded what was generally agreed to be the most successful function of the season.

Last week the Postmaster-General issued a White Paper as a Further Defence of the New Telephone Rates. It is to a great extent a repetition of statements in the reports of the Departmental Committee and of the Select Committee on Telephone Charges, together with Mr. Illingworth's replies to deputations which have protested against the new scale, &c. It is denied that no balance-sheet of the telephone service has ever been made public, as annual accounts on a strictly commercial basis have been published regularly since the National Company's system was taken over. As much of the criticism of the rates is based on the percentage increase to large users, two new tables are given to show the incidence of the new charges. In the first, London subscribers have been grouped according to their calling rate, and the table shows the present and proposed charges at the mean of each group, together with the percentage of the total number of London subscribers falling within each group. For purposes of comparison, the rate which it is proposed to charge in New York has been added.

Obituary.

We regret to record the death of Mr. R. Rankin, managing director of Messrs. Van Raden & Company, which occurred on Thursday, Feb. 17. The announcement will not come altogether as a surprise to his many friends, as Mr. Rankin had been in failing health for some time. Before joining Messrs. Van Raden & Company he was engaged for many years as works manager to the Electrical Power Storage Company, and had made many contributions to the literature of secondary battery practice. He was the first chairman of the Informal Meetings Committee of the Institution of Electrical Engineers, and his work both in committee and at the meetings did much to make these gatherings a success.

We also regret to record the death of Mr. James H. Carson, late manager of the Anglo-American Telegraph Company, which occurred on Saturday at his residence in Upper Westbourne-terrace, London, in his 81st year. Mr. Carson was connected with telegraphy practically all his life. He was born at Stafford, and in 1852 he entered the service of the Electric and International Telegraph Company, but in 1865 he joined the newly formed Atlantic Telegraph Company, which subsequently became the Anglo-American Telegraph Company. He served this Company in many capacities, and in 1893 he became its general manager. From his first association with telegraphy he was interested in long-distance communication, and was on board the "Great Eastern" when she laid a submarine cable from Valentia (Ireland) to Heart's Content (Newfoundland) in 1866. Mr. Carson's forte was the rapid handling and transmission of messages, his experience being that, given a quick and reliable service, the public is ready, and by competition even compelled, to use the telegraphs freely. His Stock Exchange service of one minute between London and New York was one of the marvels of the day, and frequently as many as 2,500 messages of this class were passed over the Anglo Company's cables between those points in the course of an afternoon. In the negotiations which led to the merging of the Anglo Company with the Western Union Company's interests he took a prominent part, and he only retired from active work a few years before the war. Under his direction the Anglo Company's service reached the pitch of efficiency that made possible the system of "arbitrage" transactions, dependent entirely on very rapid transmission, by which financiers are enabled to buy on one side of the Atlantic and sell again on the other within a few moments.

Business Items, &c.

We learn that Mr. A. Flinders Caine, A.M.I.E.E., M.I.H.V.E., has resigned his position as manager of the heating and cooking department of the Edison Swan Electric Company, of Ponders End.

Messrs. H. W. Smith & Company (1920), Ltd., have engaged Mr. S. H. Hammett, who was for a number of years with Messrs. Baxendale & Company, Manchester, as their representative in Lancashire.

Messrs. Scholey & Company, Ltd., 56, Victoria-street, Westminster, announce that from 21st inst. their head office will be transferred to their works. After that date their address will be Victory Works, Gloucester-road, Croydon. Telephone: Croydon 2164.

Mr. Leonard Harvey, 25, Victoria-street, Westminster, S.W.1, who has during the past few years made a special study of pulverised coal applications and uses, and has been representing an American firm as European manager, informs us that he is relinquishing this position and proposes to carry out his original intention of practising as a consulting engineer upon matters pertaining to pulverised coal and colloidal oil, at the address mentioned.

The Ironsides Company, of Columbus, Ohio, U.S.A., has established an agency in this country for the sale of the "Ironside" roll neck and gear shield greases, which are now said to be used by practically all the leading rolling mills in the United States. The gear shield is used for heavy gearing and pinions, such as are used on electric railways, tramways, coal mines and docks, lifts, chains, &c. Users of the Ironsides lubricants are reported to have testified to a saving of over 50 per cent. in wear and tear of rolls and brasses, and also great economy in use owing to the absence of waste. Further particulars may be obtained from Mr. John Hanlon, 61A, Bold-street, Liverpool, who has been appointed sole European agent for all the Ironside specialities.

Messrs. Todman, Ryall & Company, Ltd., 38, Grosvenor-gardens, Westminster, S.W.1, announce that in response to numerous requests by customers, they have designed a suitable terminal connection box for their well-known "L.W." dynamos and motors. The box can be fitted either on the top, side or bottom of machine, according to requirements. They hope to be in a position to supply any machine from stock fitted with this arrangement within the next two or three weeks. In the firm's new catalogue an illustrated description is given, showing the compactness and accessibility of the design of the machines, together with the horse-power, speeds, &c., at various voltages. A copy will be sent on request. The firm have also issued their stock lists of dynamos and motors.

When the Twiss Electric Transmission, Ltd., commenced business the promoters of the company anticipated that they would be received, perhaps somewhat sceptically at first. Instead of slow though steady progress they have, however, been overwhelmed with business. Despite the straining of every nerve and the enthusiasm of a loyal and hard-working staff, the company state that they have been unable to keep pace with orders, and business has come in quicker than they could make patterns and tools, enlarge and adjust their organisation, buy and install machinery. Their chief, and perhaps the paramount, difficulty has been to obtain increasing supplies of raw material in disorganised markets and consequently there has been delay in making deliveries to customers. The company, however, now report that most of the difficulties, which have caused the delay, have been surmounted; they have practically caught up with orders, and they promise not only soundness in engineering and quality of manufacture, but also dependability in regard to time of delivery of their specialities. The company's address is 62 and 63, Queen-street, London, E.C. 4, and they specialise in the manufacture of line and h.t. material, and they undertake contracts for the erection of all transmission and distribution lines, &c.

Catalogues, Price Lists, &c.

The Edison Swan Electric Company, Ltd., have issued a leaflet on the Sangamo A.C. and D.C. Watt-hour Meters supplied by them.

In Folder No. 2449 the General Electric Company, Ltd., give a description, with illustrations and prices, of their L.2440 "Sonorous" high-voltage electric trembling bell and high-voltage "Link" pushes for use in connection with the bell.

A leaflet recently issued by the Hart Accumulator Company, Ltd., Stratford, E.15, relates to their "GSL" type batteries for motor car starting and lighting. These are similar in design and general characteristics to their well-known "MSL" type batteries, but are intended for use where increased capacity is required, without a corresponding increase in the floor space occupied.

The Edison Swan Electrical Company have also issued a pamphlet on their E.O. type of enclosed oil switches. There is a general specification of the design and construction of these switches, which are specially adapted for motor circuits. There are some good illustrations, with dimension diagrams, weights and other particulars of some of the standard types, but switches can be supplied for any particular current or for any special purpose.

The design and construction of the Peebles-La Cour Motor converter are well known to most of our readers, and the makers, Messrs. Bruce Peebles & Company, Ltd. of Edinburgh, have recently issued a French edition of their motor converter pamphlet for circulation in France and French-speaking countries and colonies. The pamphlet, which is admirably printed and well illustrated, should do much to make our gallant Allies acquainted with the merits and advantages of the converter.

Tenders Invited.

Stockton-on-Tees Electricity Committee require tenders for six months' supply of stores. Forms of tender, from the Electrical Engineer.

Tenders are required by March 15 for the supply and erection of six electric cranes and coal-handling plant at the Port of Boulogne.

Tenders are invited (by March 31) for the construction of port works at Paysandu (Uruguay), including electric handling and lifting apparatus.

Croydon Corporation want tenders by March 7 for two natural draught cooling towers. Specifications from Borough Electrical Engineer.

Tenders are wanted by March 1 for additional electric fittings for the County Sanatorium, Almeley, Herts. Specification can be seen at the office of the County Surveyor, High Town, Hereford.

The Commissioners of H.M. Works, &c., invite tenders by March 2 for the supply of electric lamps for six or 12 months. Forms of tender from the Controller of Supplies, King Charles-street, S.W. 1.

Bermondsey (London) Guardians require tenders by March 3 for six months' supply of stores, including electric lamps (item 71). Forms of tender from the Clerk, 283, Tooley-street, S.E.1.

Aberdare Urban Council require tenders by March 4 for supply of cable, meters, joint boxes, electric lamps, &c., for one year. Specifications, from the General Manager of the Electricity Department.

Tenders are required by March 14 for six months supply of electrical goods to the Cheshire County Asylum, Parkside, Macclesfield. Forms and tender, &c., from the Clerk.

The Education Authority for Dumfriesshire requires tenders by March 2 for electrical installations work at the Woodbank Hostel, Dumfries. Forms and tender, &c., from Mr. W. Arnott, 163, Hope-street, Glasgow.

Manchester Corporation require tenders by April 4 for 33,000 and 6,600 volt switchgear, induction regulators, &c. Specifications from F. E. Hughes, Town Hall, Manchester.

Aylesbury Corporation require tenders by March 11 for one year's supply of stores, including electric lamps, ironwork, &c. Specifications from the Borough Engineer.

Chatham Town Council want tenders by March 10 for six (or 12) months' supply of incandescent lamps, &c. Specifications from the Borough Surveyor.

Leeds Education Department requires tenders by March 8 for electrical work for 12 months in buildings under its control. Specifications from the architect, Calverley-street, Leeds.

Ballinrobe Electricity Supply Company, Ltd., requires tenders by March 15 for the erection of poles and overhead lines. Specifications from Messrs. J. P. Tierney & Co., 44, Kildare-street, Dublin.

The Deputy Postmaster-General, Melbourne, will receive tenders until April 19, for the supply of telephone switchboards (schedule 1,670) for the Australian Commonwealth Postmaster-General's department. Specifications may be seen at the Department of Overseas Trade.

New Zealand Public Works Department invite tenders (March 10) for sub-station equipment for Hamilton, including switchboard panels, instrument transformers, oil switches, &c. Specifications at Department of Overseas Trade, 35, Old Queen-street, S.W.1.

Rotterdam Municipal Council invite tenders for an electric revolving crane for the waterworks, capable of 5,500 lbs. The crane must be provided with a grab for unloading coal, and also a grab for unloading gravel. Particulars from Mr. A. van Delden, the Acting Manager of the Rotterdam Municipal Waterworks, Rotterdam.

Tenders are invited up to March 21 for the supply and delivery to the Postmaster-General's Dept., State of New South Wales, of telephone and telegraph apparatus, testing instruments and switchgear parts (Schedule 814); up to March 29 for the supply to the Postmaster-General's Dept., State of Western Australia, of telegraph materials (Schedule 333), and to April 5 for the supply and erection of accumulators, &c., at the Telegraphic Office, Eucla (Schedule W. A., 647), and up to March 30 for supply of switchboard apparatus and parts (Schedule 515), to the Postmaster-General's Dept., State of Queensland. Forms from High Commissioner for Australia, 406, Australia House, Strand, W.C.2.

Tenders are invited in connection with the electrification of the Cape Town–Simonstown and Durban–Pietermaritzburg Railways, for the supply of turbo-alternators, boilers, condensing plant, passenger and freight locomotives, motor coaches and underframes, motor bogies, electrical equipment of coaches, sub-station equipment and transformers. Specifications and forms of tender from the High Commissioner for the Union of South Africa, 32, Victoria-street, London, S.W., or the General Manager, Johannesburg. Further technical information can be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1. Tenders to the High Commissioner by May 3.

The Electricity Commissioners of Victoria (Australia) invite tenders for the supply of plant and material required for the Morwell Power Scheme, including 25,000–12,500 kw. turbo-alternators, 600 kw. turbo-alternators, transformers, switchgear, cables, transmission steel towers, steel telephone poles, &c.; also for telephone wire (specification 45) and pin type insulators (46). Tender forms and specifications can be obtained from the Agent-General for Victoria, Victoria House, Melbourne place, Strand, London, W.C.2, and drawings can be seen at the offices of Messrs. John Coates & Company, Ltd., consulting engineers, at the same address. Tenders by noon, March 31, to Mr. R. Liddelow, secretary, Electricity Commissioners, 673, Bourke-street West, Melbourne.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

139,461 [illegible] apparatus (24/2/1[illegible])
142,115 Western Electric Co., Ltd. Electric wave filters. (15/7/15.)
[illegible] line of negligible attenuation comprising a plurality of sections each of which contains lumped impedance in series with the line and lumped impedances in shunt across the line, said series and shunt impedances having values dependent upon the upper limiting frequency and the lower limiting frequency of a range of frequencies it is desired to transmit without attenuation, such values being so proportioned that the structure transmits with practically negligible attenuation, sinusoidal currents of all frequencies lying between said two limiting frequencies, while attenuating and approximately extinguishing currents of neighbouring frequencies lying outside of said limiting frequencies.
144,710 Elektro-Osmose Akt.-Ges. (Graf. Schwerin Ges.). Electro osmotic separation of substances. ([illegible] 4 18.)
147,546 Krupp Akt.-Ges Grusonwerk. Magnetic separators. (11/7/19.)
150,297 Teppati. Electrical illuminating apparatus for cinematographic projecting apparatus and the like. (27/8/19.)
155,345 British Thomson-Houston Co. (General Electric Co.) X-ray apparatus ([illegible] 19.)
155,346 Harman & Le Bas. Dynamo-electric machines. (10/9/19.)
155,392 Smith & Sons & Dorer. Electric lamp for motor and other vehicles. (25/9/19.)
155,402 Suckling. Electric hand lamps. (6/10/19.)
155,407 Vincent. Locking-device for electrical switches. (10/10/19.)
155,409 Marks. (Vlug.) Apparatus with variable self inductance. (10/10/19.)
155,414 Roe. Electric contact maker for railways. (14/10/19.)
155,434 Mansell. Regulating-switches of the multiple-contact type. (11/11/19.)
155,449 O'Neil. Junction or connection boxes for electric conductors. (10/12/19.)
155,457 Levin. Electrolytic apparatus. (31/12/19.)
155,476 Tagliaferri. Electric furnaces. (2/2/20.)
155,480 Routin. Electrical apparatus for indicating and repeating movements at a distance. (3/1/20.) (Addition to 131,635.)
155,484 Waygood-Otis, Ltd. (Soc. Anon Ateliers Otis-Pifre.) Driving and transmission mechanism for electrically operated lifts, swing bridges, and other heavy machinery. (19/2/20.) (Patent of Addition not granted.)
155,499 Rutherford. Carrier or means for supporting electric-lamp or other shades, reflectors and the like. (6/4/20.)
155,504 Hall. Time-controlled electric circuit controllers. (3/5/20.)
155,509 Donovan. Electric starting and regulating switches. (27/5/20.)
155,516 Roe. Metal brushes for use in connection with electric switches for controlling train movements. (21/6/20.)
155,517 Roe. Train stopping apparatus controlled by track signals and tokens. (21/6/20.)
155,524 Graaff. Fire-extinguishing process and device for burning transformers and similar apparatus. (31/12/19.)
156,280 Holslag. Electric arc welding and like operations and electrodes therefor (30/6/19.)
156,301 Crompton & Co., Ltd. & Jones. Electric switches. (19/9/19.)
156,303 Austin Motor Co., Ltd. & Walker. Electric generating plants. (24/9/19.)
156,304 Powell. Minimum electric current indicators. (24/9/19.)
156,330 Bolitho. Amplifying device for use in wireless telegraphy and telephony. (6/10/19.)
An amplifying arrangement wherein a reversed reactance coil in the circuit of a quenching valve, which is supplied with high tension current generally of relatively low frequency, reacts with a coil in the oscillation circuit of the "trigged" amplifying valve, and quenches the oscillations as rapidly as is required according to the frequency of the oscillations applied to the quenching value terminals.
156,339 Halden & Co., Ltd. & Halden. Electric photographic printing or copying machines. (10/10/19.)
156,343 Gowan, Miller & Metropolitan-Vickers Electrical Co., Ltd. Control of electric motors driving planers and the like. (14/10/19.)
156,344 Johnson. Terminal caps for electric conduits. (14/10/19.)
156,346 B. T.-H. Co., Ltd. (G.E.Co.). Electric motor controllers. (15/10/19.)
156,353 Automatic Telephone Mftg. Co., Ltd. & Smith. Electro-magnetic mechanisms applicable to telegraphic and like purposes. (18/10/19.)
156,354 Pritchard & Mangles. Telephone transmitters. (20/10/19.)
156,363 B. T.-H. Co., Ltd. (G.E.Co.). Starting devices for electric motors. (28/10/19.)
156,372 Gehrig. Automatic electric regulator. (7/11/19.)
156,398 Mossay, Mossay & Co., Ltd. & Ransomes, Sims & Jefferies, Ltd. Electrically-propelled road vehicles. (12/12/19.)
156,403 Kearton & Riley. Telephones (19/12/19.)

APPLICATIONS FOR PATENTS.

July 14, 1920.

21,231 Lawrence. Trollies for overhead tramways.
21,256 de Forest. Radio-signalling systems. (10/5/15, U.S.)
21,271 British Electric Transformer Co. & Roothaan. Transformers.
21,304 B. T.-H. Co. & Whitaker. Electric machines.

July 15, 1920.

21,330 Willis. Earthing clips for cables, &c.
21,336 Campbell & Tattersall. Means for electrically reciprocating hammers, pistons, &c.
21,340 Waite. Fuse holders.
21,341 Walters. Electrically-driven vehicles.
21,354 Taylor. Wireless telephone transmitters.
21,381 Ducousso. Driving electro mechanism for operating rail track apparatus.
21,382 Marconi's Wireless Telegraph Co. Reception of wireless signals. (28/7/19, U.S.)
21,383 Marconi's Wireless Telegraph Co. Variable controlling elements for wireless telegraphy, &c. (31/7/19, U.S.)
21,389 Akt. Ges. Brown, Boveri et Cie. Induction regulators cooled by forced draught. (15/7/19, Switzerland.)

July 16, 1920.

21,420 Barlow. Electric machinery.
21,460 Gill. Wireless directional transmission and reception apparatus.
21,461 Carter. Electrical and mechanical locks for lift gates.
21,481 Siemens Schuckertwerke. Arc welding apparatus. (19/8/19, Germany.)
21,490 B. T.-H. Co. (G. E. Co.) Arc welding.
21,492 Beeton. Apparatus for converting heat into electrical energy.
21,505 Della Veneria. Apparatus for breaking, commutation, inversion and deviation of an electric current.
21,507 Stone & Honey. Electric machines.

July 17, 1920.

21,511 Stott. Electrically-driven trucks.
21,537 Radio Communication Co., Scott-Taggart & Turner. Trigger relays for radio communication.
21,538 Radio Communication Co. & Scott Taggart. Modulation systems in radio communications, &c.
21,585 Trost. Wireless telegraphy. (—/7/19, Denmark.)

Companies' Reports, &c.

LONDON ELECTRIC SUPPLY CORPORATION.

Mr. Robert H. Benson, who presided over the annual meeting of the London Electric Supply Corporation, Ltd., on Monday, delivered an important speech and referred to the pioneering work done by the Company and to the position created by the Electricity Supply Act, &c. The gross revenue last year was £372,230, against £305,107 in 1919, and there was an increase in net revenue of £1,240. Dealing with the history of the Company, he said it did not turn the corner till 1904, when they made the supply of power their principal business, and in 1914 they at last saw the road clear. Their costs of production were the lowest in London (a halfpenny per unit); they paid 4 per cent. dividend on the ordinary shares, and set aside £29,000 for reserves, and they fondly foresaw dividends large enough to establish their credit and to finance the public demand for more power. That maintenance of the credit of producers was a condition of efficient service to the public which was generally overlooked by consumers, and sometimes also by legislators. The war completely altered the position. Sea-borne coal was cut off and rail-borne took its place, bad in quality and high in price. The cost of labour was also up 260 per cent., and production was nearly three times pre-war cost. During the past year they had built up a fine business, and now it was possible to look forward to a supply of coal both better and cheaper.

He thought they were on the road to surmount the losses of the war, and that there was a fair chance of resuming from the point where they left off at the end of 1914, subject only to a final settlement by Parliament of the future of the industry and the restoration of its credit on the basis contemplated in Clauses 1 and 13 of the latest Electricity Supply (No. 2) Bill. In these clauses one might discern the first sign of recognition on the part of the legislative mind of the rock upon which their electrical industry had come near to splitting—namely, inability to borrow money for capital purposes. It was no small problem to find the money needed for the plant to meet the ever-increasing demand for power. In fact, the financing of incorporated industry, coupled with willingness to work like a nigger, was the great national problem. The distribution of output was as important as its production, and was an even more delicate problem, but finance was the life-blood of both. Referring to diagrams showing where every 20s. paid by the consumer went, he said that the ordinary shareholders got the last 4d. out of every 20s. paid by the consumer.

Their own capital account was overdrawn by £182,045, and they were borrowing £35,000 from their bankers. They must have more plant wherewith to produce more power to meet the natural increase in next winter's load.

Every progressive industry needed every year more capital than its annual net revenue. He knew one that required 10 times as much. Others required five times as much, others less; the most progressive required the most money. If they did not get it the public service suffered.

Last year he showed how the march of events and the approach of 1931 (when they were confronted with an option of purchase on something like a scrap basis) paralysed their ability to raise sufficient money to keep up with the demand for power. He believed that it had at last dawned on the legislative mind that it was a mistake to keep an industry poor in order to buy it up cheap. In order to do their utmost to work under the conditions prescribed by the Act of 1919, the company had allied itself with eight other companies, and they were in consultation with the London County Council and local authorities as to how to obey the Act and put forward a scheme for the general supply of London. Within the limits of the Act they might rest assured that the interests of the shareholders were being jealously guarded by the directors. An engineering scheme was being prepared by four engineers (of whom their managing director and chief engineer was one), representing the supply companies, the local authorities, and the London County Council. It would therefore seem probable that, as all three bodies were working together, a harmonious scheme, so far as engineering was concerned, would be put before the Electricity Commissioners. Beside the engineering scheme for the whole of the area of Greater London, the difficult question of administration by a "joint electricity authority" was having the careful consideration of the directors, along with those of other supply companies. As to the new Bill, he said it seemed to be realised at last that in order to borrow, producers must be enabled to repay; and that the difference between works cost (or the cost of bulk supply) and the price paid by the purchaser must be made sufficient, over a period of years, to establish the credit of the producer so that he could finance his capital requirements. As regards a company, the condition of such credit and ability to finance was nowadays 10 per cent. dividends on a large ordinary stock with a small superstructure of fixed charges. Otherwise the alternative was for the Government to buy us out at a fair price and find all the money itself for the future. Referring to the diagrams prepared by the Company, he said that for the year 1919 Labour (brains and hands), along with raw materials (mainly Labour), took 11s. 11d. out of every 20s. paid by the consumer; in 1920 Labour took 12s. 8d. Depreciation, reserves, and interest on borrowed money took 3s. 6d in 1919, against 3s. 1½d. in 1920. Capital in 1919 got 1s. 7½d., and this year 1s. 4d., of which 1s. went to pay the fixed preference share dividend, and the ordinary shareholders get the odd 4d., which gave a 2½ per cent. dividend or the same rate as last year. The State's share for taxation in 1920 was 2s 10½d. out of every 20s., against 2s. 11½d. for 1919, *i.e.*, the State was taking 2s. 10½d. per 20s. out of £372,000, instead of 2s. 11½d. out of £305,000. The diagram was ocular proof of the solvency of this country, and the only chance for Labour as well as for the State was, firstly, increased output and no ca'canny; secondly, distribution as perfect as the experimental genius of the race could make it; and, finally, economy, both public and private, along with the best possible banking system to manage the biggest market in the world—namely, the money market.

LONDON ELECTRIC RAILWAYS.

Lord Ashfield presided over the annual meetings of the four railway companies which form the London Underground group on Thursday last. At the Metropolitan District Railway meeting he said that the companies had, in the opinion of those who had studied the matter, gone a long way towards placing their revenue upon a satisfactory and stable footing, and there was not any cause in sight which would demand another general revision of the present level of fares. They thought the immediate future of the companies was reasonably assured if the cost of operation and maintenance now receded—and there were indications of that—and the growing trade depression did not prevent the natural growth of traffic which they were entitled to expect.

Having drawn attention to the manner in which the transport facilities at the disposal of the public had been augmented during the year, the Chairman said that the serious problem ahead with regard to London traffic was that of development. Among other contemplated works for which Parliamentary powers already existed was the Edgware and Hampstead line, extending from Golders Green through Hendon. That ought to be constructed at once, and, if constructed, ought to find a large and remunerative traffic. The difficulty that stood in the way was money. The labours of 1920 had been directed to the placing of the companies as they were now constituted on a stable foundation, and if this foundation had been securely laid, he hoped they could acquire the further capital which would enable them to build upon it a system of transport facilities worthy of the record of their companies' endeavours in the past and worthy of that vast metropolis. He referred to the possibility of agreement being reached in the conflict of interests between those now engaged in London transport. The most hopeful sign of all had been the action of the London County Council in approaching the Ministry of Transport with a view to direct negotiations between representatives of the Council and of the companies taking place under the auspices of the Ministry. The directors felt it their duty to take part in these negotiations, which were now proceeding.

Presiding over the Central London Railway Company's meeting, Lord Ashfield said that the Company had been more advantaged by the increase of fares than the other deep-level tubes. It enjoyed a unique position in proceeding east and west across London by the shortest and most direct route. That gave it an advantage over the other east and west routes, which traversed a longer distance to complete the journey. The railway showed for the year an increase in passengers of 4 per cent., while the other deep-level tubes showed a decline. That increase was partly due to the opening in August of the extension to Ealing, from Shepherd's Bush, over a line provided by the Great Western Railway. The traffic on that line was very disappointing, but was slowly growing, the chief obstacle being the fares charged, which were on a main-line railway basis and not upon the revised basis established for local London traffic. The opening of the extension had, however, supplied a feeder to the Central London Railway and contributed to the number of passengers carried. The length of the extension was 4¼ miles, and only two stations were open, one at Acton and one at Ealing. The Great Western Railway were taking steps to provide two additional stations, one at Old Oak Common and one at Twyford. When those were open the traffic should materially increase. The directors would raise the capital necessary for connecting up the L. & S. W. Railway near Shepherd's Bush to give through running to Richmond as soon as possible.

At the meeting of the London Electric Railway Company, Lord Ashfield said that the results of the increase in fares were fairly satisfactory. He might safely say the worst was now past and they might look forward to an improvement in the coming year. Expenditure on capital account last year (£88,404) was chiefly attributable to the acquisition of joint rolling stock for the working of the extension to Watford over the L. & N. W. Railway, of which their company paid one-third. The rolling stock statement showed an increase of 17 in the number of cars owned, in fact, 18 of the 22 cars borrowed from the Central London Railway during the war for the opening of the extension service had been returned, and in addition 30 other cars used for it had been released for other work. The company increased its car mileage worked by 2,637,267 car miles, a substantial contribution towards the relief of congestion. The capital commitments amounted to £182,500, mainly representing the acquisition of 40 new trailer cars to increase the length of train worked on the Bakerloo section from five to six cars and the equipment of the lifts with landing control.

At the meeting of the City & South London Railway Company, the chairman gave a comparison of the results of the increase in fares in the last three months of 1920 with the results for the first three months. The receipts from passengers increased by 30 per cent., but there was a loss of 14 per cent. in the number of passengers carried. That was due to the fact that the railway was paralleled for the greater part of its length by tramways, upon which a cheap midday fare of 2d. any distance was in force. Until the railway was made more attractive by the reconstruction of its tunnels and the provision of new and standard rolling stock, it was not possible to look for much success. The serious obstacles in the way of raising the £1,750,000 wanted for the improvement and renovation of the line had prevented their taking any active steps to that end, but they hoped to proceed with the necessary improvement as soon as conditions permitted.

The directors of the Telegraph Construction and Maintenance Company, Ltd., recommend a further dividend of 7½ per cent.

The recent issue of preference shares by the Melbourne Electric Supply Company, Ltd., were over-subscribed, and letters of allotment and regret have been posted.

The directors of the Clyde Valley Electrical Power Company recommend a final dividend on the ordinary shares at rate of 10 per cent. per annum, making 7½ per cent. for the year 1920, compared with 5 per cent. for previous year.

The directors of the Bournemouth and Poole Electricity Supply Company, Ltd., have declared a final dividend on the ordinary shares at the rate of 7 per cent. per annum (less tax) for the half-year ended Dec. 31, making 6 per cent. for 1920, as in the previous year.

The directors of the Kensington and Knightsbridge Electric Light Company, Ltd., have recommended a dividend of 5 per cent. on the ordinary shares for the half year ended Dec. 31, making, with the interim dividend paid in August last, 9 per cent. for 1920.

At an extraordinary general meeting of the Edison Swan Electric Company last week, the resolution passed on the 17th ult., empowering the company in general meeting from time to time to increase the capital by the creation of new shares of such amount as might be deemed expedient, was unanimously confirmed as a special resolution.

The directors of the Chelsea Electricity Supply Company, Ltd., recommend a dividend of 7 per cent. per annum on the ordinary shares for the past half-year, making 6 per cent. for 1920. A sum of £17,312 is applied to depreciation, £2,178 written off cost of extinction of founders shares and £2,925 written off investments, leaving about £2,429 to carry forward.

The directors of the Charing Cross, West End and City Electricity Supply Company, Ltd., recommend a dividend on the ordinary share capital of the West End undertakings for the half year ended 31st Dec., 1920, at the rate of 5s. 6d. per share, making, with the interim dividend already distributed, 8 per cent. for the year 1920.

The directors of the County of London Electric Supply Company, Ltd., have declared a final dividend on the ordinary shares at the rate of 11 per cent. per annum (less tax) for the half-year ended Dec. 31, making 8 per cent. for the year, as in 1919. The sum of £50,000 is placed to reserve for depreciation, £62,500 to general reserve and £18,500 carried forward.

At the meeting of the Lancashire & Yorkshire Railway Company last week, the chairman (Mr. E. Fielden) referred to the subject of the electrification of the Oldham and Royton branch line, and said the directors were quite satisfied that it would be good business to electrify the line. Like many other things, it was a question of finding the money, and at present they could not do it. They were agreed that it would be a paying proposition.

Last week Mr. Justice Astbury confirmed an alteration of the objects of the British Electrical Federation. Mr. N. Green said the company did not carry on business at a profit. Its sole business was protecting and assisting its members, who comprised a large number of electrical firms, and it would be found desirable that the company should act as trustee in respect of matters such as superannuation, pensions and debenture issues of its members.

At the meeting of the Northampton Electric Light & Power Company, Ltd., on Wednesday, it was reported that the receipts for 1920 were £103,738, and after paying expenses, &c., the balance available (including £1,109 brought in, interest, &c.) is £23,418. Units sold increased from 6,589,108 to 7,646,577. £12,360 has been added to depreciation fund, out of which £1,360 has been allocated to motors, £500 has been placed to battery suspense fund. The directors propose a final dividend on the ordinary shares at the rate of 5½ per cent., making 8 per cent., carrying forward £1,500.

At a meeting of the Rushden and District Electric Supply Company, Ltd., on Wednesday, it was reported that the number of consumers (chiefly for lighting) had risen from 223 to 308 during 1920, but owing to the depression in trade during the last six months the output of electricity had remained stationary. Lighting and heating connections had increased by the equivalent of 2,035 32-watt lamps, making a total of 7,352, and motors had increased from 685 h.p. to 761 h.p., of which 319½ h.p. were let out on hire. The maximum load on the plant was 365 kw., and the number of units sold was 584,220. A final dividend of 4 per cent. making, with the interim dividend already paid 6½ per cent. for the year, was declared and £316 carried forward.

The directors of the City of London Electric Lighting Company, Ltd., recommend payment of the following dividends: On the preference shares, 6 per cent., being 1s. 2·4d. per share, and on the ordinary shares, 12 per cent. (2s. 4·8d. per £1 share). On account of these dividends 7·2d. per preference share and 9d. per ordinary share was paid in September, and the balance remains to be paid. In addition to the foregoing dividends the directors recommend payment of a bonus of 2 per cent. per ordinary share on account of the reduction of dividend for the year 1916, leaving the reductions in 1917 and 1918 to be dealt with in the future. After payment of the dividends and bonus, less tax, and providing for other appropriations, there will remain about £23,000 to be carried forward.

At the meeting of the London, Brighton & South Coast Railway Company last week the speech of the chairman (Mr. Macrae) was mainly devoted to the future control of railways, the high wages paid to railway servants, the effects of the higher fares and freight charges, &c. He said they were very anxious to get on with their scheme for the electrical equipment of the suburban railways, and the Government had been approached with a view to authority being given for the work to proceed, but they had not succeeded in carrying the matter much farther. That was to be regretted, as in their opinion the extension of electrical working could not fail to have a very beneficial effect upon the company's business.

The gross profit of the Smithfield Markets Electric Supply Company, Ltd., for the year 1920 amounts to £9,262, compared with £6,588 in 1919, and the net profit to £8,719, against £5,464. A sum of £3,500 has been placed to depreciation fund and £800 to debenture stock redemption fund. After adding the balance from 1919, there remains £5,748. The directors propose to pay a dividend at the rate of 5 per cent. per annum on the ordinary shares (£3,000), to place £2,000 to reserve and to carry forward £748. The removal of official control of the Markets in July last re-established normal conditions during the second half of the year, resulting in a satisfactory increase in output.

The report of Messrs. Allen Liversidge, Ltd., for the year ended Oct. 31 last states that during that month the capital was increased from £100,000 to £300,000, and the company purchased, for £93,720, the whole of the shares of the Dissolved Acetylene Company, and of Imperial Light, Ltd. The net profit is £35,469, making, with the balances brought in, £43,064. After providing for excess profits duty, the balance of amalgamation issue expenses, and reserve, a further dividend at the rate of 15 per cent. per annum (making 12½ per cent. for the year) is recommended on shares numbered 1 to 100,000, and at rate of 12½ per cent. per annum for six months to Oct. 31 last on shares numbered 100,001 to 193,720. In addition to the amalgamation, the company purchased the Hammersmith factory, plant and goodwill of Messrs. W. A. S. Benson & Company, manufacturers of electric, gas and oil fittings and tableware. Since the close of the financial year the great progress of the company has been maintained, and the business is rapidly expanding. The report and accounts were adopted at the meeting last week.

Lord Aberconway, who presided over the annual meeting of the Metropolitan Railway Company on Friday, said that the directors had increased their fares, in common with all companies outside the London area, in August last, and a considerable increase in revenue had resulted. A new scale of fares for short distance traffic in London came into force on Sept. 26. Up to the present they were quite satisfied with the result; there had been a small diminution in the volume of traffic, chiefly in the East of London, but the increase in revenue had been material. The number of passengers carried was approximately 169,250,000, or 55,000,000 more than in 1913. Since the last meeting seven new steam trains and 12 new electric coaches had been delivered; four new steam locomotives had been brought into use, and the remodelling of the electric locomotives in order to add 50 per cent. to their haulage capacity and increase their speed was proceeding satisfactorily. The new trains provided for the most expeditious entraining and detraining of passengers.

The chairman, in reply to questions raised, said that the company, if grouping came about, would probably be included with the District, the Tubes, the East London, and what he might generally call the Metropolitan group. That would not present any difficulties to them. As to increased dividend, that depended on working charges going down and traffics keeping up. The Government had led the railways into a very difficult position. They had put up the cost of everything, including wages. If the Government were suddenly to throw the railways back into the duck pond to swim or sink, some of the lines might find themselves in a very awkward position.

The revenue of the Lanarkshire Tramways Company for the year 1920 was £229,547, and the expenses were £197,967. Deducting contributions payable to local authorities, income tax, interest on debentures, &c., and £9,000 transferred to reserve for depreciation, and adding the balance brought forward (£5,280), the sum available is £19,342. Of this amount, £8,867 has been paid for the interim dividend at rate of 5 per cent. per annum, and the directors recommend payment of a dividend of 5 per cent. per annum for the half-year ended December, making a total dividend of 5 per cent. for the year, carrying £1,131 forward. The revenue increased by £29,678 and the expenses by £49,907, compared with 1919, and there was also an additional expenditure of £7,763 on deferred repairs during the year. The considerable increase in expenses was caused by the additional charges for electrical energy and the extensive repairs which were carried out at a cost of £16,000 in excess of the previous year's expenditure, and to the further rise in wages paid to the staff. The total amount paid by the company for wages last year was £116,000, compared with £93,000 for 1919, and £34,400 for 1914. The employees' demand for an increase of 12s. per week would involve an additional annual charge of approximately £20,000. The company's new provisional order abolishes half-penny fare stages, and gives authority to run motor omnibuses within the whole County of Lanark. As Lanark County Council did not accept the terms upon which the company were prepared to dispose of its undertaking, the company has acquired the lines constructed by the Council at a cost price—*i.e.*, £60,981.

In moving the adoption of the annual report and accounts at the meeting of the Sunderland District Electric Tramways, Ltd., recently, the chairman (Mr. H. R. Hogg) said that it was only in August last they received from the Ministry of Transport their long overdue licence to raise the fares. Meanwhile several fresh rises of wages had been granted to the men. During the period under review they paid the motormen and conductors alone £4,800 more than in the previous 12 months. They had enlarged and brought up to date the sheds, workshops and rolling stock; much labour had been expended in putting the track in better order. The cables would now require attention. The number of passengers carried during the year was 7,611,000, a slight reduction on the previous year. They had completed a trial arrangement for running their cars into Sunderland, and for the past month they had been using for the purpose a portion of the corporation track. The traffic receipts increased by £7,821, but working expenses had risen by £12,258.

Referring to the fresh claim for an increase of wages of 12s. per week for the whole tramway industry, he said the limit had been reached if the system was to be carried on at all. If the not over-burdensome type of labour was not now sufficiently well paid on about the present level, tramways must cease to exist and some other form of transport devised. If the men who had taken up that employment were still dissatisfied, they must try some different type of work for earning a living. Of their total receipts (£77,730), the cost of running and management (all practically labour) was £55,836, which with allowance for depreciation of cars, cables and buildings (£5,707 10s.) left only £16,187. Deducting debenture interest and the reduction on investments the balance was only £6,787. They proposed to pay 5 per cent. interest on the first and second income bonds, and 5 per cent. on the preference share capital, leaving to be carried forward £1,542.

The net profit of the Electrical Distribution of Yorkshire, Ltd., for 1920 was £5,426, against £4,354 in 1919. With the balance brought forward (£1,153) the total is £6,579. The directors recommend payment of a dividend (tax free of income tax) at rate of 6 per cent. per annum on the ordinary shares, absorbing, with the interim dividend paid in August, £3,882. A sum of £1,000 has been placed to reserve, and £1,696 carried forward. There has been a large increase during the year in the number of consumers of electricity, and many others are awaiting a supply. Substantial extensions have been made to the mains of all the Company's undertakings where they are authorised to supply, despite the delays which have been occasioned by the difficulty in obtaining labour and materials. In the case of eight undertakings the commencement of supply has not been possible on account of the condition imposed by the Board of Trade that a supply was not to be commenced until a date to be fixed after the termination of the war. This delay is causing considerable inconvenience to the inhabitants of the districts who desire a supply, and the Company is making every endeavour to obtain permission to proceed. The Company's application is now under consideration by the Electricity Commissioners, and it is hoped that the difficulty, which is purely technical, will soon be removed. The development of lighting supply outside the large towns in the West Riding has been largely due to the Company's enterprise, and the reduction in capital costs through the purchase of electricity in bulk from the Yorkshire Electric Power Company, and the distribution of the expenses over a large number of electric lighting orders have enabled the Company to supply electricity at prices which are in many cases cheaper than those in adjoining districts with a greater density of population. In order to provide for extensions, further capital will be required, and at an extraordinary meeting on Tuesday it was decided to increase the share capital from £100,000 to £150,000, and to give authority to the directors to borrow up to one-third of the share capital.

New Companies.

The following list has been compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, Chancery-lane, London, W.C.2: –

ALKLUM ELECTRICS, LTD. (172950).—Reg. Feb. 3. Capital £1,000 in £1 shares. To carry on business of general electrical engineers. Directors: C. H. Worsnop, H. E. Hodgson, R. Wande, A. Worsnop and A. Parker. Regd. office: Waterside Works, Waterside, Halifax.

GREENSFIELD GENERAL ENGINEERING COMPANY, LTD. (173033).—Reg. Feb. 8. Capital £2,000 in £1 shares. To acquire and carry on business of engineers, engineering agents and engine and machine repairers. Directors: J. Y. Wilson, J. E. Wilson, W. Mathieson and T. P. Wilson. Reg. office: 30, Ellison-st., Gateshead, Durham.

HARRIS-ANDERSON PATENT ANTI-CORROSION SYSTEM, LTD. (172,845.) Reg. Jan. 28. Capital £1,000 in £1 shares. To acquire and carry on business of manufacturers of the Harris-Anderson patent anti-corrosion system applied to steam boilers, &c. Directors: A. W. Wilson and W. G. Clegg. Reg. offices: 24, Grainger-street West, Newcastle-upon-Tyne.

J. H. McBEAN, LTD. (173034).—Reg. Feb. 8. Capital £5,000 in £1 shares. To acquire and carry on the business of electrical engineers. Directors: J. H. McBean (Ch. and Man. Dir.), and A. W. Blackburn. Qualification of Directors: £500. Reg. office: Clarence Mills, Bradford-road, Batley.

WHITWORTH ELECTRIC LAMP COMPANY, LTD. (173062).—Reg. Feb. 9. Capital £5,000 in £1 shares. To carry on business of electrical engineers and factors. Directors: H. Harrison and W. C. Hands (permanent Directors). Qualification of permanent Directors 2,000 shares. Reg. office: 195, North End-rd., West Kensington, W.14.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics."—"The Handley Page Wing," by F. Handley Page; "Soaring Flight," by M. A. S. Riach.

"Cabinet Maker."—(Empire Number.) "Furniture at the British Industries Fair"; "Timber Supplies from Empire Sources"; and "Antiques, Spurious and Genuine."

"Chemical Age."—(Special Number.) "Electrical Installations in Chemical Works."

"Farm and Home."—(Special Cultivation Number.) "Effects of Cold Weather on Tractors"; "The Benefits of Thorough Cultivation"; and "Farm Implements and their Makers" (illustrated).

"The Fruit-Grower."—"Shows in 1921"; "Natural Enemies of Tree Insects"; and "Lea Valley Research Station's Appeal."

"Gardening Illustrated."—"Carnations in Vases" (illustrated); "Feeding Fruit Trees in Winter"; and "Chrysanthemums: Seasonal Notes."

"Hardware Trade Journal."—(Special Empire Number.) "Hardware at the British Industries Fair"; and "Travelling in Hardware."

Forty Years Ago.

(The Electrician, February 26, 1881.)

Electric Light at Norwich.—The Town Council, preparatory to adopting the electric light in their streets, have given their sanction to its trial in the market place.

Advantage of the Electric Light.—The contractor for a new bridge being built at Cork, in order to get his work done within the specified time, is having the electric light installed, so that he can work night and day. What would he have done a few years back?

Electric Signals for Railways.—The Paris-Lyon-Mediterranée Company have decided to erect new telegraph posts between stations distant more than eight or ten kilos from each other. Semaphores will be placed near these posts, and thus trains can be stopped and kept at a proper distance from another.—*La Lumiere Electrique.*

Photophonic.—"Theoretically a telephone with a blackened disc [diaphragm] enclosed in a high vacuum and connected with an external telephone should serve as a receiver; and the writer of these lines has already attempted to devise a thermo-electric receiver for reproducing sounds from invisible calorific rays."—S. P. T. in *Nature.*

Prices of Metals, Chemicals, &c.

Tuesday, Feb. 22.

		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£74 0 0	—	£2 0 0
Electro Wirebars ...	,,	£77 0 0	—	2 0 0
H.C. wire, basis ...	per lb.	0s. $11\frac{13}{16}$d.	—	$\frac{1}{4}$d.
Sheet	,,	1s. $1\frac{1}{8}$d.	—	$\frac{3}{16}$d.
Phosphor-bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. $3\frac{11}{16}$d.	—	$\frac{1}{4}$d.
Brass 60/40—				
Rod, basis	,,	0s. $8\frac{1}{2}$d.	—	$\frac{1}{4}$d.
Sheet, basis	,,	1s. $1\frac{3}{4}$d.	—	—
Wire, basis	,,	1s. $1\frac{3}{4}$d.	$\frac{1}{4}$d.	—
Pig Iron—				
Cleveland Warrants	per ton	£10 0 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£29 0 0	—	—
Lead Pig—				
English	,,	£21 10 0	—	£1 10 0
Foreign or Colonial	,,	£19 5 0	—	£1 10 0
Tin—				
Ingot	,,	£170 5 0	—	£2 0 0
Wire, basis	per lb.	2s. $4\frac{1}{8}$d.	—	$\frac{3}{8}$d.

Salammoniac.—Per cwt. 100s.-95s.

Sulphur (Flowers).—Ton £14 10s.

,, (Roll-Brimstone).—Per ton £14 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £35.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 10d.

Sodium Chlorate.—Per lb. $4\frac{1}{2}$d.

Rubber.—Para fine, 0s. $11\frac{1}{2}$d.; plantation 1st latex, 1s. $1\frac{3}{4}$d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by Messrs. W. T. Hanley's Telegraph Works Company, Ltd.

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Arrangements for the Week.

FRIDAY, February 25th (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers on "A Note on the Hot-Wire Inclinometer," by Mr. R. H. Humphry; "On the Magnetic Susceptibility of Certain Natural and Artificial Oxides," by Profs. E. Wilson and E. F. Herroun; "On the Refractometry of Prisms," by Mr. J. Guild; and "On Tracing Rays through an Optical System," by Mr. T. Smith.

Junior Institution of Engineers.

8 p.m. At Caxton Hall, London, S.W. Lecture on "Measurements of Precision in Engineering," by Mr. H. T. Davidge.

SATURDAY, February 26th.

Royal Institution.

3 p.m. At Albemarle Street, London, W. Lecture on "Spectroscopy—Celestial Spectroscopy," by Prof. A. Fowler, F.R.S. (Lecture III.).

MONDAY, February 28th.

Institute of Transport.

5.30 p.m. At the Institution of Civil Engineers, Gt. George Street, London, S.W. Paper on "Electrification of Main Line Railways in Relation to Traffic Working," by Sir Phillip Nash.

Institution of Electrical Engineers.
Liverpool Sub-Centre of the N. Western Centre.

7 p.m. At the University, Brownlow Street, Liverpool. Paper on "Temperature Limits of Large Alternators," by Mr. G. A. Juhlin.

Institution of Electrical Engineers.
North-Eastern Centre.

7.15 p.m. At Armstrong College, Newcastle. Lecture on "Thermionic Valves," by Mr. W. D. Owen.

Institution of Electrical Engineers.
Informal Meetings Section.

7.30 p.m. At Anderton's Hotel, Fleet Street, London, E.C. Annual Smoking Concert.

Royal Society of Arts.

8 p.m. At John Street, Adelphi, London, W.C. Cantor Lecture on "Application of Catalysis to Industrial Chemistry," by Dr. E. K. Rideal, M.B.E. (Lecture III.).

WEDNESDAY, March 2nd.

Institute of Cost and Works Accountants.

7 p.m. At the Institute of Chartered Patent Agents, Staple Inn, London, W.C. Lecture on "Some Deviations in Costing Principles," by Mr. R. J. H. Ryall.

Industrial League and Council.

7.30 p.m. At Caxton Hall, Caxton Street, London, S.W.1. Lecture on "Scientific Management as a Factor in Production," by Mr. A. R. Stelling.

THURSDAY, March 3rd.

Royal Society.

3 p.m. At Burlington House, Piccadilly, London, W. Discussion on "Isotopes," opened by Sir J. J. Thomson, O.M., F.R.S.

Institution of Electrical Engineers.

7 p.m. At the Hotel Cecil, London, W.C. Annual Dinner.

FRIDAY, March 4th.

Institution of Electrical Engineers.
Students' Section.

6.30 p.m. At Faraday House, Southampton Row, London, W.C. Paper on "Telephonic Transmission through Submarine Cables," by Mr. A. Rosen.

Birmingham and District Club.

6.45 p.m. At Grand Hotel, Colmore Row, Birmingham. Tenth Annual Dinner.

Royal Institution.

9 p.m. At Albemarle Street, Piccadilly, London, W.1. Discourse on "Severn Crossings and Tidal Power," by Mr. W. A. Tait.

SATURDAY, March 5th.

Royal Institution.

3 p.m. At Albemarle Street, London, W.1. Lecture on "Electricity and Matter," by Sir Ernest Rutherford, F.R.S. (Lecture I.)

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices on receipt of published price, plus postage.]

"Electrification of Railways," by H. F. Trewman, M.A. (London: Sir Isaac Pitman & Sons.) Pp. ix.+78. 2s. 6d. net.

"Elements of the Mathematical Theory of Electricity and Magnetism," by Sir J. J. Thomson, O.M. (Cambridge: University Press.) 5th edition. Pp. 410. 25s. net.

"Dynamical Theory of Gases," by J. H. Jeans. (Cambridge: University Press.) 3rd edition. Pp. vii.+442. 30s. net.

"Elementary Principles of Continuous-current Armature Winding," by F. M. Denton. (London: Sir Isaac Pitman & Sons.) Pp. x.+102. 2s. 6d. net.

"Small Single-Phase Transformers," by E. T. Painton. (London: Sir Isaac Pitman & Sons.) Pp. x.+95. 2s. 6d. net.

"Mechanical World" Electrical Pocket Book, 1921. (Manchester: Emmott & Company.) Pp. 376. 2s. net.

"An Introduction to Technical Electricity," by S. G. Starling. (London: Macmillan & Company.) Pp. xii.+181. 3s. 6d.

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Notes.

London Electricity Supply Companies.

WHEN we consider the high prices of fuel and all supplies as well as the advances made in salaries and wages, the results obtained during the past year by the London electricity supply companies are surprisingly good. In several cases increased dividends have been declared, the City of London, Metropolitan, Chelsea, Charing Cross, South Metropolitan and the Smithfields Markets Companies being in this category. Even where the dividend is the same as in 1919 the financial position is much better for there are increased appropriations to the reserve and depreciation funds. Owing to the removal of the lighting restrictions and the increased demand for power and heating the energy consumed, the total connections, and the gross receipts all show striking advances over the figures of the preceding year. We have no doubt that this development will continue. In fact, the coal situation, which at the moment is not promising, seems the only serious obstacle to the continued prosperity of these concerns.

Advance in Heating Load.

ONE of the most remarkable features of the year has been the rapid increase in the demand for energy for heating, cooking and domestic purposes, especially in the West End of London. For instance the chairman of the St. James' & Pall Mall Company, Mr. WALTER LEAF, announced at the annual meeting last week that a large part of their new connections were for heating purposes, and that the domestic use of electric heating had been advancing with great rapidity, as the advantages of its cleanliness and other subsidiary merits became more widely known. The Company is, according to the Chairman, now in a position to compete directly with coal for heating and lighting and its directors are looking forward to an even more rapid development in the near future. A somewhat similar state of things applies in the districts served by the Westminster, Brompton & Kensington, Kensington & Knightsbridge and Charing Cross West and City Companies and other undertakings supplying residential districts. We have no doubt that with further propaganda even this satisfactory state of things could be very greatly improved.

The Future of Electricity Supply in London.

NATURALLY the future of electricity supply in London and especially the position of the supply companies in the projected schemes for the re-organisation of the industry in the Greater London area were referred to by the chairmen at the meetings. The speeches do not, however, throw very much fresh light upon an intricate, though very important, subject. We gather from Mr. BENSON, Chairman of the London Electric Supply Corporation, however, that nine of the Companies are acting in conjunction with the London County Council and the other local authorities in preparing proposals for submission to the Electricity Commissioners in conformity with the Electricity Supply Act, and that the four engineers who are engaged in the elaboration of the engineering details are likely to be successful in working out a harmonious scheme. It is not, however, from the engineering side that difficulties are likely to arise, great though these are in London ; it is rather from the administrative point of view—in the elaboration of anything like an acceptable plan for the formation of a Joint Electricity Authority—that trouble will be experienced. Still, though we are not disposed to minimise the difficulties of the situation there is no reason why, with mutual goodwill, and provided the companies are granted an equitable share of the representation on the Joint Authority, a suitable scheme should not be evolved. As the public enquiry will not be held before June there is still over three months in which to discuss details and to complete negotiations. We sincerely hope that as a result a really workable agreed scheme will be evolved.

Financing Industry During Transition Stages.

ONE of the effects of the reorganisation of electricity supply in this country has been to make the problem of financing the necessary extensions to meet the growing demands for power and light during the period of transition very difficult. Under the most favourable circumstances money is not easily obtained at present, and the natural result of the existing uncertainty as to the immediate future in London has been to render it impossible for the companies to raise the capital required by ordinary methods. According to the CHAIRMAN of the London Electric Supply Corporation, who dealt with the subject at some length at the annual general meeting of the Company, the minimum amount of capital expenditure needed each year exceeds the net annual revenue and in many cases a much greater sum is necessary. In order therefore that a company should be able to raise such a sum he considers that the dividend on the ordinary capital should be at least 10 per cent. Mr. Leaf, of the St. James' & Pall Mall Company referring to extensions at the St. John's Wood Station made by the Company and the Westminster Electric Supply Corporation, said that until a scheme of reorganisation was prepared, it was not practicable to issue further capital in the form of shares and it had been decided to make use of short-term notes. It is essential that there should be no shortage of supply at any time. But that distrastous state of affairs is imminent, unless provision is made for covering the present period of uncertainty. Fresh capital must be procured somehow; and if that statement is doubted we would point to the telephone system of the country which is still suffering from the evil effects of the policy adopted towards the National Telephone Company just prior to the purchase of its undertaking. We therefore sincerely hope that nothing will be done which will militate in any way against that normal development of electricity supply which is truly the life blood of the industry of the country.

Joint Meetings.

We are glad to see that technical institutions, whose objects are more or less similar, are more and more adopting the policy of holding joint meetings. The Institution of Electrical Engineers has always been to the fore in this respect, while the Faraday Society has also done useful work in this direction. We now notice that the Institution of Mechanical Engineers and the Society of Chemical Industry are holding a joint meeting to-day when M. Paul Kestner, of Paris, will read a Paper on "The Degassing and Purification of Boiler Feed Water." While this subject is one of equal interest to mechanical engineers and to chemists, electrical engineers should not be left out in the cold and, although the Institution of Electrical Engineers is not officially represented on this occasion, we hope that those electrical engineers who are also members of the Institution of Mechanical Engineers will attend and take part in the discussion. The more such problems are viewed from different aspects the more are they likely to receive satisfactory solution, while the educational value of hearing the problem discussed by both engineers and chemists cannot be over-estimated.

Engineers on the Severn Barrage.

Not the least interesting of these joint discussions is the one which took place in Birmingham recently under the joint patronage of the Institutions of Civil, Mechanical and Electrical Engineers, the subjects being the Severn Barrage and the Third Interim Report of the Water Power Resources Committee. While recognising the engineering interest of this now famous scheme the meeting quite rightly laid greater stress on the financial difficulties and especially deprecated the brass-band effects with which the publication of the details has been accompanied. But as regards these same financial details opinions seemed to differ. Mr. Chattock stated that the cost of machinery with a capacity of 476,000 kw. would work out at rather over £17,000,000, though, if the Thury system were employed, this could be reduced to £11,000,000. On the other hand, Mr. F. H. Clough roughly estimated that the cost of machinery, switchgear and transmission lines would be £20,000,000. Generally the meeting for these and other similar reasons showed themselves opposed to the scheme in anything like its entirety, though Mr. N. B. Rosher thought that with its aid it would be possible to transmit a maximum load of 100,000 kw. from the Severn to the Birmingham district by overhead lines, at a capital cost of £1,000,000, or 0·081d. per unit, which with a generating cost of 0·5d. per unit would, therefore, make it possible to supply Birmingham with energy at 0·631d. per unit, or to sell it at 0·8d. per unit—a figure considerably lower than the present tariff. The discussion undoubtedly confirmed the view of the Water Power Resources Committee that the advisability or otherwise of utilising the power of the Severn for the generation of electrical energy is worth further inquiry, and we cordially agree with Mr. Addenbrooke that it is most unfortunate that the Ministry of Transport should have fouled the waters of technical discussion by their ill-conceived pronouncement. This policy has probably put back for years any rational development of the Severn power, as any scheme now put forward, however well thought out, will be inevitably regarded with suspicion by those who have the best right to judge its merits.

The Qualities of the Young Engineer.

The best methods of training the young in the ways of the world have been the theme of great writers from Xenephon to Mr. Bernard Shaw. There is nothing surprising in this, for it is only natural that the successful should wish to show how it was done, while the unsuccessful find some consolation in discussing how hard luck defeated their efforts. At the same time even the cynical will agree that though wisdom is more than ever the prerogative of babes and sucklings experience is still the possession of the middle-aged; and it is from the latter source that the young engineer can derive most assistance in directing his steps aright. Young electrical engineers will, therefore, be well advised to study an address recently delivered by Mr. Llewelyn Atkinson to the Students' Section of the Institution of Electrical Engineers. Mr. Atkinson's main thesis was that every young man entering the engineering profession would be well advised to specialise in a particular subject to such a point that he becomes recognised as an authority in that subject. To this foundation of specialisaton must, however, be applied a super-structure of economic training including the principles of business, of organisation and of finance; and especially a determination to train himself in clearness of thought and expression, to cultivate a good temper and generally to train body and mind to make both perform as efficiently as possible the work that their owner may call upon them to do.

The Hard Case of the Scientific Engineer.

Such a course of training carried to its logical conclusion would tend to remove the disability whereby the commercial engineer receives greater material rewards than the purely scientific engineer. Mr. Atkinson explains this by saying that the latter has no cause for complaint, being engaged on work which gives him mental and intellectual pleasure. But the same may be equally truly said of the commercial engineer, as conceal it though they may, there are quite a number of people who like making money for its own sake. The true cause of this difference it seems to us is implied in Mr. Atkinson's scheme of training. The scientific engineer too often finds his own special subject so all-absorbing that he has no energy or interest left for anything else, while the commercial engineer has by the very nature of his work to develop a broader intellectual outlook and by training his social and economic faculties obtain that breadth of vision which goes far to ensure success in engineering or anything else.

Some Thoughts on Protection.

The apparatus employed for the protection of electrical machinery and networks has suffered great changes since the days when it consisted mainly of circuit breakers of elementary design, whose protective character in practice was often neutralised by the addition of string to the vital parts. On a system of any size it is not unusual nowadays to find each machine, transformer, feeder and tapping point fitted with devices of a more or less complicated character whose object is, as it were, to sense an approaching breakdown and to cut out the faulty section before the rest of the system is harmfully affected. The ingenuity of these devices can only be a matter for admiration, tinged, however, with a little doubt as to whether quite all the complications are necessary. Sir Philip Dawson is apparently one of those in whom this doubt predominates, for addressing the students of Faraday House the other day he gave it as his opinion that generators and transformers were themselves their own best protection and that the multiplication of devices for protecting them against themselves was to be deprecated. On the other hand an engineer responsible for one of the largest interconnected systems in the country recently informed us that no such system could be expected to operate efficiently and that it would not be possible to guarantee that continuity of supply which is absolutely essential nowadays, unless protective apparatus was extensively employed. It is highly probable that the truth lies somewhere between these two extremes and that while Sir Philip Dawson is quite right in calling attention to the dangers which may arise through the unnecessary multiplication of this apparatus, he is going too far to say that it should be eliminated altogether. This seems one of those practical points connected with modern electricity supply which would be clarified by discussion before the Institution of Electrical Engineers. It is a matter those responsible for the arrangements of the meetings might well consider.

◆

Light as an Aid to Publicity.

It is, we believe, a fact accepted by publicity experts that the success of advertisements depends essentially on the appeal they make to the eye of the observer. Naturally, therefore, the manner in which the object presented to the eye is revealed by light has an immediate application to their profession. It is surprising that the uses of artificial light for advertising have received comparatively so little attention outside those who are associated with the manufacture of lighting appliances. At the meeting of the Illuminating Engineering Society last week the happy thought was acted upon of combining in an evening's discussion papers on shop-window lighting and illuminated signs; and it was interesting to find that the chief point brought out in the discussion was the need for concerted action. At present each user of an illuminated sign acts on his own; adjacent signs may kill each other; a charmingly lighted shop-window may be obliterated by glaring masses of lights exhibited by an adjacent cinema (which has no goods to illuminate, but only desires to attract!). What is the good of it all?

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The Lighting of Exhibitions.

In addition to this internecine strife between advertisers we have the general public who are not always grateful for the efforts made to convey information to them by luminous means. Protests have been raised against the huge flashing signs on the Embankment, and Mr. Leachman, who read a Paper on luminous signs, hinted that advertisers would do well to make terms with the public by aiming at luminous advertisements of a more artistic character. We agree that tastefully executed and mildly luminous signs, and properly illuminated shop-windows add to the attractiveness of a city by night and should be welcomed. The difficulty is to find some means of influencing dispensers of glaring light and of striking a balance in the interests of both advertisers and the public. Meantime, as was suggested in the discussion, why not begin with exhibitions, where there is no real obstacle to concerted action in matters of illumination? It is common knowledge that at present the lighting of exhibitions, even those devoted to technical subjects, is usually of a chaotic character, each exhibitor being a law unto himself and frequently a menace to his neighbours. Let us hope that when the rumoured Electrical Exhibition at length materialises these ideas will be acted upon.

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The Display of British Industries.

The two sections of the British Industries Fair at Birmingham and in London, respectively, which have been open during the past fortnight have given an opportunity to buyers both in this country and from abroad to obtain some idea of the progress the trade and industry of the country have been able to make in changing over from war to peace conditions. From this point of view and doubtless for more commercial reasons they have been a success, but the lesson would have been more striking had a little more care in preparation been taken both by the organisers and by the exhibitors. For instance, at Birmingham where British engineering was largely represented, the impression left on the mind of the otherwise uninformed visitor must have been that, in this sphere, we are largely concerned with the infinitesimal. Very little, if anything, was to be seen of mechanical engineering products such as locomotives, agricultural machinery and cranes, while even machine tools were inadequately represented. Electrically, there was the same glorification of the molecular, and, though we are second to none in desiring the wider development of domestic electrical apparatus, it seems a great mistake that the opportunity was not seized of bringing before the foreign buyer what we can do in the manufacture of turbo-alternators, switchgear and large motors. The real reason for this serious omission seems to lie in the desire to impress the prospective buyer with what Messrs. "Smith, Jones & Co." are doing rather than with what British manufacturers can do. It is a trait which, though human, is one which should be kept in subjection if the greatest good is to come from these very useful exhibitions.

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Inventions by Research Workers.

Considerable dissatisfaction has been expressed by engineers and chemists engaged on research work for Research Associations at the conditions governing patents taken out for inventions made in the course of their work. We are glad, therefore, to note that, in order to allay irritation, and to evolve an equitable method of dealing with the matter, which is one of considerable public importance, a strong and representative Inter-Departmental Committee on Patents has been appointed by the Lord President of the Council. The chairman of this Committee is Mr. Kenneth Lee, and there are representatives of the Admiralty, War Office, Air Ministry and Post Office, with a couple of scientists and two experts on patent law and Mr. A. Heath as secretary. In our opinion the position of a scientific worker engaged by a research association who makes a discovery is analogous to that of an invention by a mechanic or workman, and similar principles should apply. The strict legal rules are not, however, generally employed and the patent is taken out in the names of the workman and his employers. It frequently happens that tests, adjustments and alterations have to be made in the original invention in order to render it a commercial success, which is the true test of the value of a patent, and the advice and skill of the inventor are essential for reaching this stage. Similarly, we think that research workers should have some definite inducement to develop their inventions.

The Electrification of Railways.

The problems attending the electrification of the railways of this country have been considered during the past week from two different points of view by Sir **Philip Nash** and Sir **Philip Dawson** respectively. And if we compare the Paper read by the former before the Institute of Transport last Monday with the lecture delivered by the latter to the students of Faraday House last Friday, we are able to obtain by the combined processes of cancellation and integration some idea of the view-points with which the mechanical and electrical engineer severally regard this important question. Though, like many of the literary efforts which emanate from the Ministry of Transport, Sir **Philip Nash's** Paper arouses in the informed reader a spirit of criticism which its many undoubted good points do not altogether succeed in allaying, we hasten to add it is a different production from the egregious Severn Barrage scheme, not only in its matter but in its manner of treatment. Equally and alternately Sir **Philip Nash** praises and criticises electric working, with the result that the effect on the reader is of standing under a shower bath from which hot and cold streams flow, the change being made without the slightest warning. Or, to employ a less fanciful simile, the Paper forms an interesting study of a mechanical engineer faced with the practical benefits which follow electrification, though at the back of his mind he still continues to feel there must be wrong about it somewhere if he could only find where.

Finance and Standardisation.

It would seem that one of the principal objections which Sir **Philip Nash** has to anything like the wholesale electrification of our railways is that it would at present be impossible to raise the necessary capital. This, of course, is quite true. But it would also be interesting to know how far he considers the Ministry of Transport is to blame for that state of affairs. For as long as such documents as Colwyn reports are issued the investors of the country are not likely to look upon railways as a safe outlet for their surplus capital.

Sir **Philip Nash** also raises, or perhaps it would be more correct to say re-incarnates, the bogey of interchangeability by pointing out that unless we decide on a standard system we shall in a few years be faced, electrically speaking, with the difficulties which at present exist with regard to lack of uniformity in air brakes, loading gauges and wagon stocks. As we have already pointed out, this point can be made too much of. In our opinion there is much electrification, especially of suburban lines, that could be undertaken without the system chosen causing any difficulty either now or in the future. Indeed, we agree with Sir **Philip Dawson** that standardisation is only a good thing if it is not carried too far.

The mechanical engineer in Sir **Philip Nash** also peeps out when he goes into the question of the advantages and disadvantages of electric working. For after stating the former quite fairly he gives a formidable list of the latter, including among them such matters as speed variation, greater risk to employees, induction, electrolysis, difficulties of the transition period, and the danger of complete interruption. All these, no doubt, exist, but with enterprise and ingenuity it should be possible to overcome them, difficult though that task may be. After all, that is what difficulties are for.

The Facts of the Matter.

The real facts of the matter are that on many lines a point has been reached when electric traction with all its disadvantages, presumed and actual, must be adopted if there is not to be almost complete breakdown from congestion It is evident, in fact, from the course of the discussion on the Paper that railway engineers are convinced that a large measure of electrification is inevitable, and that the only real obstacle is ways and means.

On the other hand, as might be expected, Sir **Philip Dawson** has no qualms as to electrification. The only doubts in his mind arise on such points as the best system to adopt and upon the best way to solve the many interesting technical problems that will arise. Sir **Philip Dawson** has often been called, he says unfairly, a "single-phase man." He now makes the interesting statement that though this is true as regards main line working for suburban traffic, direct current has much to recommend it. We may, perhaps, be permitted to ask in all seriousness whether any change is contemplated on the Brighton Railway, where the suburban traffic is particularly dense and where for whose complete electrification plans have already been deposited with the Ministry of Transport. This, however, is a minor point, and the lecture is well worth study not only as indicating the enormousness of the prospective railway load but as showing how this load will have to be dealt with.

The Suburban Traffic Problem.

The most suggestive part of Sir **Philip Nash's** Paper is, however, that in which, discarding technicalities, he deals with the question of short haul suburban traffic. He thinks that the present London terminal stations will soon be insufficient to accommodate this traffic, that to extend them would be uneconomical, and that therefore all traffic originating within, say, eight miles of the terminal station should be diverted elsewhere, to the tramways or tube railways for instance. On the other hand, he would attempt to stimulate the traffic between London and places, say, 8 to 30 miles away. But to do so, if the experience on the London & South Western Railway goes for anything, would cause even greater strain on the facilities than does the present short distance traffic. The only way of overcoming this difficulty, which is undoubtedly a grave one, would seem to be either to build a high-speed tramway network on the lines suggested by Mr. **John Brodie**, in his presidential address to the Institution of Civil Engineers, or to link up the existing railway systems either with the tube railways or with a circular railway built round London, as suggested by Mr. **Alexander Ross**, and operating some sort of through suburban traffic. To either of these suggestions there are obstacles greater in number and extent to those which Sir **Philip Nash** sees in wholesale electrification. We doubt very much whether from this point of view the terminal problem is so bad as he makes out and one effect of electrification would certainly be not only to improve the circulation but to make the space available more generally utilised throughout the day instead of only at the morning and evening rush hours. For these reasons we are sorry to see Sir **Philip Nash** still clinging pathetically to the idea that he has propounded before, that it is possible to deal with the suburban traffic on some of our railways by improving the steam service. This is a delusion, or at the best a temporary panacea, and even in cases where some such arrangement has been put in force with some success, before long it will be necessary to consider seriously the claims of electric traction, which can give the only true solution of the problem Sir PHILIP NASH himself in another mood recognises this when he says that electrification will slowly but surely take place. Not only is this the case, but the sooner that it takes place the better it will be for the railway companies, though so far the Ministry of Transport has not done much to help.

Electricity Supply in Victoria.

The impetus given by the war to the development of electricity supply, more particularly in its application to industrial power operations, compelled close attention being paid to improved methods of generation and supply, and particularly to the existing organisation of the industry. This was all the more necessary for purely economic reasons, and the natural outcome of this requirement was a demand for fresh legislation which would allow the reorganisation of electricity supply on a modern basis. This desire for reorganisation has not, however, been confined to the United Kingdom; indeed, the movement seems to be world wide. For instance, the question, as well as the kindred topics of utilising the water power available for the generation of electrical energy and the economising of fuel resources, is receiving close attention in the various states of the Australian Commonwealth, in New Zealand, in India and other parts of the Empire. We have recently referred to the excellent work that is being done in this direction in India and in New Zealand, but in many respects the developments that are being suggested in Victoria, the most progressive of the Australian States, deserve special consideration, especially from an electrical point of view.

ENGLISH MODELS THE BASIS.

To some extent the legislation governing electricity supply in Victoria is based upon English models and is to be found in two acts—the Electric Light & Power Act, of 1915, which repealed and re-enacted with some amendments five earlier Acts, and the Electricity Commissioners Act, 1918. Under the latter three Electricity Commissioners have been appointed, with even more extensive powers than our own similar body, and since their appointment they seem to have been using their authority to excellent purpose. In addition to being entrusted with the administration of the Act of 1915, they are also authorised to prepare plans and specifications for a coal mining and electricity undertaking of some considerable size at Morwell, to which we have already referred. The specifications for this scheme have been prepared and tenders are at present being invited for the necessary generating plant for utilising the extensive brown coal deposits at this place and for transmitting electrical energy thence to Melbourne a distance of 86 miles. Ultimately it is expected that energy will be transmitted to Geelong, a distance of 126 miles, to Ballarat, 156 miles, and to Bendigo, 186 miles distant. Some time ago the State Parliament appropriated about £1,000,000 for the first section of this important project, including the generating plant, and a Bill has just been passed allocating £1,430,000 for the second portion. It has also been decided to increase the number of Commissioners to four and to appoint a permanent chairman of the Board, which will then be an exact copy of our own Commission. The Government expect to be able to provide about 75,000 kw. by June, 1923, and energetic steps are to be taken to carry out the complete scheme as early as possible.

CO-ORDINATION AND UNIFICATION.

In addition, the Commissioners have power to inquire into and report on the steps that should be taken to secure the co-ordination of all State or privately-owned electricity undertakings in Victoria, and to obtain such standardisation of plant, equipment, systems, frequencies, and pressures as will admit of efficient interconnection. They are also required to report on the prospects of establishing in Victoria new industries requiring large quantities of cheap electrical energy and as to the means which should be taken to encourage the use of electricity, especially for industrial purposes. This mixture of Sir JOHN SNELL and Mr. BEAUCHAMP is probably only possible in a young country. But matters do not stop there. They are also metaphorosed into a kind of Water Power Resources Committee, in which rôle they are to carry out investigations into the existence and extent of coal deposits and water power for use in the generation of electricity; and finally they are charged to discover the safest and most economical means for promoting, establishing and improving works for the generation, supply and use of electricity in the State. So that they are not likely to qualify for the unemployment dole for some time to come. But they may even go further still, for they have power to construct and maintain any electrical undertaking; to supply electricity to any Commonwealth or State Government Department, to any public body or institution or in bulk to any undertaker or any statutory Corporation, while they may also carry on any business usually associated with an electrical undertaking. Whether they will, or can, exercise all these powers is a matter for interesting speculation, but apparently in Victoria they are not so frightened of innovations or of bureaucracy as we are here.

WATER POWER CONCESSIONS.

As regards water power, any concession for its utilisation is not to exceed 50 years, which, though not over liberal, is much better than the thirty years allowed for an order granted to a company under the Electric Light & Power Act of 1915. Finally, we notice, with some curiosity, a power "to make rules for or with respect to the examination and licensing of wiremen." In Australia, South Africa and elsewhere there is a demand, as there was some years ago in this country, for the licensing of wiremen in order to ensure that only good and efficient men may be employed on installation work, and the same idea is cropping up again over here. This would, however, seem to be rather a matter for a Trade Association, who have means of weeding out incompetent workmen without the aid of rules or examinations than for a body such as the Commissioners.

THE NECESSITY OF A WISE DECISION.

It will be seen from the above brief outline of the powers and duties of the Victorian Electricity Commissioners that even greater importance is attached to a good and cheap supply of electricity for industrial purposes than in this country, and that existing undertakings are to have very little say in bringing this desirable state of things about. But the work is going to be arduous, for electricity supply grew up gradually in the State with very little control of the voltage of supply, system or frequency, the result being that there are at present various voltages in use, though the standards of 430 volts for power and 200 volts for lighting purposes are now being laid down. The standard system is the three-phase, with a frequency of 50 cycles. At present the Commissioners are engaged on a close investigation of the steps which should be taken to secure the ultimate co-ordination and unification of all electrical undertakings in Victoria, but no definite conclusions have yet been arrived at, though a report is anticipated during the year. It will be obvious that much future progress will depend on a wise decision on this point.

Propagation of Periodic Currents over Non-Uniform Lines.

By JOHN R. CARSON
(American Telephone and Telegraph Co.)

The purpose of the present Paper is to integrate the differential equations of the transmission line for the general case where the line parameters (R, L, C, G) are arbitrary functions of the distance x, as measured along the line. The general case is of some theoretical and practical importance; furthermore, the method of solution employed is of interest in itself, as it furnishes a direct and simple way of deriving the transmission line formulæ for the usual case where the line parameters are constants.

We start with the differential equations of the line voltage V and current I; in usual notation these are

$$dV/dx = -Z(x) \,.\, I = -Z \,.\, I \quad . \quad . \quad . \quad . \quad (1a)$$

$$dI/dx = -Y(x) \,.\, V = -Y \,.\, V \quad . \quad . \quad . \quad (1b)$$

In these equations, as indicated by the functional notation, the impedance $Z=ipL+R$ and the admittance $Y=ipC+G$ are in general arbitrary functions of the variable x. Steady-state conditions are assumed and V and I involve the time t through the common factor $\exp(ipt)$ which is omitted for convenience.

Integrating $1a$ and $1b$ with respect to x

$$V = V_0 - \int_0^x dx_1 Z \,.\, I \quad . \quad . \quad . \quad . \quad . \quad . \quad (2a)$$

$$I = I_0 - \int_0^x dx_1 Y \,.\, V \quad . \quad . \quad . \quad . \quad . \quad . \quad (2b)$$

These equations are now in form for solution by a well-known method of successive approximations, commonly called the Picard process. In accordance with this method V and I are the limits of the infinite sequences

$$V_0 V_1 V_2 \; . \; . \; . \; V_n$$
$$I_0 I_1 I_2 \; . \; . \; . \; I_n,$$

where the successive terms are defined by the scheme

$$V_1 = V_0 - \int_0^x dx_1 Z \,.\, I_0 \cdot \quad I_1 = V_0 - \int_0^x dx_1 Y \,.\, V_0$$

$$. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad .$$

$$V_n = V_0 - \int_0^c dx_1 Z \,.\, I_{n-1} \cdot \quad I_n = I_0 - \int_0^x dx_1 Y \,.\, V_{n-1}.$$

If the indicated operations are formally executed the resulting solutions are:—

$$V = V_0 \,\Sigma r_{2n} - I_0 \,\Sigma r_{2n-1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3a)$$

$$I = I_0 \,\Sigma s_{2n} - V_0 \Sigma s_{2n-1}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3b)$$

where the r and s series are absolutely convergent and are defined by

$$r_0 = 1 \qquad s_0 = 1$$

$$r_n = \int_0^x dx_1 Z \,.\, s_{n-1} \quad s_n = \int_0^x dx_1 Y \,.\, r_{n-1}. \quad . \quad . \quad (4)$$

The summations in (4) are taken from $n=0$ to $n=$infinity.

If, as in the usual case of the telegraph equation, the parameters Z and Y are constants, the foregoing solution reduces to the usual formulæ. To show this, let $\sqrt{Z/Y}=K$ and $\sqrt{ZY}=m$; then treating these quantities as constants we have at once

$$\Sigma r_{2n} = \Sigma s_{2n} = \cosh mx$$

$$(1/K)\Sigma r_{2n-1} = K \Sigma s_{2n-1} = \sinh mx$$

and

$$V = V_0 \cosh mx - K \,.\, I_0 \sinh mx \quad . \quad . \quad . \quad . \quad (5a)$$

$$I = I_0 \cosh mx - \frac{1}{K} V_0 \sinh mx, \quad . \quad . \quad . \quad . \quad (5b)$$

which are the general formulæ for the line voltage and current in terms of their initial values at $x=0$.

Returning to the general case, and guided by the form of the restricted solution ($5a$), ($5b$), let us now introduce the variables P, K and h which we shall define by the equations

$$h^2 = \Sigma r_{2n} / \Sigma s_{2n}$$

$$\cosh {}^2 P = \Sigma r_{2n} \,.\, \Sigma s_{2n} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$$K^2 = \frac{\Sigma s_{2n} \,.\, \Sigma r_{2n-1}}{\Sigma r_{2n} \,.\, \Sigma s_{2n-1}}.$$

It is now easy to show that equations ($3a$), ($3b$) expressed in terms of P, K, and H become

$$V = hV_0 \cosh P - hK \,.\, I_0 \sinh P \quad . \quad . \quad . \quad (7a)$$

$$I = \frac{1}{h} I_0 \cosh P - \frac{1}{hK} V_0 \sinh P. \quad . \quad . \quad . \quad . \quad (7b)$$

These equations are the generalised form of the restricted solution $5a$, $5b$, into which they degenerate when the parameters Z and Y are constants.

A FRENCH SOLUTION.

In connection with the foregoing solution attention should be called to a discussion of the same problem by C. Ravut in the issue of May 8, 1920, of the "Revue Generale de l'Electricite." In this Paper Ravut arrives at a solution which is formally equivalent to equations ($7a$) ($7b$), but which is valid only when the line parameters are subject to certain rather severe restrictions. This is a consequence of the fact that Ravut's solution requires in effect the expansion of the parameters Z and Y as power series in the variable x, and his auxiliary functions corresponding to the r and s series of the present Paper are expressed in terms of the derivatives of Z and Y with respect to x of all orders from zero to infinity. Compared with the present solution it is believed that this has distinct disadvantages both from a formal mathematical standpoint and also from that of actual numerical solution. In the first place, Ravut's solution is of restricted convergence and excludes entirely the important case of discontinuous variation of line parameters, whereas the present solution is absolutely convergent. Furthermore, even when Ravut's solution is convergent, its computation would be laborious and likely to be inaccurate. The present solution, on the other hand, is readily and accurately computable by means of an integraph, and the computation is no more difficult for irregular and discontinuous variations than for those which follow some simple law. The advantage attached to the present form of solution is particularly marked in the case where the spatial variations are rapid. In this case as the form of solution shows, the effect of the variations decreases in general with their spatial frequency, whereas the convergence of Ravut's solution decreases.

CASE OF SMALL VARIATIONS OF LINE PARAMETERS.

In practical problems arising in connection with telephone and telegraph transmission, we are usually interested in the case where the variation of the line parameters is small and fluctuates about a mean or normal value. To investigate this case it is convenient to write

$$Z = Z_0(1+z(x)) = Z_0(1+z)$$
$$Y = Y_0(1+y(x)) = Y_0(1+y),$$

where, as indicated, Z_0 and Y_0 are constants and z and y are functions of x. We now consider the case where z and y are small compared with unity, and neglect second order quantities in these variables. Writing $m_0=\sqrt{Z_0 Y_0}$ and $K_0=\sqrt{Z_0, Y_0}$ and defining the functions z_{jk} and y_{jk} by

$$\frac{x^k}{k!} z_{jk} = \int_0^x dx_1 \frac{x_1{}^{k-j}(x-x_1)^{k-j}}{(k-j)!\,(k-1)!} z(x_1)$$

$$\frac{x^k}{k!} y_{jk} = \int_0^x dx_1 \frac{x_1{}^{k-j}(x-x_1)^{k-1}}{(k-j)!\,(k-1)!} y(x_1),$$

it is easy to show that, to a first approximation,

$$r_n = \frac{(m_0x)^n}{n!}(1 + z_{1n} + y_{2n} + z_{3n} \; . \; . \; . \; + y_{nn})$$

$$s_n = \frac{(m_0x)^n}{n!}(1 + y_{1n} + z_{2n} + y_{3n} \; . \; . \; . \; + z_{nn})$$

if n is even, and

$$r_n = K_0\frac{(m_0x)^n}{n!}(1 + z_{1n} + y_{2n} + z_{3n} \; . \; . \; . \; + z_{nn})$$

$$s_n = \frac{(m_0x)^n}{K_0 n!}(1 + y_{1n} + z_{2n} + y_{3n} \; . \; . \; . \; + y_{nn})$$

if n is odd.

It is now a simple matter to sum the r and s series, as previously defined. Omitting the detailed work which presents no difficulties, we get

$$\begin{aligned}\Sigma s_{2n} &= (1-d_1)\cosh m_0x + (d_2+d_3)\sinh m_0x\\ \Sigma r_{2n} &= (1+d_1)\cosh m_0x - (d_2-d_3)\sinh m_0x\\ K_0\Sigma s_{2n-1} &= (1+d_1)\sinh m_0x - (d_2-d_3)\cosh m_0x \quad . \quad (8)\\ \frac{1}{K_0}\Sigma r_{2n-1} &= (1-d_1)\sinh m_0x + (d_2+d_3)\cosh m_0x\end{aligned}$$

where the departures d_1, d_2, d_3 are defined by

$$\begin{aligned}d_1 &= \frac{m_0}{2}\int_0^x dx_1 \sinh 2m_0x_1(z(x_1) - y(x_1))\\ d_2 &= \frac{m_0}{2}\int_0^x dx_1 \cosh 2m_0x_1(z(x_1) - y(x_1)) \quad . \quad . \quad . \quad (9)\\ d_3 &= \frac{m_0}{2}\int_0^x dx_1(z(x_1) + y(x_1)).\end{aligned}$$

By aid of equations (8) and (9) the solutions (3*a*), (3*b*), and (7*a*), (7*b*) are expressible in terms of m_0, K_0 and the departures $d_{1,\,2,\,3}$.

The Case of the Infinitely Long Line.

The foregoing solution, as formulated in equations (7*a*), (7*b*), is not immediately applicable as it stands to the case of the infinitely long line. To deal with this case we remark that, if we consider a point x sufficiently far out on the line, cosh P and sinh P approach the common limit *exp* (P) and V and I both tend to zero. Consequently, if x is made indefinitely large, the right hand sides of 7*a* and 7*b* must ultimately vanish, and from either of these equations we get

$$V_0 = KI_0.$$

Consequently K is the characteristic impedance of the line, and is given by the limit, as x approaches infinity, of the fraction

$$\frac{\Sigma s_{2n} + \Sigma r_{2n-1}}{\Sigma r_{2n} + \Sigma s_{2n-1}}.$$

This takes a particularly simple form for the case of small variations considered above; substitution of formula (8) for the r and s series gives for the characteristic impedance K

$$K = (1+k)K_0,$$

where

$$k = m_0\int_0^\infty dx_1(z(x_1) - y(x_1))e^{-2m_0x_1}. \quad . \quad (10)$$

This equation for the impedance K permits of some interesting deductions. For example, it is at once evident that the effect of the variations of the line parameters decreases as their distance from the sending end of the line increases, as we should expect. Again, if the variations are periodic in one-half the wave-length, their effect on the characteristic impedance is cumulative, and variations which are themselves small may result in large impedance irregularities. This effect has been experimentally observed in actual lines.

The foregoing analysis is of some utility in a number of practical problems. Among these may be instanced the following: (1) The characteristics of lines whose parameters, due to changes in the spacing of the wires, change discontinuously at frequent intervals; (2) the optimum method of splicing up cables from short segments which may be supposed to vary irregularly in their constants by small amounts. In so far as the consequent impedance irregularities are concerned, the latter problem is equivalent to that of minimising the integral k of equation (10), subject to any restrictions which may be imposed by practical conditions.

The Electrification of Main Line Railways in Relation to Traffic Working.*

By SIR PHILLIP NASH, K.C.M.G., C.B.

One of the principal difficulties in forming a fair judgment of the advantages of electrification lies in obtaining true comparisons of steam and electric operation from actual results. Moreover, so many of the figures which can be consulted are those of performances of new up-to-date electrical equipment, compared with steam locomotives designed many years ago. But nearly all electrification can be shown to effect some direct savings in money over steam operation, though only in special cases will the direct savings be sufficient to pay interest and depreciation charges on the capital involved and to leave any surplus profit. It is necessary, therefore, largely to depend upon the collateral savings and benefits to justify the expenditure involved, and such collateral savings do not invariably accrue to a sufficiently important extent in main line electrification.

Principal Fields for Electrification.

Broadly speaking, the electrification of main lines can only be expected to show direct savings when traffic is very dense, and even in such cases the most favourable conditions for electrification are a network of lines covering a rather limited radius, or a section of line where the volume of traffic is such that increased line capacity must be provided if steam haulage is to be continued. From a traffic working point of view the principal fields for electrification appear to be short-haul passenger services, the operation of terminals of large cities, freight haulage over sections of line having very dense traffic or heavy gradients, and in certain large yards for freight shunting services.

Few, if any, existing railway companies can contemplate additional capital expenditure for electrification, except for short distances under special conditions. And, in fact, no time could be more inopportune than the present for the financing of big schemes of railway development and improvement. On the other hand, the high cost of skilled labour, the high cost of coal, and the necessity for conserving supplies of fuel, all tend to strengthen the justification for electrification.

Another important aspect, which acts as a deterrent upon railways contemplating electrification, is the question of system to be adopted. One of the most disconcerting factors is the possible variations which exist in design, maintenance and operation, affecting the generation of current, distributing and contact systems, voltages, types of locomotives and other general features affecting equipment. This difference in systems must surely involve troublesome questions at some future date, but, in the meantime, a clear view is difficult as to which system it is best to adopt. It is clear that unless, in these early days of electrification some regulations are laid down, we shall be in the same position in regard to interchangeability of electrical railway equipment that we are in to-day in the absence of uniformity in air brakes, loading gauge, wagon stock and other matters, which position is restricting progress.

The Advantages of Electrification.

The principal advantages and limitations of electrification from the traffic working point of view are quicker acceleration and deceleration, electric power can be shut off when not actually wanted for use, an electric motor can take a larger overload than a steam locomotive, due to the higher speed attained under electric haulage, a higher frequency of trains in a given period can be reached; relief from annoyance and losses due to smoke, cinders, hot gases, &c., and reduction in the risk of losses by fire from these causes. There is no smoke to obscure signals, but, on the other hand, overhead equipment increases the difficulty of seeing signals; coal stages, ash pits, turn tables and water installations are not necessary. The electric locomotive is capable of a much higher mileage per day than a steam locomotive; its maintenance costs are lower since it has less moving parts, and it can work for considerably greater periods between heavy shop repairs. Compared with the steam locomotive, there are no losses of heat by radiation, no fire lighting, washing out or drawing fires. The availability of electric current is convenient for other purposes. An electric locomotive can be designed to afford a greater tractive effort than is possible for a steam locomotive for the same axle load and within the same loading gauge. As long as rotary motion is maintained, the absence of "pounding" in electric locomotives enables a higher axle load to be taken than in the case of a steam locomotive, without increasing the destructive effect on the road bed. The electric locomotive is little influenced in efficiency by extreme cold, nor does its performance depend on the skill of the driver to the extent which is the case with steam locomotives. The whole weight of an electric freight locomotive can be made available for adhesive purposes.

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* Abstract of a Paper read before the Institute of Transport.

The Limitations of Electric Traction.

The principal limitations are as follows:—

An electric locomotive is not capable of varying its speed and tractive effort in the same ready manner as a steam locomotive. At the present time, the number and diversity of types of electric locomotives under trial act as a deterrent. The highly developed system of power stations, line equipment and electric locomotives require more highly specialised labour for their proper maintenance and operation than is necessary with steam operation. There is a greater concentration of risk both in maintaining physical continuity of services and in the relations of railways to labour. Induction and electrolysis are liable to cause interference and damage. Electric locomotives can only be used where rail or overhead conductors exist. The transition period during conversion from steam to electric haulage offers peculiar difficulties in the efficient and punctual operation of train services. In order to get the fullest value out of the expenditure on electrification, increased frequency of trains, and increased train load, especially with goods trains, coupled with a reasonable increase in speed, are essential. To ensure safety in the handling of more frequent services of trains, additional expenditure will most probably be involved in improved signalling. To maintain the high frequency of trains, fly-over junctions or tunnelling will be involved. To enable higher freight train loads to be safely handled at higher speeds the fitting of continuous brakes to wagon stock may have to be undertaken, as also possibly the strengthening of draw gear. Steam operation is not susceptible to complete interruptions as is the case with electric operation. It will be seen that some of these limitations will gradually disappear, or be mitigated, as electrification becomes more general and as the science develops with increased experience and research.

Short Haul Services.

One of the formidable difficulties before certain main line railway companies is that of terminal accommodation for increasing suburban traffic. Main line railway companies are forced to provide these expensive terminals for long distance passenger and other purposes, but the extension of the same terminals for the purpose of accommodating short-haul traffic cannot go on indefinitely.

From the main line railway point of view, there is therefore a limit in length of haul of suburban traffic, within which it is uneconomical to allow and much less to encourage the use of these expensive main line London terminals. Purely for the purpose of illustration, the short-haul traffic originating within, say, 8 miles of some of the London main line termini may be considered, as being the class of traffic which is the principal cause of congestion and for which heavy expenditure on terminal extensions would not be justified. This short-haul traffic, which must necessarily entail low fares, is the class of business for which tram and other undertakings compete, and the main line railway companies are at a disadvantage in that respect in having to permit the use of their costly terminals.

Electrification quickly builds up a big traffic as far out as a 30 mile limit, which not only produces a heavy peak hour travel, but an improved all-day load curve. It is in the direction of stimulating traffic between, say, 8 and 30 miles from their termini that railway companies may be expected to turn their attention.

Electrification Commercially Considered.

Quicker transit for short distance passengers is of great importance, especially in view of the competition with road vehicles and trams. Main line railway companies have to consider whether electrification is a commercial proposition for short-haul traffic and, primarily, the deciding factor must be the density of traffic. But there comes a time when a steam operated suburban service cannot handle the traffic offering, and it is then not a question as to whether the cost of operating per train mile will be less under electrical conditions, but rather as to whether capital expenditure to increase the steam service is any greater than that necessary to convert from steam to electric haulage.

The actual cost of working steam and electrical trains of similar seating capacity for the same number of train miles per hour on suburban services used to be in favour of steam, but with the present high cost of fuel and operating expenses, it is doubtful whether steam operation can now be cheaper, even where density is not very great, and certainly not where the density is high. Electrification can offer 40 to 45 trains per hour over the same metals, when not confined to a single terminus. Steam operation cannot reach these figures. If the additional line and receiving facilities were provided to permit of the same service with steam, and if such expenditure were to be debitable entirely to the suburban service, the cost per train mile of steam operation would, under former conditions, have been as great, if not greater. To-day it will certainly be greater.

Electrification on the multiple unit system is therefore to be advocated as a means of providing the additional facilities required for suburban traffic, but the full possibilities of steam operation for this class of traffic should not be ignored. The Great Eastern Railway Company have probably got the most acute suburban traffic problem of any railway company in the Kingdom, and, before embarking on a necessarily enormous expenditure in electrification, have been able to increase their steam service on certain sections to a remarkable extent. This has been achieved by a close study of every incident of steam operation, by the elimination of every possible cause of delay, and by capital expenditure on works which can improve, ease, or assist the expeditious handling of traffic.

It is doubtful whether more expeditious movement of steam trains in and about passenger terminals could be obtained than is at present done every day in some London termini. These movements have been developed to a surprising extent, and do not take place to the same extent in other countries. At Liverpool Street station, about 1,200 trains a day are dealt with under "steam" conditions, which is probably the largest single terminal movement in the world.

Main Line Services.

A very careful study is necessary to determine whether the operating results can justify the expenditure on the electrification of main lines. The justification will depend primarily on the traffic density, and the savings will not exactly be those of the difference in cost of operation as between steam and electricity, but rather the effect this will have on the capital expenditure on the undertaking as a whole.

The elimination of train stops for locomotive purposes, inseparable from steam traction, is a valuable advantage. On the Newport-Shildon branch of the North Eastern Railway, 7 per cent. of the total freight engine hours is absorbed in locomotive duties for electric locomotives as against 25 per cent. for steam locomotives on similar services. The electric locomotive is capable of performing a much higher mileage per day than the steam locomotive.

For instance on the Harlowton and Avery Section of the Chicago, Milwaukee and St. Paul Railway, which section is 440 miles long, with one intermediate engine depot, and over which express passengers and general services are worked on regular schedules, electric locomotives do 440 miles per day and are subject to inspection after not less than 3,000 miles or not more than 5,000 miles. Records show that engines have worked continuously on this section for 766 miles. On the Norfolk and Western Railway of America certain mineral lines are worked electrically. Since electrification, the average speed of these trains has been increased from 6 to 14 miles per hour, and five electric locomotives do the work of 17 steam locomotives.

The maintenance costs of an electric locomotive are claimed to be considerably lower than those of a steam locomotive. With the former there are fewer parts requiring costly repairs, and an electric locomotive only depreciates when it is actually running. On the basis of fuel consumption there is also a very large saving in favour of the electric locomotive, while regenerative control is also a decided advantage on hilly sections, and by avoiding excessive wear and tear of brake blocks, overheating of tyres, &c., reduces the maintenance cost of permanent way.

Shunting Operations.

Statistics show that of the total freight engine mileage, no less than 41 per cent. is occupied in shunting. Of this 26 per cent. is performed by regular shunting engines, and 15 per cent. by train engines. In the direction of reducing the cost of the process of shunting electrification offers possibilities. The results of a test of shunting by steam locomotives carried out by the London, Brighton and South Coast Railway, who are studying the question of electrification of shunting yards, is interesting. Tests were taken at several different yards, and the following was the average performance of a steam yard shunting engine. During a period of 435 minutes, 190 minutes, or 43 per cent., were spent standing, and 245 minutes, or 57 per cent., moving. During 121 of the 245 minutes, the regulator was open. Therefore, steam was only being used for 28 per cent. of the time, but the engine was, of course, consuming coal during the whole time. The average speed of the test worked out at 2·71 miles per hour for the whole period.

There remains the question of shunting by train engines, in the event of main line electrification taking place. The electrification of all the sidings connected with a railway is clearly not practicable, and it seems that the electric locomotive will, when necessary, have to carry a battery equipment, in the form of a tender, to enable it to work away from the fixed equipment.

The Fundamental Question.

The fundamental question is whether the substitution of electric for steam haulage for the purpose of traffic working is warranted by increased efficiency, or by increased production of movement, and, finally, whether it is financially practicable, bearing in mind that electric installations involve higher cost than steam, and there must be a scrapping of existing plants.

The wholesale electrification of the railways of the country or even the electrification of the whole of any one railway is obviously neither practicable, nor desirable, bearing in mind the cost and results to be obtained. The doom of the steam locomotive has not been sounded. These facts should not, however, discourage any advocate of electrification, as gradually, where justified, electrification will slowly but surely take place, and there is a large and profitable field for both electrical engineers and manufacturers.

The traffic of the country is not going to remain stagnant, and railway managers will continue to consider the continual growth of facilities to cope with increased business, and prevent congestion, slowing down, and even paralysis. Suburban electrification offers great opportunities for obtaining increased earnings with prospects of giving a reasonable return on new capital, and this should encourage railway companies to tackle judicious electrification round the great centres of traffic and about our larger cities. Later on, when electric working has to be extended to main lines, the task is more straightforward and the burden of capital, for which interest has to be found, will be lightened.

DISCUSSION.

Anyone who doubts the interest of railway officials in the question of electrification would have had those doubts set at rest by a visit to the meeting of the Institute of Transport at which the above Paper was read. The "Civils" theatre was crowded, and both the Paper and the subsequent discussion were followed with the greatest appreciation.

Sir **Herbert Walker** (London & South Western Railway), in introducing Sir Philip Nash, said that he was certain electrification could now save the railways money and bring with it increased traffic and cheaper operation. His own experience had been that while the cost of operating electrified lines during the last few years had increased by 100 per cent., the increase in the operation of the steam-worked lines was over 200 per cent., and though this, of course, applied to suburban lines only, the figures were worth consideration.

In opening the discussion which followed the reading of the Paper, Sir **John Aspinall** said that electrification was nowadays purely a question of capital cost, for while in 1905 it was possible to provide electrical equipment at the cost of £15,000 per mile, at the present time the sum required would be nearer £40,000 per mile, or in other words, completely to electcrify our existing railway systems would require a sum equal to two-thirds of the present capital account. It was obvious then that electrification would have to proceed little by little, and his opinion was that great advantages would be obtained by electrifying shunting yards forthwith and following with goods trains. Sir Philip Nash had made a great point of terminal congestion, but it was a matter for consideration whether in future terminals would not have to be avoided altogether, by putting them underground and providing running round loops. Sir Philip had rightly called attention to the advantages of regenerative control, and such a system would be of great use on such lines as those to be found in the mining districts of South Wales, where the load was all in one direction and that downhill.

Sir **William Forbes** (London, Brighton & South Coast Railway) said that his experience had been that while electrification brought with it 150 per cent. increase in traffic it meant 200 per cent. increase in money. A scheme was now ready for forwarding to the Ministry of Transport for the electrification of the entire main line between London and Brighton. When this was carried out they hoped to obtain a saving on operating expenses of 6 to 7 per cent., taking the 1920 figures as a basis, and without regard to any increased traffic which would undoubtedly accrue. Electrification was a necessity at the present time, but the railway companies must receive some help to enable them to carry it out.

Sir **Philip Dawson** said that given certain conditions his experience on both the London and South Coast Railway and the Great Eastern Railway showed that electrification was worth while financially even now. Unless in fact capital was found for the purpose railways would be unable to deal with the increased traffic, which traffic could only be dealt with electrically. The terminal facilities at Victoria and London Bridge had been increased over 100 per cent. by electrification, though the limit had been reached with steam operation.

Sir **Vincent Raven** said that electric traction on the North Eastern Railway had been entirely satisfactory. On the Shildon-Newport section they had been able to replace 13 heavy steam locomotives by five electric locomotives, and the maintenance cost of the latter was only about one-third of the former charges. Electrification was intimately bound up with labour questions, for as wages were unlikely to come down the number of men employed would have to be reduced. Electrification would enable this to be done by reducing train, shed and other similar staffs. He thought that too much had been made of the capital question, as a good deal of the expense of the change over should be allocated to revenue. He was in favour of railway companies not building their own power stations but obtaining their energy from the supply authority.

Mr. C. H. **Merz** said that as regards electric traction, the same course was likely to be followed as with power. At present no factory was complete without electric power, owing to the greater ease and facility with which it could be applied. In considering this matter everyone connected with the railways should take a hand, and a closer study of the problems by non-electrical people was very necessary.

Electricars Electrics for Municipal Transport.

During the past eighteen months we understand that Messrs. **Electricars, Ltd.**, have been engaged in very considerable experimental and research work in connection with the needs of the Municipal Engineer and Surveyor. One of the results of their energies is depicted in the accompanying illustration.

It is considered by its manufacturers that this electric vehicle is the nearest approach that has yet been reached to the ideal municipal wagon. Perhaps two of the most difficult requirements of the refuse collecting wagon are:—(1) Adequate carrying capacity; (2) Keeping the body sufficiently low to enable the filler to work without the use of a ladder.

New Municipal Electric Wagon.

Number one is a very difficult factor, owing to the different conditions which obtain in each town, but its importance is apparent when it is considered that no vehicle can be earning anything for the owner, while it is standing idle being loaded. It is, therefore, essential to determine the correct carrying capacity of the vehicle in order to avoid wasting the time of the vehicle on the one hand and wasting the time of the fillers on the other. In practice, it has been generally found that the 40 to 50 cwt. Edison Accumulator Wagon is the most economical unit to employ for this class of work.

With regard to number two, it is almost unnecessary to say that while the old method of using a ladder to load the van with the horse-drawn vehicles was tolerated, it is absolutely ruled out in the case of mechanically propelled vehicles, doing to the enormous waste of time involved.

In the case of the wagon we are referring to Messrs. Electricars, Limited, have been successful in keeping the loading line sufficiently low, as it is only 5 ft. from the ground, which means loading from the curb at a height of 4 ft. 8 in.

Temperature Limits of Large Alternators.

DISCUSSION AT LEEDS.

A meeting of the North Midland Section of the Institution of Electrical Engineers was held at Leeds on February 8th, at which Mr. G. A. JUHLIN's Paper on "Temperature Limits of Large Alternators" was discussed. An abstract of the Paper was given in our issue of January 28th.

Mr. W. M. SELVEY said, listening to the Paper, he felt that Mr. Juhlin was breaking the news that in relying on thermometer temperatures for alternators we had actually been getting in the interior of the machine temperatures of the order of those which he (the author) was now suggesting should be used. If this was the impression which Mr. Juhlin wished to convey, he was absolutely justified in asking that it should be recognised. The generators coupled to the earlier turbines were always built with high overload capacities, so that they could be run continuously without damage. At present, machines very quickly burnt out if run for any considerable period on any overload. To-day, also, machines were running at higher speeds than before. This meant less material for a similarly rated machine, hence the same amount of heat had to be got rid of from a smaller mass of material. Good electrical insulation was, generally speaking, good heat insulating material. If, then, our insulation could be made to stand nearly any temperature likely to obtain, our old pre-occupation about temperature would go by the board. Formerly, temperature limits had been laid down because of the deteriorating action of the heat on the insulation. It was difficult suddenly to take up the view that the temperature would not matter could we have the entire insulation heat resisting, and Mr. Juhlin had adopted a reasonably cautious attitude. It was doubtful whether the necessary measurements could be made accurately with the temperature detector or whether it could be used without weakening the insulation of the machine. Dealing with the difference between 6,000 and 11,000 volt machines, the author apparently expected higher temperatures at a higher voltage. A larger machine with more insulation, less copper, a higher density and higher loss would be necessary, and there would also probably be an appreciable difference in output per pound of material.

CALCULATIONS VERSUS TEST RESULTS.

Mr. F. CREEDY said he had never been able to get any calculations which agreed with tests, and that he would like to know Mr. Juhlin's experience in this respect.

Mr. O. SPURR said that in specifying temperatures the operating engineer was only playing for safety. Other causes of breakdown besides those mentioned by the author, were bad workmanship in assembling, assembling under bad conditions and transport difficulties. No matter how careful winders were they were sometimes asked to work under such adverse conditions that it was practically impossible to turn out a good job. Even in the shops too much care could not be taken on big machines. A coil could be so easily damaged and the damage might not be seen nor its effects appear until later. The final word had not been said on air washers, and the question of refrigerating the air after washing must be considered.

Mr. J. D. BAILIE pointed out that in the tests carried out by Mr. Juhlin the heating had been applied continuously to the test bars. He would have liked to have seen results of experiments in which it had been applied intermittently. Rigidly clamping the end turns might be detrimental owing to the expansion of the coils. If new and higher temperature limits were adopted rotor sizes, and hence peripheral speeds, could be reduced. He had always been nervous of wet air filters and his feeling was at the present for air coolers.

Mr. G. A. JUHLIN, in reply, said that if a record of the internal temperatures of machines operating to-day could be obtained, it would be found that the average would be very near what he was putting forward. The majority of designers were of the same mind as himself on this matter. In the early days machines were designed for close regulation. The stator was not loaded up, and though the rotor was fairly loaded, it did not have to withstand a big increase in current density under considerable overload. To-day this was not so. Though higher speeds meant better cooling, the problem of getting rid of the heat was made more difficult. It was at present not commercial to use mica alone. A little of some other substance had to be used, though this little was being continually cut down. Something better had been evolved not in the way of insulation but in the method of manufacture, and it was possible to get 33 to 50 per cent. more material into the same space as the mica test wraps referred to in the Paper. That meant getting rid of bonding material, eliminating all air spaces, and thus approaching nearer an ideal condition for that insulation material. The impression that there was a higher temperature limit for 11,000 volt than for 6,000 volt machines was erroneous, but with equal external thermometer temperatures the 11,000 volt machine would have a higher internal temperature. The 6,000 volt machine had slightly more material in it, so that the output per pound of material was little altered.

DISCUSSION AT BIRMINGHAM.

Mr. JUHLIN's Paper was also discussed at Birmingham on February 2nd.

In opening the discussion, Dr. G. KAPP said that in his opinion the most important matter was not to get cheaper, but safer, machines, and safer machines involved an exact knowledge of the heating conditions. He could not agree that the use of a thermometer was the simplest and easiest method. Anyhow it was misleading. It was essential to know the actual temperature at the hot spot, and this necessitated a detector actually at the hot spot. A null method of determining hot spot temperature suggested by him consisted in using in the outside circuit a couple of the same material as that embedded in the machine at the hot spot. The outside couple was immersed in a liquid which could be heated until a galvanometer gave zero reading. The outside couple was then at the same temperature as the embedded couple, and its temperature could be accurately measured.

Major A. M. TAYLOR suggested a method of deducing the hot spot temperature indirectly from observations on, first, the increase of resistance of the whole circuit due to the combined action of the normal part and the hot spot part, and then, the increase of resistance in the complete curcuit when the hot spot was not active (as, for example, when the stator was cool). To carry out the suggestion it was necessary to know the proportion of the length of the circuit covered by the hot spot.

THE ONLY SURE METHOD.

Mr. A. T. BARTLETT said that as regards the use of temperature detectors this was the only sane way of running plant. In the case of a power house, if a set was started up cold and the steam end was capable of dealing with a certain overload, the generator could also be overloaded for a time if the detector showed that the safe temperature was not exceeded. In his opinion, ascertaining temperatures by balancing methods was wrong. The power house attendant already had enough to do, and all detector instruments should be of the inspectional type.

Mr. W. J. LINE said that it appeared to follow from the mechanical tests described by the author that breakdown under high voltage might be expected to occur at the same place as mechanical breakdown, namely, where the insulated conductor left the slot. He believed it was a fact that breakdowns did occur more frequently at this point than elsewhere. But he questioned whether it could be inferred that electrical failures occurred where mechanical failures occurred due to bending of the insulated conductor at its point of emergence from the slot. In connection with the results of some dielectric and other tests made some years ago by Wilson and Mitchell, it was suggested that as the density of the dielectric force at the ends of the slots in which the coils were embedded was considerably increased the ends of the slots should be rounded, and this suggestion seemed worthy of consideration.

GRADUAL DEVELOPMENT V. IMMEDIATE INCREASE.

Dr. M. KAHN said he favoured gradual development rather than an immediate increase of temperature limits. All firms building large units and many operating engineers were alive to the question and data and experience were continuously increasing. The question was not an urgent one, as it was quite possible to produce the sizes at present required within the limits of a total working temperature of 120°C. Manufacturing and operating engineers who had to rely on these units for a large proportion of the load had no interest in running risks. The accumulation of experience would naturally tend to lead to a development up to a safe limit in course of time. A point not mentioned by Mr. Juhlin, which might conceivably determine the safe temperature limit, was the expansion of the long coils in large machines.

DISCUSSION AT NEWCASTLE.

Mr JUHLIN's Paper was also discussed at Newcastle on February 14th.

Mr. E. FAWSETT was pleased to hear that the use of thermometers for the measurement of alternator temperatures was now entirely superseded. With the use of embedded temperature detectors, however, there was always the fear that there might be hotter spots than that where the detector was embedded, and the positions must, therefore, be chosen with care. The increase-in resistance method was also preferable to thermometers and would give a fair indication of the maximum temperature of the machine if the design was good, and if a cooling curve for the machine was available and the temperatures obtained by the resistance method were plotted back allowing for the time interval. A continuous indication of the temperature of a machine would be of the utmost value at times when it was desired to run on overload. The manufacturer should specify the temperature limit which a machine could stand, and, having specified it, should be prepared to stand by the specification and accept responsibility for the behaviour of the machine up to that temperature.

The Advantages of Higher Temperature Limits.

Mr. T. **Carter** objected to the author's expression of the thermal conductivity in the terms of the number of watts lost per cubic inch as no lateral dimensions were specified. It should be specified as the number of watts transmitted through 1 in. length of the material having a cross-section of 1 sq. in., which was not necessarily the same thing. Regarding the advantages to be gained from the adoption of higher temperature limits the statements made in the Paper were rather vague and some quantitative statement was required. The present lower temperature limits were on the safe side, and although some people were prepared to accept the higher limits the majority had still to be educated.

Mr. W. N. **Waite** said machines could not be worked on the basis of a fixed load rating, as the load which the machine could carry was dependent upon the ultimate temperature attained which, of course, varied with the temperature of the air prevailing. The position of the thermo-couples in the machine required careful determination. In one instance the thermo-couple thought to be in the hot spot, registered 40°C. with the machine on load, when the load was cut off and the fan stopped the temperature rose to 92·7°C., and when the machine came to a standstill the temperature was 79·5°C. measured by thermometer, and 72·5°C. measured by resistance. The necessity for the measuring instrument being as simple as possible ruled out the resistance method and also ruled out the neutral zero thermo-couple method.

Mr. C. H. **Davison** remarked that thermo-couples were now generally accepted as means of temperature measurement, and improvements in machine design had largely removed the troubles of hot spots. Regarding the limiting temperature for the mica insulation more consideration should be given to the limiting temperature of the fibrous material and shellac used to hold the mica together, and attention should be given to the discovery of better binding materials. High voltage machines were always safer than low-voltage machines, as, owing to the thicker insulation employed, they were better able to withstand the shocks and surges encountered on a commercial system.

Higher Voltage Machines.

Mr. R. M. **Longman** was another speaker who favoured the higher voltage machines because of the greater insulation. If machines were to be run to the specification suggested there would be no overload capacity and the very best workmanship in all joints would be necessary. Any carbonisation of the insulation would allow movement and the shocks of the system would give rise to pounding of the insulation, so weakening the mica.

Mr. J. R. **Beard** inquired whether any machines had been run at the B.E.S.A. rating for any length of time.

Mr. G. A. **Juhlin** (in reply) said it was preferable to specify a machine should stand a temperature of 160°C. than to specify that it should have a temperature rise of 40°C., because the latter, depending upon the air temperature, conveyed no meaning. The binding material in the insulation was certainly of great importance and the amount of such binding material was now being considerably reduced, all mica insulation being put on under heat. In view of the enormous number of layers of mica used, any movement due to expansion could only be exceedingly small. For heavy current conductors he preferred laminated conductors to stranded conductors, owing to the difficulty of using mica insulation with the latter. If a machine was being run to its limits as indicated by temperature detectors then the question of overload could not arise. Only four cases of trouble had been encountered in the American machines where the trouble could be rightly attributed to high temperatures and the temperatures in these cases were very much above the specified limits.

Mr. Ll. B. Atkinson on the Qualities of the Young Engineer.[*]

In addition to the Central Students' Section of the Institution in London, which has 406 members, there are now five other students' sections, and the total number of students on the roll of the Institution is 1,756, of whom 1,138 are attached to students' sections. Among the students of the Electrical Engineers we may reasonably look for future Presidents of our Institution. My recollections go back clearly to the days when I was a student of the Institution of Civil Engineers, and I realise the advantages which accrued to me from listening to discussions and reading Papers in the students' section. Provided the speaker at students' meetings speaks to the point and on a subject on which he can give new or relevant information, he is helping his fellow members and abtaining a useful and proper publicity for his own abilities. Such publicity is the means of making acquaintances and not infrequently of meeting with business openings or opportunities which might otherwise have not occurred.

In nearly all cases material success will reach its highest point for a given quantity of ability, if that ability is devoted solely to one subject. In any case, it is well to specialise on something or some branch of a subject to the point of being a recognised authority and master of such a subject, and for a given level of ability material success will be greater for ability devoted directly to the commercial rather than to the scientific side of engineering.

A Definition of Ability.

Ability covers such qualities as clear appreciation of the elements of a problem, sound judgment as to the weight to be attached to these elements, the power to *decide* on the most suitable solution of the problem, and the power to execute the solution decided upon. These qualities are equally applicable to an engineering or a commercial problem. The designer and the commercial engineer have to deal with the same problem, but the designing engineer will only indirectly or slowly feel the benefit or loss arising from a correct or incorrect solution. The commercial engineer will almost immediately realise the result of his decision and profit or loss arising, and the money value of his service, and this will much more quickly reflect itself on his earning power, either as an employer or a manufacturer, than in the case of the designing engineer. Probably it is from this cause that the best paid parts in engineering work are on the selling or commercial side, but so also is the weeding out of ability not equal to its tasks more ruthless.

A manifesto issued by a recently formed union of scientific workers is, I think, intended to convey the idea that a person employed on research is in a different category from a designer paid to design or a cook paid to cook dinners. To my mind, that is fallacious. Research workers have only to show that their employment is sufficiently profitable when high salaries are paid to them, and they will be able to demand equivalent payments. The scientific worker has a set off, compared with the commercial engineer, in an occupation giving great mental and intellectual pleasure, greater *réclame* if success is won, a more regular life, less anxiety and harass, and less risk. So to you I suggest that whatever your energy, attainments, study the principles of business, of organisation, of finance, of economics.

The Study of Economics.

Those who would like to dip into economics might look into two quite small books, "A Geometrical Political Economy," by Mr. H. Cunynghame, and a reprint from The Electrician of articles which appeared in 1918 and 1919 under the title of "The Economics of Works Costs," by Mr. J. R. Dick, who is head of an engineering works producing electrical specialities. The former is graphical and the latter analytical, but either illustrates my point that business problems may be studied by very powerful methods useable by those who like engineers are trained in these methods.

When I was apprenticed in Kitson's locomotive works the keeping of costs was very perfunctory. There was no check and much manipulation. All these methods in modern works have gone. Costs are accurately ascertained and checked by special staffs, the planning of outside work is done by the head office and the control of the execution entrusted to a young trained engineer. I strongly urge you to seize every opportunity of getting into such outside work. Again do not be afraid to study the markets and prices of the raw materials engineers have to deal with. Study the elementary principles of contract law, the transfer of property or rights to property and the consideration given, and how contracted conditions may sometimes arise without intention, and also study the principles of capitalisation and control of limited companies. Never allow men under your charge to be where—if any accident to plant or lifting tackle takes place—they will be injured.

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[*] Abstract of an address by Mr. Ll. B. Atkinson, President of the Institution of Electrical Engineers, to the Students' Sections at Birmingham, on January 4, 1921, and in London on February 18, 1921.

THE NECESSITY FOR ACCURACY.

A scientific training will lead to scientific accuracy in thought and expression. The taking of trouble in thinking out and framing expressions is rather out of fashion, but this makes it the more easy to mark one's way in the crowd by taking trouble in this direction. Care comes with age and experience. He had read in his father's diary: "It is a pity X is so careless, we have had to relevel a whole section of the railway again, owing to his inaccuracy." Yet X became a celebrated engineer and a president of one of our Institutions. Men of ability and position were usually anxious to help the younger men who were working seriously at the problems of science and industry. He spoke gratefully of the help and guidance given to him as a young engineer by such men as Sir W. Siemens, Sir Wm. Preece, Prof. Ayrton, Dr. Silvanus Thompson and many others.

A man of position and experience, speaking to him of someone who complained of the difficulty of getting on, said: "I do not know of a single case of a man of reasonable ability who works reasonably hard, and who has a good character and good health and who is absolutely honest who has not got on." Another speaking of the members of his staff said, "there is a very small apparent difference between the man worth £100 a year and the man worth £1,000 a year. The first does his work well, but comes a minute or two late, and at the closing hour he has put everything away, has washed his hands and has his hat on, ready to go. The man with £1,000 a year finishes when the job is finished and has prepared his mind for the day's work by the time he comes in the morning."

Among the greatest of powers to be cultivated is unfailing good temper. It saves nerve strain and exhaustion to yourself and helps others along at the same time. Take part in the social activities connected with your works or societies connected with your profession and industry. It is another means of opening new channels of thought and new avenues of employment. Our real friends when we get older are those we have cultivated as young men. Social changes that are taking place must mean a diminution of relative wealth and position to the classes from which young engineers are drawn, but it need not mean a diminution of happiness and contentment. If education, refinement and regard for others were equally distributed much that we dislike in these changes would disappear. The great experiment in education which is just beginning will tell us a good deal, but not perhaps for 20 years. In the meantime all you can do is not to take any step that accentuates difference of class. On the whole, engineers have a wider and more tolerant outlook on these matters than other professional classes, because in youth they are in working contact with manual workers.

Sir Philip Dawson on Electric Traction.

Speaking on the subject of electric traction to the senior students of Faraday House on Friday last, Sir **PHILIP DAWSON** said he wanted to give some idea of the possibilities of this form of working as applied to heavy railway work. The application of electricity to tramways brought about a great loss of passenger traffic on suburban railways, and electric traction was adopted to meet that competition. The necessity for generating economically caused polyphase alternating current to be used, and that brought about the idea of employing alternating current for traction purposes. The invention of the single-phase motor brought about the possibility of using pressures up to 16,000 volts on the overhead system. That, again, militated against the direct current system of 500 and 600 volts, though, at the same time, improvements in direct current motors enabled the working pressure on that system to be raised to 1,500 and subsequently to 3,000 volts. The advantageous characteristics of the three-phase system, which was also occasionally used, were now obtained with the single-phase system by means of the split-phase locomotive.

THE DANGERS OF STANDARDISATION.

Standardisation of traction systems, though necessary, worked more harm than good if carried too far. This error had been avoided by the Electrification of Railways Advisory Committee of the Ministry of Transport. He thought their report was a remarkable success when the very varied opinions which had to be brought together were considered. In France they had gone too far on this question by definitely standardising at 1,500 volts. In Germany, Sweden and Switzerland they had standarised on the single-phase system with $16\frac{2}{3}$ cycles and a line pressure of 16,000 volts. Belgium had not yet standardised, but the density of traffic was so great and the distances so small in that country that practically a big suburban system had to be dealt with, and probably about 1,600 volts direct current would be most satisfactory. The U.S.A. did not propose to standardise yet, and side-by-side extensions were going on of high-tension 3,000 volt direct current and 11,000 single phase volt 25 cycles alternating current.

SUB-STATION DRAWBACKS.

It might truly be said that the whole question of systems was to decide which paid best. With 1,600 volts alternating current on the overhead conductor, and supposing there were one train circulating over a line, the train could be supplied with current from two sub-stations, or possibly one; but with direct current at 750, or even at 3,000 volts, many more sections had to be used, they would be closer together, and each must have sufficient capacity to supply the whole demand of the train. If there were as many as nine sub-stations, the power station would only have to supply the power required by that one train, while each sub-station would have to be capable of doing the same thing. In that case the plant installed in the sub-stations would be nine times the plant installed in the power station. That gave a rough idea of the difference between the two systems. At 1,500 volts, direct-current motors were cheaper, lighter and slightly more efficient than alternating current and their cost of maintenance was less.

In working out capital costs the total cost of electrical equipment and rolling stock must be compared with the cost of line equipment and sub-station plant. If there were constantly a train on each section, then the total amount of plant in the sub-stations in each case would be practically the same. Therefore, where there was a very frequent and continuous traffic, it was practically certain direct current would have an advantage over alternating current; but where trains were very heavy and infrequent, and the lines long, the high-tension alternating-current system would cost less than the direct current with single phase.

THE FREQUENCY QUESTION.

There were advantages gained by using $16\frac{2}{3}$ cycles, particularly in the design of the motor, though it meant heavier and more costly transformers. As regarded the direct-current system, the question of frequency also arose. It was simply an economic question. Rotaries at 50 cycles were not as stable as those at 25 cycles, and it had, therefore, to be considered whether the difference in the stability was such as to make it incumbent on railways electrifying with direct current to adopt 25 cycles. If 50 cycles could be standardised, so much the better for everyone.

One of the most important points that had yet to be settled was the permissible drop in the earth return circuit. This was being considered by the Electrification of Railways Advisory Committee. With regard to interference with telegraph and telephone circuits, Mr. Houghton said that during the 11 years' working of electric traction on the Brighton line there had been no troubles to speak of.

ENERGY COSTS AND DEMANDS.

At pre-war prices the cost of current was a little over 50 per cent. of the operating cost of an electric railway, and therefore the cheapest possible current was necessary. One train going out of Victoria station took over 2,000 kw. to start. That gave some idea of the amount of current required for operating a railway. Of the total demand for electricity in the London area contemplated by the Electricity Commissioners, about half would be required for railways. When the suburban electrification of the Brighton system was completed, there would be 40,000 kw. to 50,000 kw. on that railway. When the Great Western suburban electrification was completed, it would require about double that power. The load for the Brighton line would justify a plant of 100,000 kw., and for the Great Western 150,000 kw. or more.

The load factor of the railway load was also very satisfactory. On the Brighton railway they were only working 30 motor coaches, of these a portion were operating over a short system. When they had 300 motor coaches or more, operating on a larger system, the load factor would be better. It would not be far wrong to take 40 per cent. as the load factor of a large railway generating station, and few loads in London could be added to it which would greatly improve it.

Generation and Distribution.

Theoretically, better results were got with very high steam pressures, but he did not think very much was gained by going over 325 lb. per square inch, and boiler temperatures of about 657°F. There was little difference in capital cost between 25 and 50 cycles. As regarded economy in very big stations, at Detroit in 1916, for a load factor of 41, they got the kilowatt-hour for 19,700 B.Th.U., and when they had to use worse fuel in 1918, at an improved load factor of 47, they used 20,900 B.Th.U. Lots road worked out at 29,000 B.Th.U., Dunston 21,400, and the German stations, burning brown coal, at load factor of 40 per cent., at 25,000. Experience seemed to indicate that over 33,000 volts between conductors, three-core cables were inadvisable. Higher than that the magnetic field affected the insulation in a few years. The A.E.G. were experimenting with the use of three-core cables up to 60,000 volts, and the French school were considering the question of utilising single-core conductors for extra high pressures. There was an installation in Paris with mains of 35,000 k.v.a. They were going to have mains of 150 km. in length, with 50 cycle single-phase cables, laid side by side in concrete ducts underground. They might go as far as a maximum section of 300 sq. mm., though they did not recommend going beyond 200 mm. He had a strong impression of the views of the late Mr. Duddell on extra high tension cables, who came to the conclusion that it was not safe to work with 6,000 volts between the conductors.

They also considered safety devices, and came to the conclusion that the only safety was to be found in the cables and transformers themselves. In Switzerland and France, with 50,000 volts between conductors, three-phase 50 cycles [illegible], no safety appliances were being installed.

The Severn Barrage Scheme Once More.

A joint meeting of the Institutions of Civil, Electrical and Mechanical Engineers was recently held in Birmingham to discuss the Severn Barrage Scheme and particularly the Third Interim Report of the Water Power Resources Committee. Mr. J. D. Watson presided.

The discussion was opened by Mr. R. A. Chattock, who remarked that no estimate of the cost of the scheme had been given in either of the reports. The M.O.T. scheme mentioned 1,000,000 H.P. with an average of half-a-million H.P. over a ten-hour day; the Water Power Resources Committee an average of 260,000 kw. over a ten-hour day. On the latter basis assuming an average efficiency of 63 per cent., the capacity of the generators at the barrage should be 476,000 kw. The cost of the necessary electrical machinery would be £17,707,000, which was far too high; he therefore suggested constant current direct-current generators in place of constant potential generators, run in series on the Thury system. The cost of the electric plant, exclusive of foundations, buildings, &c., would in this case be £11,998,000. On the basis of electrical machinery only current would cost on the M.O.T. Scheme 0·544d. a per unit, and on his suggested scheme 0·369d. per unit. The cost of other sections of the work would probably be far heavier than the cost of the electrical equipment, and he welcomed the suggestion that the Board of Trade should appoint a special Committee of Inquiry, mainly composed of technical and scientific members, to make investigations.

Prof. E. C. Lea discussed in detail the complex tidal variations in the Severn and the geological features of the site. Before taking decisions careful hydrographic surveys and records should be made, especially in regard to the problem of silting, which might materially affect first costs. The daily and the 14-day variations of the tide must be studied in relation to proposed capacity of the reservoir. The turbines should work efficiently at heads varying from 6 to 36 ft.

Mr. J. W. Twinberrow described the scheme which he had submitted to the Water Power Resources Committee and the subsequent discussions with this Committee and the M.O.T. Further suggested investigations included a study of the geology of the Severn Tunnel and Beachley, aided by borings and trial holes, and an examination of the old G.W. Railway drawings; continuous records from tidal gauges at both spots; determination of the silt in suspension in samples of water and its effect on turbines; a survey of the highland in order to find if any better site for the reservoir than that chosen at Tintern existed; a consideration of the probable effect of vested interests; a study of the effect on high tension generators and transformers in the humid Severn atmosphere and a fresh survey of the Estuary.

Further Study Necessary.

Mr. H. F. Raikes urged the need for further study of tidal conditions, with a view to finding the best site for a solid and water-tight foundation. Fourteen years were consumed in boring the Severn tunnel and much underground water was encountered. Silting up might seriously interfere with navigation and water-storage. The construction of dams across the Severn and Wye might seriously affect fishing interests on both rivers. He thought all would agree in deprecating the manner in which the scheme had been introduced to the public by the Ministry of Transport without any engineering evidence of its practicability.

Mr. F. W. Macauley remarked that the site for the proposed dam for the reservoir up the Wye Valley was in a limestone formation, such as would not be approved by any engineer. His dam foundations would be a vanishing quantity. The "lined type" of reservoir necessitated by this formation would be very expensive, exceeding £1,000 per million gallons of content. Much fuller investigations were needed before it could be decided that the most vital factors of the whole scheme, the barrage and the reservoir, were feasible.

Mr. F. H. Clough said one could not go far with technical considerations until it was ascertained that the financial aspect was reasonably sound. It appeared that machinery, switchgear and transmission lines would cost about £20,000,000. Capital charges on this sum at 15 per cent. (based on 15 years' life) would be £3,000,000 per annum, and with a continuous output throughout the 24 hours of 150,000 kw. the price per unit due to this capital charge would be 0·67d. The civil engineering he estimated would cost £10,000,000, involving an additional cost per unit of 0·17d. for 150,000 kw. load, and proportionately higher for smaller loads. Possibly the barrage could be built to develop the more expensive part of the scheme gradually as demand warranted, or as money could be obtained. In this respect, the scheme differed from many water-power schemes where the whole capital expenditure must be incurred before any power could be delivered. Tidal irregularities in the Severn might be due to a "resonance" effect, which might be materially modified by the barrage and have an important bearing on the calculated performance of the machinery.

The History of the Scheme.

In opening the proceedings at the second meeting Mr. G. L. Addenbrooke gave a detailed account of the constitution and private deliberations of the Water Power Resources Committee which was eventually asked to place their evidence before the Ministry of Transport. The Ministry of Transport, without a word of warning, had afterwards launched the now familiar proposal in the newspapers. If such procedure were repeated by Government Departments, the confidence of independent engineers in placing proposals before them would receive a rude shock. Sir John Snell had recently authorised The Electrician to state that neither he nor his Committee had any part in these proceedings. Mr. Addenbrooke said that further inquiries, Parliamentary procedure, and the raising of the necessary finance, would probably make it impossible for the first sod to be turned under four years. There were available six years at least in which these matters could receive further consideration.

Mr. N. B. Rosher dealt with the transmission of 100,000 kw. to Birmingham, approximately 70 miles away. The cost with overhead transmission would be approximately one-quarter of the cost of a system of buried cables for the same section of copper. Two double circuit lines should be taken to two separate substations convenient for feeding Birmingham and district. Supply could be [illegible]. Each circuit would transmit 25,000 kw. or 50,000 kw. per tower line. The total cost of the two transmission lines capable of transmitting, including two sub-stations with switchgear, step-down transformers and induction regulators, he estimated at £1,000,000. The capital charges per unit would be about 0·081d. The units lost in transmission would add about 0·05d. per unit. The total charges were, therefore, 0·131d. per unit, or assuming a generating cost of ½d. per unit, the actual price delivered into the Birmingham mains would be 0·631d. per unit. The selling price might be fixed at 0·8d. per unit, as compared with 2d. per unit at present, and on this basis it would appear that the transmission was justified.

Prof. F. W. Burstall confined himself to the generation of power from solid fuel and liquids. It was sometimes possible to generate power on a small scale at a cost very little higher than wholesale production. In this case transmission systems involved not merely lost power, but interest and depreciation. Some people believed that the future rested entirely with enormous power stations, others had more faith in the small and medium sized motors working either direct from coal or oil. Some Diesel motors consumed less than 0·4 lb. of oil per horse-power and worked at 0·43 b.h.p. per hour, and Crossley solid injection engines would give similar results. He was interested in researches on gas engines which might also lead to substantial improvements in economy. Enormous sums of money should not be expended on schemes for the production of cheap power without first making sure that still cheaper power could not be otherwise obtained.

The Difficulties of Navigation.

Mr. W. Willet said that the scheme had been prejudiced by premature public announcements. There was something to be said for constructing a road and railway viaduct first. Experience in the nature of the ground for foundation of a barrage would thus be gained, and the viaduct might be useful for conveying material and workmen. The large amount of water run off to generate 1,000,000 h.p. would cause a swift current in the narrow channel between the barrages. This would render navigation very difficult. The scheme was on the whole very desirable, but it would be beneficial if a smaller scheme at another estuary were tried first with a view to gaining experience.

Mr. C. M. Shaw referred to experience at Worcester where 25 years ago the Corporation decided to harness the water of the Teme. Great things were expected of the scheme, but they only realised about one-tenth of expectations. One great difficulty had been the existence of vested interests. The cost of the civil engineering section of the work was very high. It might be put at 150 per cent. of the electrical section. It appeared that the pumping arrangements might cause a reversal of the flow of the Wye at certain states of the tide, which would have an important influence on the salmon spawning season, when the fish were heading up stream.

Heavy Capital Expenditure not Justified.

Mr. H. C. Young contended that the estimated saving of 2½ million tons of coal per annum—a minute fraction of the total output—did not justify the heavy capital expenditure involved.

Prof. W. Cramp said that the economic aspect was the only one the consumer would consider. In Scotland there was a much smaller scheme, at Walker Burn on the Tweed, and it appeared that the price per unit at which the energy could be sold to cover the expenditure and running costs, was not very much lower than 1¼d. per unit, under the best conditions. From a national point, the scheme was economically unsound. Some compulsion would be necessary to get districts to take the power, and to his mind that compulsion was unthinkable. He did not believe that the Severn barrage would enable the cost per unit to the consumer to be less than that produced by the average central station.

Mr. W. Wilson spoke from experience of successful hydro-electrical schemes abroad. This Severn proposal provided an opportunity for making a start in this country. The scheme should be given their most favourable consideration from a National point of view.

Mr. F. J. Moffett said that the proposal was altogether in the nature of an experiment, and should be made on a small scale There were several tidal basins round the coast which could be used for such experiments. There was one case where the units developed per annum would be 150,000,000, at a capital cost of £350,000. Energy could be supplied at about a penny per unit—quite a moderate price in the South of England.

Mr. G. L. Addenbrooke, in reply, said that as designers they had put the matter before the Water Resources Committee for investigation, merely intimating that according to their figures the matter deserved further enquiry. The report of the Water Resources Committee showed that practically they had taken that view.

The British Industries Fair.

(Continued from page 258.)

BIRMINGHAM SECTION.

By the time these lines appear many of our readers will most likely have visited the Birmingham Section of the British Industries Fair. In our last issue we gave a general description of the Fair, and described in detail some of the more interesting electrical stands. Proceeding on these lines we have :—

Messrs. Accles & Shelvoke, Ltd., who are to be congratulated upon a very fine exhibit of small motors, the design of which has received special attention. Fig. 1 shows a typical example of this machine. The yokes are of steel tube, both end brackets being detachable. The poles and pole tips are of laminated steel, the relationship of polar arc to slot pitch being such as to produce the most silent running. An interesting feature is the adoption of cast-steel spindles, ground true to the ¼ of a thousandth, the makers claiming for this arrangement advantages over that in the majority of foreign machines, where the spindles are of the softest mild steel, resulting in bent and damaged shaft extensions.

The end windings of the armature instead of being wound to form a compact mass, are arranged in the form of a centrifugal fan forcing the air round each separate coil to the ventilation holes in the cover. The terminals are arranged in a neat box at the base of the motor, and on the smaller machines where the box type brush gear is used, the whole brush holder is contained in the end bracket. The bearings are of chilled phosphor bronze, and extend a short distance outside the end brackets. These extensions are threaded and provided with a nut which contains a felt washer. The nut being screwed home becomes a stuffing gland firmly pressing the felt against the spindle and thereby rendering the bearings absolutely dust proof.

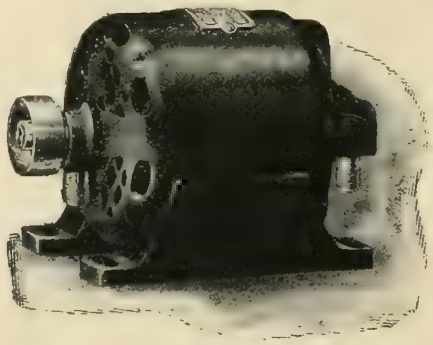

Fig. 1.—Accles & Shelvoke's Small Electric Motor.

Another interesting exhibit on this stand is "The Acvoke Dynamotor," which briefly described is a rotary transformer of the two winding type. It is totally enclosed and provided with a spindle which extends at either end, these extensions being ground taper so as to take the various buffing or grinding chucks or pulleys with which the machine is provided. A finished dynamotor armature is exhibited, and one cannot but be struck by the care and workmanship shown; both windings are former wound, and are taped separately, thereby minimising any risk of breakdown between them. The commutators are of ample size, and it is important to note that both commutators and brush holders are insulated entirely by mica.

The overall efficiency of conversion even on the smallest (90 watt) size is, we understand, over 55 per cent , which appears remarkably good.

Messrs. Accles & Shelvoke are paying attention to the requirements of the private plant owner, and have adapted their motors to the low voltages found in the majority of these installations. In these machines specially large commutators and brushes are fitted in order to cope with the heavy currents met with on the number of 25, 30 and 50 volt plants that are now installed.

An electrically-driven pump is exhibited, whilst the wants of the farmers whose farms are electrified are catered for by a range of back-geared motors, with the countershaft running at a speed suitable for driving churns, cream separators and such like apparatus.

As mentioned last week Simplex Conduits, Ltd., have a comprehensive range of Simplex and Plexsim products. Of the former the chief features are "Diaduct distribution boards," and corresponding fuse units, and the Simplex Colliery lighting system. We understand that this is the first time that the latter has been brought before the notice of the public. There is a large display of lighting fixtures for private houses, public halls, hotels and ships. The Plexsim products comprise electric kettles, percolators, grills, toasters, ovens, hot plates, porringers, &c., all tastefully displayed.

CRANES AND HOISTING GEAR.

THE MIDLAND SUPPLY COMPANY are exhibiting high-class electric cranes and hoisting gear, alternating-current motors, and control gear. Robinson electric cranes are shown under working conditions. There is also a two-motor type electric monorail travelling hoist, capable of lifting three tons, an electric monorail single motor type hoist with hand travel, capable of lifting three tons, a "Robinson" electric spur gear winch, three tons capacity, and a Robinson electric friction hoist of similar capacity. These hoists and cranes are attracting considerable attention on account of their fine finish and efficient working. Fig. 2 shows one of the types exhibited. They are also made to suit lower capacities, the range in most cases being ½, 1, 2, and 3 tons.

The next interesting feature on this stand is a display of two- and three-phase induction motors of the squirrel cage and slip-ring type, made by Messrs. RAYNER & HEALD, LTD., of Derby, who specialise in the production of these machines in sizes ranging from 1 to 60 B.H.P. Here soundness of construction and excellence of design command attention. The component parts of a complete motor are tastefully arranged for examination by visitors to the Fair. The control gear displayed comprises panels for completely protecting squirrel cage and slip-ring motors during starting and running conditions, automatic air-cooled rotor starters, star delta and series parallel starters.

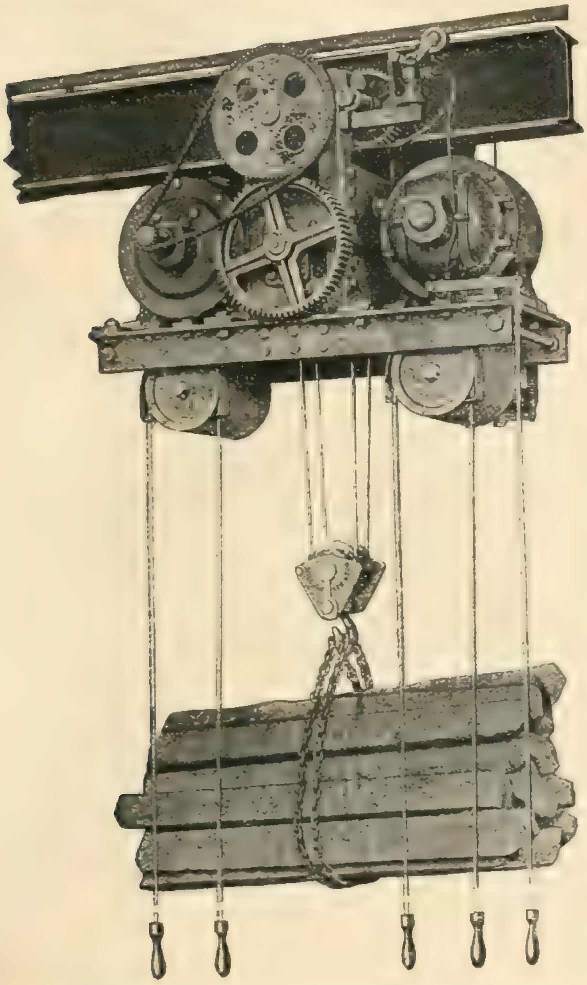

FIG. 2. A "ROBINSON" ELECTRIC HOIST. (Midland Supply Co.)

PRECISION TOOLS.

The firm of ALFRED HERBERT, LTD., which is so well known in the machinery world, display machine shop equipment, fine measuring apparatus and gauges, engineers' small tools, Coventry opening die-heads, Coventry concentric lathe chucks, and turret lathe tools. Of this collection of machine shop equipment there are three exhibits worthy of special mention. The first, a new adjustable thread snap gauge (*see* Fig. 3), is far more efficient than the ring-type for gauging screw threads. From the illustration it will be seen that with this new gauge it is possible to test, with a single operation, the pitch, effective diameter, core and major diameter of any threaded work.

The second is a capstan dial gauge (*see* Fig. 5), which has been designed for the rapid checking of small parts to close limits by unskilled labour. One complete revolution of the needle on the dial represents 0·05 in. The gauge is extremely accurate, and should prove a boon to those manufacturers engaged upon the mass production of small parts to fine limits.

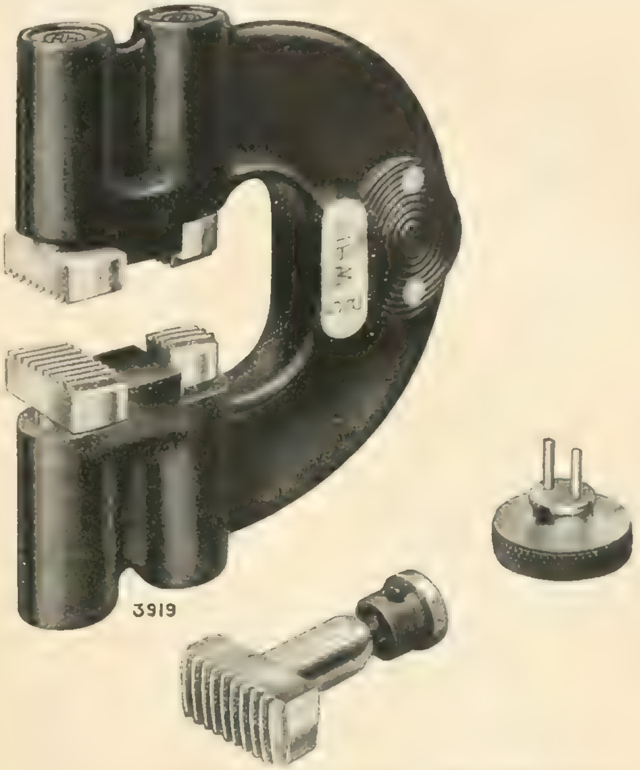

FIG. 3.—ADJUSTABLE THREAD SNAP GAUGE. (Alfred Herbert & Co.)

The third is a patent universal gauge measuring machine for testing the accuracy of gauges (*see* Fig. 4). Owing to the increased use of accurate gauging equipment, and a real appreciation of the

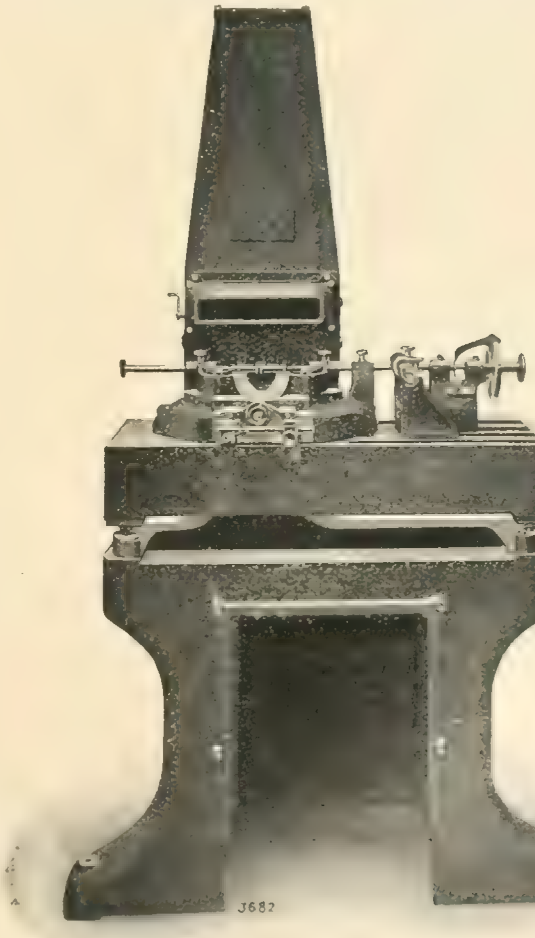

FIG. 4.—PATENT UNIVERSAL GAUGE MEASURING MACHINE (Alfred Herbert & Co.)

value of standards for reference by numerous manufacturing firms, and the accuracy to which gauges and standards have now to be made, there has been a long felt want for a measuring machine to periodically check such articles. The machine displayed is extremely accurate, giving pitch measurements to an accuracy of 0·00001 in., and diameter and length measurements to an accuracy of 0·000005 in.

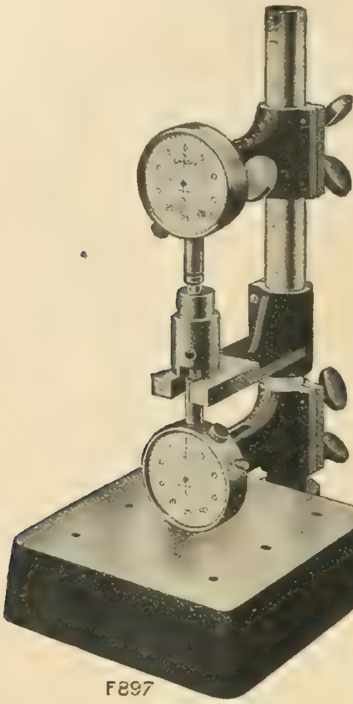

Fig. 5.—Capstan Dial Gauge. (Alfred Herbert & Co.)

The **Vincent Switchgear Mfg. Company** show some fine examples of ironclad switch and fusegear, ironclad distribution boards, and unmounted fuse elements for switchboard mounting. A special feature of their exhibits is the Vincent ironclad distribution board. Most present-day manufacturers of distribution boards supply their products with the fuse units mounted on hinged battens for inspection and easy wiring purposes, and while this is an advance on the old fixed batten method, there is the disadvantage that the fuse units usually prevent the battens from being opened wide, by catching on the iron case (owing to their projection), unless, of course, a very large case is used, which seldom is the case owing to cost of material. The Vincent Switchgear Company have got over the difficulty by fitting their fuse units on frames which are double-hinged to the case. This enables the whole units to be brought forward outside the case, and then swung open in a similar manner to the lid of the case. Fig. 6 gives a clear conception of the arrangement.

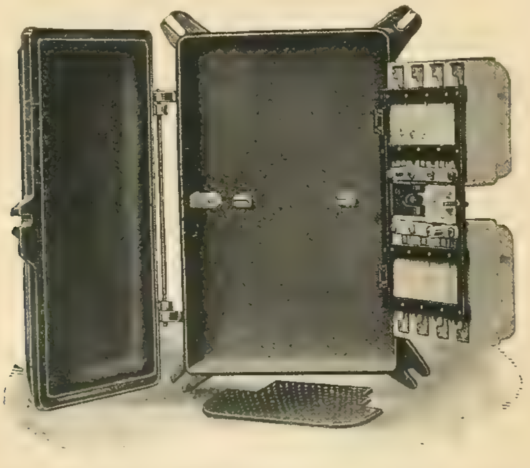

Fig. 6. View of the Vincent Ironclad Distribution Board.

(To be concluded.)

North Wales Electricity District.

The inquiry by the Electricity Commissioners into the schemes for the re-organisation supply in the North Wales and Chester area, which occupied seven days, concluded on the 23rd ult.

Mr. **Miller**, who opened the case of the North Wales Power & Traction Company, Ltd., said that in 1904 the company obtained Parliamentary powers under which they were constituted electricity supply undertakers within the area embraced by the counties of Carnarvon, Anglesey, Merioneth and Denbigh, with the exception of the borough of Wrexham, and Wrexham rural district. Water power was developed by the erection of the station at Cwm Dyli, from which overhead transmission lines were laid to Blaenau Festiniog, Llanberis and elsewhere. In 1909 the Aluminium Corporation was formed, and the power station at Dolgarrog in the Conway Valley was constructed. In 1918, Mr. Kenneth M. Clark, chairman of the Aluminium Company, acquired a controlling interest in the North Wales Power Company, and since that time the two companies had worked together and were under the same control. The Power Company owned the Cwm Dyli station and the transmission lines, and the Corporation the Dolgarrog station and the water rights in Llyn Eigiau, Cowlyd, Dulyn, Llugwy and elsewhere. The capacity of storage and the rainfall in the mountainous area were such that there would be no possible shortage of water at any time. To make the best use of that water power it was essential that the company should have a market in the industrial area on each side of the eastern border of Wales. During the next 10 years, the interim period of development, it was proposed to supply energy at an average price of 1¼d. a unit and when the development reached maturity that figure would be reduced. The erection of the transmission lines would be proceeded with as soon as the necessary powers were obtained. With the approval of the Commissioners those powers would be asked for by means of a bill. The objection that the company might extort unreasonable profits from the consumers was met by clauses in the Power Company's Act limiting the profits to 10 per cent. and limiting the prices to be charged. As to the suggestion that the Electricity Supply Act contemplated administration by public authorities, counsel pointed out that the provision for the setting up of a joint electrical authority was to be acted upon "where necessary," and he submitted that such a body was not necessary in that district. The "deficiency" clause was put in to enable the company to pay the debenture interest in the event of the income from power sold not being sufficient to do so. It would enable them to make up any deficiency of the debenture interest by a call upon the consumers in respect of the preceding year, or, if preferred, it could be made in the form of an increase of price for the coming years.

Details of Company's Scheme.

Mr. H. J. **Jack**, managing director of the Power Company, explained the work carried out and indicated the various watersheds by exhibiting a model on which the mountain ranges and valleys were shown to scale. In addition to existing resources the company proposed to construct a dam near Maentwrog which would give an enormous storage, and there were many further plans for increasing the supply of hydraulic power. It was proposed that the North Wales Company should take £250,000 of the debenture issue of the Aluminium Corporation, and should finance the Corporation to the extent of another £250,000, and in consideration the Corporation would agree to give the Power Company as much or as little electrical energy as the Power Company might desire from year to year at ¾d. per unit. It was at first intended that the companies should be merged, but the proposal bristled with difficulties. A considerable amount of further capital would be required. He had had years experience of the transmission of current by overhead mains and he found the system of transmission worked effectively and was extremely satisfactory. The longest transmission line was that to Trevor in South Carnarvonshire, a distance of 26 miles.

Mr. **Graham**, for Llandudno Council, pointed out that the Power Company proposed to deliver current for Llandudno at a point near the Colwyn Bay gas works, 4 miles distant, and asked who would bear the cost of the junction lines and their maintenance.

Mr. H. **Booth** drew attention to a clause in the Power Company's Act, under which the company are required, on being served with notice to supply current to a district, to deliver that current at a specified point within that district.

In reply to Mr. T. E. **Morris** (for Carnarvonshire County Council), Mr. Jack declined to commit himself to the principle of giving preferential treatment to consumers who were near the power stations, in the matter of price. He would not object to a clause being inserted in the proposed Act, under which, if the Power Company at any time found itself unable to carry out its obligations, the proposed Advisory Committee would carry on the works. He thought the Advisory Committee would, when it had learned its business, become the Joint Authority for the area.

A copy of the heads of the proposed agreement between the North Wales Power Company and the Aluminium Corporation was handed in. The agreement is to continue as long as the Power Company are the authorised undertakers for the district and the Aluminium Corporation shall, up to the limit of its 10,000 kw. capacity, supply current to the Power Company at ¾d. per unit, provided the load factor is not less than 45 per cent. The price is subject to a clause as to wages.

Mr. **Jack** said the promoters would be prepared to seek the advice of the Commissioners as to what the load factor should be in fairness between the two companies. The intention was to place at the disposal of the Power Company the whole of the current that could be generated at Dolgarrog, and when the customers of the Power Company required it, the manufacture of aluminium at Dolgarrog would be suspended. He would give such reasonable guarantees to maintain the position as between the two companies as the Commissioners might impose.

An Advisory Committee

As to the proposed Advisory Committee, Mr. Jack said he would give one representative to each distribution area, irrespective of its population and rateable value. Its resolutions would, he thought, in nine cases out of ten, be acted upon by the company, and in the exceptional case the committee would go to the Commissioners. The committee would give advice to the Commissioners and the company. A joint electricity committee was not needed for the district. The advisory committee would have no power as to prices charged to consumers, or as to the profit to be distributed to the shareholders of the company. It was intended that local authorities and other consumers taking current should advance capital to the company for the construction of extensions of the transmission lines required for the delivery of current, and the security for the capital would be the poles and wires so erected. Depreciation was adequately provided for in the 10 per cent. added to the estimates for contingencies. The power transmission lines had to be maintained in good condition out of revenue.

Mr. Tyldesley Jones, K.C. (for the railway companies), submitted that the clause in the scheme providing for the assessment of any deficiency in revenue in any year upon users of energy was illegal, impracticable and uncommercial, and at a later stage the clause was withdrawn.

Mr. Jack admitted that Holyhead was likely to be a large consumer owing to the extensive railway and harbour works there, but he preferred, in the first instance, to cater for the eastern industrial area, and the scheme did not provide for extension of the transmission line to Holyhead until four years hence. The railway company could construct a line at once, and the Power Company would pay interest on the outlay.

Mr. Arthur Wells, managing director of the City General Trust Company, gave evidence on the company's proposals for financing their constructive works.

Sir Harry Hawaed pointed out that, as proposed, the ordinary share capital of the Power Company would be no more than 9 per cent. of the total capital of the undertaking. That was a very low proportion. Parliament, as a special concession in the Public Utility (Capital) Issues Act of last year, allowed capital to be increased by borrowing not exceeding 50 per cent. of the share capital.

Mr. Wells thought, under the existing conditions it would be impossible to finance the enterprise otherwise than by bonds at a fixed interest.

In the course of cross-examination, Mr. Jack said the question of an abnormal drought in Wales was a bogey raised by those who do not understand water-power. Abnormal drought did not come into the question, but if there was any danger Wales ought to have first pull upon its own water resources. Wales had very fine power resources, but nothing had been done to develop them, and if local authorities took up the parochial attitude that valuable power would never be developed. There could be no rule as to places close to the generating stations having power at a cheaper rate than distant places to which the cost of transmission would be very much greater, but practically that would be so. It should be possible to lay a service wire from the main transmission line to a farm half a mile distant, and supply the farm with power at not more than 3d. or 4d. a unit. The company had included provision for laying a line to Aberystwyth in 1927, and another to Barmouth and Bala in 1928. He had come to the conclusion that those lines could be constructed for £2,000 a mile instead of £3,000 as at first estimated. As there would not be so heavy a load on them, the lower cost should suffice. If the Commissioners made the order constituting the power company the undertakers, the company would endeavour to assist Dolgelly to get an early supply. It would be a matter for the Commissioners as to whether they would allow water power outside his company to be developed.

The Chairman asked whether, if the Commissioners recognised the power company as the authorised supplier of electricity in the North Wales and Chester area, Mr. Jack would agree to the formation of a Joint Public Authority for the district who would deal with matters such as the distribution in areas not already provided for. Would that be likely to interfere more with the conduct of the power company's business than the "advisory" committee which he had already suggested?

Mr. Jack replied that he thought such an arrangement might be made, but he did not think it necessary, and, further, owing to the demands for representation that would be made upon it, it would be unwieldy.

The Chairman said that the business of the Joint Authority would, practically, be restricted to the executive committee which the authority would appoint. He said the Commissioners would consider a suggested clause of Colwyn Bay (as to the purchase of the generating plant in case of default by the company) and they would give the parties an opportunity of consulting them if necessary before their decision was given.

Sir Phillip Dawson and Mr. Ralph Freeman, consulting engineers, gave evidence in support of the scheme, and the Commissioners arranged that various representatives of authorities should submit considered written statements instead of addressing them.

Support for Company's Scheme.

Mr. Tyldesley Jones (for the railway companies) also favoured the scheme of the North Wales Power Company, as most likely to produce the desired cheap and abundant supply of electricity. In the district special circumstances rendered the scheme of the company preferable, subject to safeguards of public interest.

Mr. Lawson Taylor, town clerk of Wrexham, submitted a statement showing that Wrexham Corporation favoured the formation of a Joint Electricity Authority, but did not bind itself to become a constituent authority at present. Even if the Commissioners should be satisfied that the water-power resources of the North Wales Power Company were sufficient for the supply of the whole district, the Council would support the formation of a Joint Authority, either for the whole of the district or for the eastern portion. No capital expenditure should be incurred in providing a new generating station until the Commissioners had satisfied themselves that it was not practicable to obtain an adequate supply of electrical energy from the North Wales Power Company or from another Joint Electricity Authority at a price equivalent to or less than the price at which energy could be generated at the proposed station. No technical staff should be appointed other than such as might be required for the distribution of energy, in the event of that work being undertaken by the Joint Authority in any area the local authority of which was not an authorised undertaker. Distribution might, however, be undertaken by existing authorised undertakers not only in their own areas of supply, but in adjoining areas of local authority.

Mr. T. E. Morris, for the Carnarvonshire County Council, supported the power company's scheme, subject to reservations, and he suggested that the Commissioners might themselves appoint the members of the proposed advisory committee.

Mr. Miller, summing up for the power company, submitted that the steam and low level water-power generating works proposed by Chester were unnecessary, and that the estimates on which they were based were unreliable. The company, which was run by competent business men, who had had the vision to see the possibilities and had developed the technical resources in a very creditable manner, would, with the enlargement of its area and the assured revenue which was in prospect, get the further capital resources required.

Mr. J. H. Dickson, for Chester Corporation, submitted that their scheme, based on the two principles of public control and reasonable cost, had been fully substantiated at the inquiry. The hydro-electric stations on the Dee could be constructed, and they would in no way injure the river from the point of view of riparain owners. He criticised the financial position of the company, whose capital had, since it came under its present management, been "written up" from £220,000 to £532,000. On a foundation such as that the power company sought to build up a super-structure by the issue of second debentures to an enormous amount, unsupported by anything approaching a proper margin of tangible assets created by the expenditure of solid cash by the shareholders. There should be public control and the advisory committee suggested by Mr. Jack would not meet that necessity.

The Chairman asked the Town Clerk of Llandudno to convey to his Council the best thanks of the Commissioners for granting them the use of the Town Hall for holding the inquiry. The Commissioners could make no pronouncement at present. They had a grave and difficult problem which would take some time to solve, but they hoped, at a later date, be able to submit a draft order that would have a lasting and good effect on the developments of that richly endowed district.

I.E.E. Summer Meeting.

As already announced in The Electrician, the summer meeting of the Institution of Electrical Engineers in 1921 will take place in Scotland from June 7 to 10. The first two days will be spent in Glasgow, when visits will be paid to the new power station at Dalmarnock, and to works and other places of interest in the neighbourhood. Papers on the Dalmarnock power station and on the hydro-electric power resources of Scotland will be read. Arrangements have been made for a Clyde trip on June 8.

On June 9 the party will proceed by special train to Fort William or Banavie (Inverness Canal), and on the following day a steamer will take the visitors down Loch Linnhe to Kinlochleven, where the hydro-electric installation of the British Aluminium Company will be visited. In the afternoon the steamer will continue its journey southwards, and land the party at Oban, where the visit will end on Friday evening, June 10. The journey to Fort William and thence to Oban will give an opportunity of seeing the most magnificent scenery of the Western Highlands.

We understand that a circular giving full details will shortly be issued by the Institution.

At the last meeting of the West of Scotland Branch of the Association of Mining Electrical Engineers, a Paper was read by Mr. Sydney Burns, on "The Choice of a Small Electric Winder." The lecturer said it was agreed that development of the coal industry along scientific lines was a matter of public concern. The attention of colliery officials, and of engineers especially, was attracted by claims relating to the improvement of colliery equipment, and in a special degree to the raising of coal by more economical and reliable methods. In the discussion which followed, Mr. Frank Anslow (the president) said that electric winding was now beyond the realms of speculation, and that made the way clear for complete electrification, which was a matter of national importance.

Large Power Station Design.

At a recent informal meeting of the Institution of Electrical Engineers, Mr. J. R. Cowie opened a discussion on the design of a large power station, paying special attention to the Dalmarnock Station of the Glasgow Corporation.

During the subsequent discussion, Dr. R. D. Gifford suggested cooling by liquid air, and on the question of the drive of the station auxiliaries advocated a direct-current house set. This drew from Mr. Cowie the naïve admission that while direct current was better they were preaching alternating-current drive to consumers in Glasgow, and thought it policy to stick to alternating current in their station.

Mr. S. Utting referred to the extension of furnace air-heating methods, and Dr. Kapp thought it was making a virtue of necessity as the hot air has to be evacuated. Mr. W. N. C. Clinch spoke of steel economisers, and Mr. E. F. Hetherington knew of a case of prevision that galvanised the tubes yet did not prevent pitting. Mr A. F. Harmer elicited Mr. Cowie's preference for keeping all metering on the low-tension side.

The inevitable suggestion that the generators should be at the pit head brought the reply that Dalmarnock in full blast will make small potatoes of the output of any one colliery in Scotland; and when it was pointed out that Dalmarnock weighed coal twice on acceptance—before and after tipping—Mr. Cowie was ready with the knowledge (by hearsay) of a waggon repair works that kept all its fires a-going on the coal scraped from waggons sent for repair.

Legal Intelligence.

The Oldham Tramways Arbitration.

On Friday the Court of Appeal (Lords Justices Bankes, Scrutton and Atkin) reserved judgment in the case of the Oldham, Ashton and Hyde Electric Tramway, Limited, v. Cooper and others, upon the appeal of the tramway company from the decision of Mr. Justice Rowlatt upon four items in the Arbitrator's award as to the purchase price to be paid to the company by Ashton and Hyde Corporations and the Audenshaw and Denton Urban Councils. The amount of the award was £142,000, but the purchasing authorities contested certain items allowed and contended that other items ought to be depreciated. Mr. Justice Rowlatt came to a conclusion favourable to the company on certain items; but on the four items in question (engineering fees, cost of raising capital, interest on capital during construction, and the expenses incurred on alterations to the Guide Bridge) he decided against the company.

Electrical Engineers' Claim.

Last week Mr. Pollock, Official Referee, concluded the hearing of an action in which Messrs. J. Holbrook & Company, electrical engineers, claimed from Messrs. F. P. Bliss & Son, builders, the balance of an account for an electric installation at a house in Barley.

Mr. J. B. Matthews, K.C. (with Mr. Abinger) were counsel for plaintiffs, and Mr. Arthur Powell appeared for defendants.

From counsel's statement it appeared that the case arose out of a dispute between two firms, carrying on a similar class of business, as to the cost of donig certain work in relation to an electric lighting and heating installation. In April, 1920, defendants approached plaintiffs by telephone with a view to their undertaking the electric installation at the house and it was alleged that in the course of the conversation plaintiffs said that the cost would be about £60. But subsequently when plaintiffs went over the house they told defendants it was not a £60 job and how much it would cost it was impossible to say. It was costly enough as the wires had to be cased in steel tubing and laid not on the work, but in chases to be made in the walls, and when the work was put in hand the owner of the house was so anxious to get it done quickly that the men had to work night and day with the result that the cost was materially increased. It was also further increased by the numerous alterations required. Beyond the lighting installation there was the provision of points for radiators, the end of it being that the total amount of work, including a host of costly fittings chosen by the lady and her husband, came to £274 17s. 6d. against which there was a cash credit of £179 4s. 9d. After making the largest possible concessions in favour of defendants the plaintiffs had arrived at a balance of £95 11s. 9d., and defendants had paid £50 into court. The issues were firstly was there a contract that the work should be done for £50, and secondly, was the work so unsatisfactory that a portion of it had to be redone by someone else for which there was a counter claim of £14?

After hearing the evidence on both sides, the Official Referee found in favour of plaintiffs on both claim and counter claim, and judgment was entered for them, with costs.

Messrs. George Wills and Henry Wills, who have already given large sums towards founding the University of Bristol, recently contributed a further £200,000 to finish the substantial extension which is being built entirely at their expense.

Electricity Supply.

Middlesbrough Corporation has increased the salary of the borough electrical engineer (Mr. R. H. Scotson) by £100 per annum.

The directors of the Alexandra Docks & Railway Company, Newport, have decided to install two electric pumps.

The Worksop Coal & Iron Company has agreed to give a further supply of electricity in bulk from the Manton pit to the Urban Council in order to avoid expenditure on additional generating plant.

Preston Corporation has approved of the reommendation to purchase the undertaking of the National Electric Supply Company. Though the exact figure is not known, it is said the purchase price will reach £286,000.

Salford Corporation recently purchased a site for a new power house at Agecroft and in order to provide work for the unemployed a number of men have been employed in levelling and excavation work.

Eston Urban Council has obtained a special order and the Electricity Commissioners have directed it to obtain terms for a bulk supply of electricity from the Cleveland and South Durham Power Company and Messrs. Bolckow, Vaughan & Co.

The Herne Bay Urban Council has informed the Electricity Commissioners that it does not object to the revocation of the Provisional Electric Lighting Order of the local gas company, provided the words "and electricity" are deleted from the company's registered name.

Stepney (London) Council is recommended by the Finance and Parliamentary Council to take up for the Electricity Department a loan of £25,000 at 7 per cent., from the London County Council, repayable within 20 years. After the present month, the charges made by the Electricity Department for current will be increased to the following rates: Scale A, 8d. and 1¼d. per unit (instead of 7d. and 1d.), scale C, 1¼d. (instead of 0·9d.), and scale F, 1d. (instead of ¾d.).

The Swansea Corporation are considering a scheme, involving an expenditure of £40,000, for extending the electric supply mains to the growing area of the Amman Valley, and a special meeting of the Council is to consider the details. Several important works and collieries want supplies of energy for power and light. Ammanford, Gowerton, Gorseinon and Pontardulais are within the scope of the scheme, which, according to the chairman of the Electricity Committtee (Ald. Sinclair), has enormous possibilities, apart from the fact that a return of £5,000 per annum is assured from the start.

At a recent meeting of Walsall Town Council, Councillor J. Venables moved that no further action be taken with regard to the proposal to light High-street, Bloxwich, by electricity. He said the street was already well lighted by gas and it was extravagance to have electric light. Councillor Somerfield said it was proposed to light High-street, Bloxwich, from the overhead tramway wires, and it would be a great economy. Ald. Ingram said it was the old story; every time he lost a customer Councillor Venables (Chairman of the Gas Company) squealed, but he would do a lot of squealing during the next ten years, as automatic gas lighting was not a success. The present lighting was a disgrace. The resolution was lost.

In a recent address to the Portsmouth Rotary Club Capt. W. H. Upton Marshall, R.E., called attention to the extremely wasteful policy of having two stations, one for supplying light and power and the other for supplying the tramways. The town Council should take a broad view of the matter and arrange for the supply on modern lines, not only to Portsmouth, but to the surrounding smaller towns as well by erecting a station in a position where coal could be cheaply deposited, where future extensions could be carried out and from which electricity could be distributed by means of overhead mains. The site at Hillsea was ideal for the purpose. Such an arrangement would mean a saving in the coal costs of about £18,000 a year on the present output and would become greater as the output increased.

In consequence of the deleterious effect of producer gas upon the windings of electrical machinery, a totally enclosed dynamo has been installed at the Minehead electricity works. From "The Engineer" we learn that the generator is of the interpole type, giving 84 kw. at 210 revs. per min. A fan in the interior of the machine circulates the air in a closed circuit through a cooler, or heat dissipator, situated over the machine, the cooler consisting of airways having thin metal walls and arranged to present a large cooling surface. Another fan outside the machine forces a stream of air drawn from outside the building through the cooler. The extra cost of such a machine is no more than 25 per cent. over that of an ordinary open-type machine of the same output.

One day last month there was a sudden stoppage of elecric supply in Cork owing to a strike, but the Fordson Factory got over the difficulty by utilising Fordson tractors as a substitute. By the time the outside supply failed half the department were working under their own power in this way. On the following morning the foundry was going in full swing, tractors replacing motors on the blowers and compressors, rattlers, &c. Current for small machines and for lighting was supplied by a group of 12 tractors driving a length of line shafting from which dynamos were driven. Six 20-h.p. and four 25-h.p. electric motors were driven as dynamos, while one tractor drove a 20-h.p. motor to supply the shunt field current required by the others. The system of the shop was 460-volt three-wire direct current, and a balancer had to be provided. This consisted of two 20-h.p. motors direct coupled. The installation gave an average output of 200 h.p. and worked admirably.

Electric Traction.

The tramway fares are to be increased at Bolton on the 4th prox. The Corporation is the last tramway authority in Lancashire to take this step, but after six months experience of the new fares the position will be reviewed.

Colne Corporation has adopted the following increased scale of fares on the tramways : Half mile, 1d. ; one mile, 2d. ; 2 miles, 3d. ; 3 miles, 4d. ; full route, 5d. ; workmen, 2 miles, 1½d. ; children, 1d. ; parcels, 100 per cent. increase over pre-war rates. Riding in a tramcar will soon be almost as much a luxury as riding in a motor car.

The estimates of the Newcastle-on-Tyne Transport and Electricity (formerly the Tramways) Committee put the income for the ensuing 12 months at £598,650 ; and after making allowance for the various items of expenditure, a net surplus of £12,235 is anticipated. The increased receipts from the revision of fares during the past year came up to expectations, but the increased expenditure absorbed the higher revenue. It is hoped that the Committee will agree to give £14,000 towards the relief of rates.

We learn from the returns of the Ministry of Transport for 1919 that the capital expenditure of all the railways in Great Britain at the end of that year was £1,153,300,000, an increase of £19,200,000 over 1913. The figures for Ireland were £49,600,000, an increase of £800,000. The gross earnings of the railways in the United Kingdom, plus the estimated value of services rendered to the Government, totalled £199,879,000, against an expenditure of £187,058,000, leaving a balance of £12,821,000. With miscellaneous receipts and net Government compensation (£35,736,000), the total net income was £53,070,000. During the six years ended Dec. 31, 1919, the total single track (including sidings) increased by 764 miles, making a total of 55,254 miles for the United Kingdom. Vehicles worked by electric power provided seating capacity for 158,644, an increase of 32,193. The total length of electric railways was 589 miles, five chains, compared with 314 miles, 52 chains in 1913.

The immense success of Electric Traction on Suburban railways was referred to at the meetings of three railway companies during the week. Presiding over the annual meeting of the L. & S. Western Company, Brigadier-General H. W. Drummond said that the electrification of their suburban lines was still proving a great success. The number of passengers carried in their electric trains last year was well over 50,000,000. Since the last meeting they had added two coaches to the morning and evening trains running in the Kingston and roundabout services, and that had gone a long way to reduce the inconvenience of overcrowding. The next step to that end would have been the electrification of the Cobham and Leatherhead lines, but unfortunately when they wanted to place contracts they found that the prices of electrical equipment had advanced to such an extent as to make it very doubtful whether the work would be carried out for £1,000,000 as compared with a pre-war estimate of about £250,000. Apart from that, when the Government proposals in regard to the future of the railways were disclosed they were found to be of such an unsatisfactory, not to say confiscatory nature, that they came to the conclusion that they would not be justified in committing the shareholders to any new schemes which necessitated large capital expenditure. The electrification of the Cobham and Leatherhead lines would, therefore, have to remain in abeyance until the future position of the railways had been more clearly defined. As to the overcrowding on the Waterloo and City Railway an order had now been placed for extra vehicles, which would be in service within the next few months.

At the meeting of the North London Railway Company on the 24th ult., the chairman (the Hon. A. H. Holland-Hibbert) said that the line had held its own, despite competition. They had carried 5,000,000 more passengers, and as a result of increased fares and more passengers they had taken £61,500 more money In a great measure the change was due to the electrifying of the line, which provided a quicker and more attractive service. They were able to declare the same total dividend as last year, after putting £10,000 to general reserve, and the sum carried forward was £14,500, compared with £13,000. The railways had not been responsible for increased wages, standardisation of wages and shortening of hours. Though increased rates and fares might help he would emphatically state that if the companies were to be paying concerns the wages bill would have to be materially reduced. Railway Boards could not accede to the suggestion that representatives of labour should have seats thereon. On the subject of grouping he thought that according to commonsense their line would fall in with the L. & N.W. group. They were not a tube railway ; to put them among the London companies as a tube railway was ridiculous.

At the meeting of the L. & N. Western Company, the Hon. Charles N. Lawrence referred to the electrification of the line from Watford to Euston, and said that considerable progress had been made with the last section—the portion between Queen's Park and Chalk Farm—and they were making every effort to complete it as early as possible. In spite of difficulties it was hoped that early next year it would be possible to open the new lines throughout, and so give a much better suburban service to Euston and Broad-street. The traffic passing over the tube lines to and from the company's stations between Queen's Park and Watford continued to show a satisfactory increase, and in order to give better facilities during the rush hours, alterations had been made at Queen's Park which would allow of additional L. & N.W trains being run to and from that station and Watford in connection with the frequent tube trains between Elephant and Castle and Queen's Park.

Institution Notes.

The 44th convention of the National Electric Light Association will be held at Chicago from May 31 to June 3. The headquarters of the convention will be at the Drake Hotel.

Among the 15 candidates selected by the Council of the Royal Society to be recommended for election into the Society are Prof. William Laurence Bragg, Prof. William Henry Eccles, and Sir Eustace Tennyson D'Eyncourt.

The President of the Institution of Electrical Engineers will visit the Western Centre on May 2 next and will address a meeting at Bristol. In connection with this visit it has been decided that an informal dinner shall be held.

The following officers have been elected by the Institution of Railway Signal Engineers for the ensuing year : *President*, Mr. C. H. Ellison ; *Vice-President*, Mr. W. C. Acfield, O.B.E. ; *Hon. Treasurer*, Mr. R. J. Insell ; and *Hon. Secretary*, Mr. M. G. Tweedie.

A London Section of the Institute of Metals has been formed under the chairmanship of Dr. F. O. Hobson, of the Admiralty Engineering Laboratory. The Hon. Secretary is Mr. D. Hanson, of the National Physical Laboratory. The first meeting of the section will be held on February 24.

A course of six lectures, given under the auspices of the University of London, is to be delivered by Prof. Luigi Luiggi, on "Recent Engineering Works in Italy." The lectures will be held at the Institution of Electrical Engineers and will commence at 5.30 p.m. on March 7, 9, 11, 15, 16 and 18. They will be given in English and will be fully illustrated with lantern slides. They are addressed to advanced students of the University and others interested in the subject. Admission can be obtained without ticket.

A meeting of the Wireless Section of the Institution of Electrical Engineers will be held on Wednesday, March 16, at 6 p.m., at the Institution of Mechanical Engineers instead of at the Institution of Civil Engineers. The following Papers will be read : "On the Effect of Electron Emission on the Temperature of the Filament and Anode of a Thermionic Valve," by Mr. G. Stead, and "On Some Thermionic Tube Circuits for Relaying and Measuring," by Miss W. A. Leyshon and Dr. W. H. Eccles, F.R.S.

Business Items, &c.

Harry Nuttall and Douglas Edwin Whittaker, trading as H. Nuttall & Company, electrical engineers, 28a, Bury Old-road, Crumpsall, Manchester, have dissolved partnership. Debts by Mr. Whittaker.

Roland Edward Parker and Fredk. Bert Attwood, trading as the Up-to-Date Electrical Company & Attwood & Company, 433, Foleshill-road, Coventry, have dissolved partnership. Debts by Mr. Parker.

Arthur Ernest Blower and Ashley Cooper, electrical and engineering suppliers, 3, Paul's Bakehouse-court, London, E.C., have dissolved partnership so far as concerns Mr. Cooper, who retires.

John Andrews and Fredk. Harold Morland, electrical engineers, 21, Westbourne-street, Hull, have dissolved partnership. Debts by Mr. Morland, who continues the business, at the same address, in his own name.

Messrs. H. W. Smith & Co. (1920), Ltd., have engaged Mr. D. C. Jewell as their representative for the north-eastern counties. Mr. Jewell was for a long time at the Elswick Works of Messrs. Sir W. Armstrong, Whitworth & Company, Ltd.

An exhibition, organised by "The Woman's Leader" and the Women's Institutes, will be held at the Central Hall, Westminster, S.W.1, from May 23 to 28 next. One of the sections will deal with the heating and lighting of the home, and another with labour-saving devices.

Arthur Hy. Foster and John Froelicher, trading as A. H. Foster & Company, motor and electrical engineers, 679a, Romford-road, London, E., have dissolved partnership. Debts by Mr. Froelicher, who continues the business at the same address.

Messrs. Cleworth, Wheal & Company, Ltd., of Castleton, Manchester, manufacturers of air filters, coolers, humidifiers, &c., are now represented in the London district by Messrs. Williams, Pell & Baring, 5, Chancery-lane, W.C. 2, who will be glad to receive any inquiries as to the use of this apparatus.

Messrs. Newton & Company have recently prepared a set of lantern slides for a lecture on "Wireless Telegraphy," dealing more particularly with the Elwell-Poulsen system. These slides are accompanied by a full set of notes, which provide alternative methods of treatment for audiences of varying degree of acquaintance with the subject. Many of the slides are from hitherto unpublished photographs.

Personal and Appointments.

Chesterfield Council has increased the salary of Mr. W. A. Toppin, assistant electrical engineer, to £547 a year.

Dr. T. J. I'A. Bromwich, F.R.S., has been appointed Prælector in Mathematical Science at St. John's College, Cambridge.

The Académie Française des Sciences, Paris, has selected Sir Ernest Rutherford, Cavendish Professor of Physics at Cambridge University, to be foreign corresponding member.

Some Resignations from the Staff of the Ministry of Transport are announced, including Sir Alex. Gibb, Mr. T. Graham Menzies, Mr. John Ferguson and Mr. Guy Mannsell, all of whom have been associated with the engineering staff.

Imperial and Foreign Notes.

Orders in Council have been issued authorising the raising of a loan of £1,708,916 by the Wellington (N.Z.) City Council for tramways, street works and general improvements, and a loan of £95,000 by Wanganui Borough Council for extending its tramway service. Invercargill Borough Council has carried proposals to raise a loan of £50,000 for additions to, and improvements of, the electric supply works.

The U.S.A. Federal Court has now decided in favour of the Western Union Telegraph Company being allowed to land their submarine cable from Barbados at Miami, Florida, and connecting it with the Western Telegraph Company's cable at Bahama.

H.M. Consul-General at Amsterdam (Mr. Henry Tom, M.B.E.), who is forming a catalogue reference library at the Consulate, would be glad to receive copies of United Kingdom firms' catalogues for filing and for use in dealing with inquiries as to suppliers of British goods.

We learn from the "Electrical World" that recent statistics of the horse-power of central station plants in the U.S.A. give the following figures: Steam engines, 1,781,000; steam turbines, 9,635,000; waterwheels, 3,377,000; gas and oil engines, 207,000; boilers, 3,895,000. Adding to this 19,050,000 h.p. for electric generators, the total is almost 38,000,000 h.p.

Catalogues, Price Lists, &c.

A leaflet giving the principal advantage of Ediswan circuit breakers has been issued by the Edison Swan Electric Company, Ltd.

The Lancashire United Tramways, Ltd., now add motor char-a-banc tours to their other activities. The result is a well-illustrated booklet giving details, not only of the tours themselves, but short descriptions with excellent illustrations of the places that may be visited from Atherton and Liverpool.

Messrs. H. W. Smith & Company (1920), Ltd., have issued, subject to their complete catalogue being delivered from the printers, a 4-page list, giving particulars of size and prices of V.I.R. cables, flexibles, bell wires and cotton-covered wires. A copy will be sent to anyone interested on application to the company at Central House, Kingsway, W.C. 2.

A four-page illustrated pamphlet dealing with "Superlux" Translucent Glassware for use with electric light fittings has been issued by the General Electric Company, Ltd., 67, Queen Victoria-street, E.C. 4. "Superlux" glassware, which combines good reflecting and diffusing qualities, is manufactured in a variety of forms and sizes for use with Osram lamps of every size and type.

Another leaflet (O.2,461) recently issued by the General Electric Company, Ltd., 67, Queen Victoria-street, E.C. 4, gives an illustrated description of the "Klersite" Dynamo for the electric lighting of commercial vehicles. The dynamo is a series wound machine with a special patent pulley which, through the action of a slipping clutch, maintains the dynamo at constant speed irrespective of that of the engine. The system possesses many advantages over others, the most important being that it does not involve the use of accumulators and cut-in and cut-out devices, thereby reducing maintenance costs to a minimum. The "Klersite" supplies current at 6 volts for two 12-watt headlights or for one 15-watt headlight.

The Lancashire Tallow and Compound Company, Ltd., have issued a pamphlet dealing with their compounds for street and house service boxes, sleeve joints and their other insulating products. The range of insulating and other compounds listed covers practically all the requirements of the electrical engineer, and special attention is paid to high and low tension and other insulating compounds. An analysis of the l.t. compound, together with pressure tests of the l.t. and e.h.t. compounds is given. Among the Company's manufactures are "Boxumen" l.t. and "Insulem" h.t compounds, "Sleevol" jelly for h.t. sleeve joints, "Voltolene" transformer oil, "Tabora" and paraffin waxes, "Bitupaint" surface preservative, rosin, tallow, &c.

Liquidations and Bankruptcies.

The Bat Meter Company, Ltd., is being wound up voluntarily and Mr. J. E. Denney, 123-124, Finsbury Pavement House, E.C., has been appointed liquidator.

The Mutual Electric Trust, Ltd., is being wound up voluntarily and Mr. A. E. Wake, Norfolk House, Laurence Pountney-hill, Cannon-street, London, E.C.4, has been appointed liquidator.

Mr. Chas. Turner, 155, Norfolk-street, Sheffield, has been appointed trustee in the bankruptcy of John Wm. Gladwin, electrical engineer, 81, Burcot-road, and 1a, Meersbrook Park-road, Sheffield.

Claims against the Mutual Electric Trust, Ltd., are to be sent by March 31 to the liquidator, Mr. A. E. Wake, Norfolk House, Laurence Pountney-hill, Cannon-street, London, E.C.

British Electro-Chemists, Ltd., is being wound up voluntarily and Mr. H. J. Gully, 1, Broad Street-place, E.C.2, is liquidator. A meeting of creditors will be held at Mr. Gully's office on March 9.

The first meeting of creditors of John Vincent Bell, electrical engineer, 21, North Bar Within, Beverley, took place on March 1, and the public examination will be held on March 14 at the Guildhall, Hull.

Malcolm Thos. Birch Gordon, lately electrical and general merchant, of 20, Western Broadway, Hammersmith, London, W., has been adjudicated bankrupt. The first meeting of creditors will take place on March 7 and the public examination on April 22, both at Bankruptcy-buildings, London, W.C.

Miscellaneous.

On Tuesday the Pacific Cable Board resumed the service of week-end telegrams between the United Kingdom and Australia, New Zealand and the Pacific Islands.

It is announced in the "Journal" of the Institution of Electrical Engineers that in view of the definition of the term "therm" in the Gas Regulation Act, 1920, meaning 100,000 British Thermal Units, it has been decided to discontinue its use for the British Thermal Unit and to use the abbreviation B.Th.U.

A successful dance in aid of the funds of the Electrical Trades Benevolent Institution was held at Newcastle-on-Tyne on Friday last. More than 270 people were present, and the result is that a sum of about £100 will be added to the funds of the Institution. The guests were received by Mr. W. C. Mountain and Mrs. Mountain, and the Lord Mayor and Lady Mayoress of Newcastle were among those present.

Among the best of the house magazines is that which emanates from time to time from the Queen's Engineering Works of Messrs. W. H. Allen, Sons & Company. The January issue contains an excellent portrait of H.R.H. the Duke of York, with an account of his visit to the works some months ago. There are a large number of first-class technical articles on subjects relating to the firm's various activities and the usual crop of sporting, welfare and social news.

In an interesting lecture at the recent motor show in Glasgow, on "Magnetos for Internal Combustion Engines," Mr. A. P. Young stated that British designers had improved on the design of the German machines, both electrically and mechanically, but unless the Government protected the magneto industry as a "key" industry the British industry would perish. At present German magnetos were coming freely into this country, and on account of the favourable rate of exchange, the German makers were able to sell at prices less than the cost of materials used in a corresponding British machine.

An Inter-Departmental Committee on Patents has been appointed by the Lord President of the Council to consider the methods of dealing with inventions made by workers aided or maintained from public funds, so as to give a fair reward to the inventor, and thus encourage further effort to secure the utilisation in industry of suitable inventions, and to protect the national interest; and also to outline a course of procedure in respect of inventions arising our of State-aided or supported work which shall further these aims and be suitable for adoption by all Government Departments concerned. The members. of the Committee are: Mr. Kenneth Lee (*chairman*), Mr. W. St. D, Jenkins, Mr. F. E. Smith, O.B.E., Air Vice-Marshal Sir E. L. Ellington, Mr. H. W. W. McAnally, Mr. P. W. L. Ashley, Colonel W. H. D. Clark, Sir H. Frank Heath, Department of Scientific and Industrial Research, Mr. A. J. Stubbs, Mr. H. H. Dale, Mr. W. J. Coombes, Lieut.-Colonel P. K. Lewes, Mr. P. Tindal-Robertson, Sir R. A. Gregory, Mr. D. M. Kerly and Sir Charles A. Parsons. The Secretary is Mr. A. Abbot, 16 and 18, Old Queen-street, S.W.1.

Obituary.

The death is announced of Mr. E. A. Lambert, formerly manager of the electric lighting undertaking at Walton-on-Naze.

The death is also announced of Mr. John Clarke Hawkshaw, the well-known civil engineer, who was President of the Institution of Civil Engineers in 1902-3. He was also chairman of the Fort William Electric Lighting Company.

The death took place recently at Teheran of Mr Wm. Kingwood, director of the Persian Section of the Indo-European Telegraph Department. During the war his zeal and tact enabled him to maintain telegraphic communication between Teheran and India in spite of all opposition.

We regret to record the death of Mr. James Keith, A.M.I.C.E., of the well-known firm of Messrs. James Keith & Blackman Company, Ltd., engineers, Arbroath and London. Mr. Keith, who was born in Arbroath in 1849, was a well-known heating and ventilating engineer. He took out many engineering patents. In 1863 he started business, first in Arbroath and then in Edinburgh, as a specialist in gas, hydraulic, heating and ventilating engineering. From Edinburgh he went to London. While in Arbroath he developed the local business originally carried on by his father. The business grew, and some fifteen years ago he amalgamated it with the Blackman Ventilating Company, the firm becoming known as that of James Keith & Blackman Company, Ltd., of which deceased was managing director.

We regret to announce the death of Prof. Robert Bellamy Clifton, F.R.S., professor of experimental philosophy in the university of Oxford from 1865 to 1915. He was born at Gedney, Lincolnshire, on March 13, 1836, and from University College, London, he obtained a scholarship in 1856 at St. John's, Cambridge, graduating as Sixth Wrangler and second Smith's Prizeman in 1859. In 1860 he became professor of Natural Philosophy at Owens College, Manchester, and five years later he was elected professor of Experimental Philosophy at Oxford. On his appointment he organised the new "Clarendon Laboratory," the first built in Europe for the special purpose of teaching and research in physics. Prof. Clifton acquired a reputation as a precise and careful teacher, and among his pupils may be mentioned Sir Arthur Rucker, Sir Lazarus Fletcher, Prof. Viriamu Jones, Prof. Reinold, and Mr. R. E. Baynes. He was a member of the Royal Commission on Accidents in Mines in 1879-86; he was president of the Physical Society in 1882-84 and was elected Fellow of the Royal Society.

Tenders Invited.

Tenders are invited (by March 31) for the construction of port works at PAYSANDU (Uruguay), including electric handling and lifting apparatus.

Tenders are required by March 14 for six months supply of electrical goods to the CHESHIRE COUNTY ASYLUM, Parkside, Macclesfield. Forms and tender, &c., from the Clerk.

MANCHESTER Corporation require tenders by April 4 for 33,000 and 6,600 volt switchgear, induction regulators, &c. Specifications from F. E. Hughes, Town Hall, Manchester.

AYLESBURY Corporation require tenders by March 11 for one year's supply of stores, including electric lamps, ironwork, &c. Specifications from the Borough Engineer.

CHATHAM Town Council want tenders by March 10 for six (or 12) months' supply of incandescent lamps, &c. Specifications from the Borough Surveyor.

BALLINROBE ELECTRICITY SUPPLY COMPANY, LTD., requires tenders by March 15 for the erection of poles and overhead lines. Specifications from Messrs. J. P. Tierney & Co., 44, Kildare-street, Dublin.

WEST HAM Guardians require tenders by March 24 for three months' supply of electrical fittings, ironmongery, &c. Forms of tender from the Clerk, Union-road, Leytonstone, E.11.

GLASGOW Education Authority require tenders by March 11 for the installation of heating and electric lighting in new schools. Schedules from the Property Department, Education Offices, 129, Bath-street, Glasgow.

JOHANNESBURG Municipal Council invite tenders for 40 50-H.P. 5-600-volt tramcar motors. Tenders to the Town Clerk, Municipal Offices, Johannesburg, by March 30. Specification may be seen at the Department of Overseas Trade.

ROTTERDAM Municipal Council invite tenders for an electric revolving crane for the waterworks, capable of lifting 5,500 lbs. and provided with a grab for unloading coal, and also a grab for unloading gravel. Particulars from Mr. A. van Delden, the Acting Manager of the Municipal Waterworks.

The Argentine Department of Sanitary Works (BUENOS AIRES) invite tenders (by March 21) for 11 sets of centrifugal pumps with electric motors and accessories, two groups of water turbines and generators, including switch-board transformers, &c. Representation by a resident agent is essential. Specifications at the Department of Overseas Trade.

Tenders are invited by the SERB, CROAT, SLOVENE MINISTRY OF PUBLIC WORKS for the erection of a power station, main conductors and transforming stations in connection with an electrical scheme at Kostolac for the supply of current for Belgrade, Semlin, &c. Tenders to the Director, Ministry of Public Works, Belgrade, by May 1. A translation of the specification and conditions of tender, &c., may be inspected at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

Tenders are invited up to March 21 for the supply and delivery to the Postmaster-General's Dept., State of NEW SOUTH WALES, of telephone and telegraph apparatus, testing instruments and switchgear parts (Schedule 814); up to March 29 for the supply to the Postmaster-General's Dept., State of WESTERN AUSTRALIA, of telegraph materials (Schedule 333), and to April 5 for the supply and erection of accumulators, &c., at the Telegraphic Office, Eucla (Schedule W. A., 647), and up to March 30 for supply of switchboard apparatus and parts (Schedule 515), to the Postmaster-General's Dept., State of QUEENSLAND. Forms from High Commissioner for Australia, 406, Australia House, Strand, W.C.2.

Tenders are invited in connection with the electrification of the CAPE TOWN–SIMONSTOWN and DURBAN–PIETERMARITZBURG RAILWAYS, for the supply of turbo-alternators, boilers, condensing plant, passenger and freight locomotives, motor coaches and underframes, motor bogies, electrical equipment of coaches, sub-station equipment and transformers. Specifications and forms of tender from the High Commissioner for the Union of South Africa, 32, Victoria-street, London, S.W., or the General Manager, Johannesburg. Further technical information can be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1. Tenders to the High Commissioner by May 3.

STOKE NEWINGTON (London) Borough Council have accepted the tender of W. T. Henley's Telegraph Works Company (at £18,668) for the supply and laying of distributing mains.

A tender by Messrs. Hick, Hargreaves & Company for the supply of a second twin-type condensing plant at £15,800, was recently accepted by HAMMERSMITH Council. The contractors have now submitted a revised tender of £15,500, and the contract has been settled on that basis.

LEIGH (Lancs.) Corporation recently accepted the following tenders:—One 2,500-kw. turbo-alternator, Fraser & Chalmers Engineering Works, £18,694; e.-h.-t. and l.-t. switchgear, Ferguson, Pailin, Ltd., £2,420; one 500-kw. Peebles-La Cour converter, Bruce Peebles & Company, £4,070.

MARYLEBONE (London) Borough Council has accepted the following tenders: Ferguson, Pailin, Ltd., two cable panels, with protective devices and cable screens for Aybrook sub-station, and three truck-type interlocking cubicles for Messrs. Selfridge's premises, £1,597; Sanders & Foster, steelwork for foundations for turbo-alternator, &c., £3,740; Metropolitan-Vickers Electrical Company, two exciters, rheostats and supporting stools to provide for inverted running of two 1,600 kw. rotary converters at Aybrook-street; W. H. Allen, Son & Company, motors for induced draughtfans, £1,160.

Companies' Reports, &c.

ST. JAMES' & PALL MALL MEETING.

By way of preface to his speech at the annual meeting of the St. James' & Pall Mall Electric Light Company, Ltd., the chairman (Mr. Walter Leaf) paid a tribute to the memory of Mr. Marlborough Pryor, who was for many years a director of the Company, and he announced that Mr. Montague Gluckstein, a director of the Westminster Company and Mr. Robert Benson, of the London Electric Supply Corporation, had joined the board. During the year there was a satisfactory growth alike in connections, which had increased by 1,002 kw., and in output, which had grown from a little over 12 million units to 13½ millions. That meant that customers were using their connections more freely; in other words, they had now recovered from the effect of the artificial restrictions on lighting due to the war. The growth would have been still more noticeable had it not been for the abnormally mild weather of the present winter. A large part of their new connections had been for heating purposes, and had been but little used. They had there a latent expansion which would only show itself when they returned to more normal climatic conditions.

The profits last year justified an increase in dividend and they were able to allow an all-round discount of 5 per cent. on accounts for the first three quarters of 1920 to customers paying standard rates, which was equivalent to returning to them an amount considerably in excess of the extra dividend. Unfortunately the situation at present was not so clear as one could wish. The future course of the coal market, consequent on the coming removal of Government control, was very obscure; they had to face a heavy increase in charges for interest and expenses on capital expenditure, and they found it necessary to withdraw the discount. They had taken the opportunity to consolidate in a fresh tariff the various additions they had made in difficult times.

ELECTRIC HEATING PROGRESS.

During the war the average price of coal had risen from 15s. 3d. per ton in 1913 to 42s. 3d. at present, or 177 per cent. During the same period the average price charged had risen only from 2·89d. to 3·84d. per unit, or 33 per cent. The initial price to their small consumers for lighting had risen from 6d. to 7½d., or only 25 per cent. The figures were a measure of the economies effected in generation during the period. That was due to the foresight of their engineers and managers in providing in due time the new large units at Grove-road. Their bold policy had already been fully justified, and they were convinced that by continuing it, and by that policy only, they should justify themselves in the future. It might be added that, through that economy they were now in a position to compete directly with coal for heating and lighting purposes. The domestic use of electric heating had been advancing with great rapidity, as the advantages of cleanliness and other subsidiary merits had become more widely experienced; and they looked forward to even more rapid development in the near future.

The surplus remaining, after paying the same dividend as last year, had been placed to the credit of the contingency fund, which was thus increased from £20,000 to £30,000. They were sure that, looking at the large and continuous growth in their business, that reserve was none too large. Their total revenue had risen by over £19,000. Unfortunately, their expenses continued to grow in an even larger ratio. They had advanced from £170,000 to about £187,000; but the real increase in recurrent costs was still greater, as last year they had to apply £14,727 to writing investments down to market price, but this year they needed only £1,579 for the same purpose. They had advanced money to the Central Company, in equal shares with the Westminster Company. Last year it stood at £55,000; this year it was no less than £112,000. There had been further serious delay in the completion of the first of the two 10,000 kw. sets on order for Grove-road but it would be completed within the next few months. In consequence of the delay the available plant there, together with the steam plant in the stations of the St. James' and Westminster Companies, was only just sufficient to meet the demand, which, however, was throughout the winter carried on without disturbance or breakdown. Good progress had been made in the manufacture of the second 10,000-kw. set and the additional boilers, and the whole plant should be completed in time for next winter's load. The reorganisation of Carnaby-street station had been delayed by the non-completion of the new plant at Grove-road. Motor converting plant of the latest type, of 1,000 kw. capacity, had already been installed, and the remainder of the necessary machinery would be brought into commission during the summer.

FINANCING EXTENSIONS.

After references to coal supplies, the new administrative buildings and the wages agreement, Mr. Leaf said the policy of the Central Company had been to keep their station absolutely up-to-date, and for that purpose they had not hesitated to authorise those extensions alike in buildings and plant, involving from first to last a capital outlay of some £800,000. The work had been carried out with the express sanction of the Electricity Commissioners, and, though that sanction did not import any legal guarantee, it seemed virtually to indicate the intention that if, as seemed probable, the generation of electricity in London was taken over as a public service under a Joint Electricity Authority, the works which had been thus sanctioned should be fully utilised in the future supply of London. The financing of expenditure during the period of transition was a difficult problem. The point had been reached when it was no longer wise to extend the loans made by the two parent companies to the Central Company. Until a scheme was formed, which would define the future position of the electric companies of London, it was not practicable to issue further capital in the form of shares. The board of the Central Company had therefore decided, with the co-operation of the boards of the parent companies, to make an issue of short-term notes, which would be placed on the market as soon as the moment seemed favourable. The notes will be secured by the joint and several guarantees of the parent companies, as well as by a charge on the Grove-road properties. Having dealt with the negotiations for the future of the electrical supply of London, he said their efforts were being directed to three main points. In the first place, they were doing their best to ensure that the Joint Electricity Authority should be a business board of management, and not, as might possibly be the case, a political cockpit! In the second, they were endeavouring to make sure that the price at which their generating systems were taken over should be a fair price. And thirdly, they were aiming at securing such terms for the renewal of their tenure as would allow a fair return upon their capital—such a return as would enable them to raise from time to time the fresh capital needed for growth. If they could not obtain all those points, it might possibly be advisable for them to stand aside, and be content with the terms of purchase under the Act of 1888. The whole position was one which bristled with difficulties and it was making a heavy call upon their time and energies.

SOUTH METROPOLITAN MEETING.

Mr. H. St. John Winkworth, who presided over the annual meeting of the SOUTH METROPOLITAN ELECTRIC LIGHT & POWER COMPANY, LTD., announced that substantial progress had been made, notwithstanding the abnormal cost of fuel and the high rate of wages. The total horse-power connected at the end of the year was 30,726, compared with 28,596 at the end of 1919. There were 539 new services, representing 56,553 35-watt lamps, against 522 services and 59,410 lamps last year. The total number of consumers was 8,091; the number of units sold was 17,643,122, against (15,642,716) and the average price obtained increased from 2·39d. to 2·55d. per unit. Only a small addition in the price was charged to the consumer, the higher cost of production being substantially covered by the increased output and a better load factor. The receipts from sales of current were £186,775, compared with £155,531, and the total receipts £199,037, against £166,996. Referring to the appreciation shown by consumers and others of their extensive show-rooms at Lewisham, he said the gross receipts exceeded those of 1919 (which was a record year), the turnover being a little under £26,000.

COAL AND RATES.

Coal cost £73,570, an increase of £13,618. A large part of their coal was sea-borne, and, although freights had materially fallen, the average cost per ton was greatly in excess of the previous year. The decontrol of coal would, it was hoped, enable them to secure deliveries of cleaner fuel and of the required quality. Wages had increased by about 250 per cent. over pre-war figures, and he hoped that the new national agreement would remove one of the most fruitful causes of labour disputes. The enormous increase in the rates throughout the country constituted a heavy burden upon industry, and added to the already too high cost of living. Steps should be taken to limit the amount leviable upon rateable property. In addition to the high rate an increased assessment on the undertaking would come into force as from the end of this month. After completing the analysis of the accounts he said the available total was £96,146, and the directors propose to increase the dividend on the ordinary shares from 6 per cent. to 8 per cent., and to carry forward £18,260, compared with £12,323 brought in.

The business of the West Kent Company showed a satisfactory improvement, and a dividend of 10 per cent. on the ordinary shares had been declared. A sum of £8,000 had been placed to the reserve and £1,742 carried forward. The West Kent Company's application for sanction to the acquisition of a freehold site on the Lower Thames acquired for the erection of a large up-to-date power house had been deferred by the Electricity Commissioners until after the scheme or schemes for the re-organisation of electricity in London had been received. The delay was most regrettable, as it had prevented the company from concluding negotiations for important business which could only be dealt with on comprehensive lines. As to the prospects of the current year, much depended upon labour settling down and manufacturers finding a market for their productions. While it was probable there would be trade depression, there was reason to hope that it might be only of short duration, and that the works and factories in their area would soon resume their activities. A number of substantial new connections had been made during the past year and the receipts from those would enable the company to continue to make further progress during the current year.

MATHER & PLATT'S BEST YEAR.

Mr. L. E. Mather commenced his speech to the shareholders at the annual meeting of Mather & Platt, Ltd., on Monday, by paying a tribute to the memory of his father (the late Sir Wm. Mather), who passed away during the year and who had been chairman of the present company since its formation. He said it was largely due to his foresight, enthusiasm and broad-minded outlook that the Company held the strong position in which it was. Dealing with the year's work, he said that 1920 had been the best year in their history and the increased profit was due to the larger volume of business transacted. The percentage of profit on the turnover was no greater in 1920 than in 1919, though the available total was much larger. Yet they thought it wise to recommend the same dividend, and to increase the amount carried forward. The capital of the Company had been increased by 313,660 shares, issued to ordinary shareholders and employees, which would absorb a larger amount of the available total in future. The issue of shares to employees had been very much appreciated, and considerably more were applied for than they considered it wise to allot. Their tonnage output for the last six months of 1920 was 30 per cent. greater than for the similar period in 1913, their previous record year as regards tonnage output. They had made considerable extensions at Park Works and had had to purchase premises in London for their London and overseas organisation. All those reasons had called for more working capital, with the result that it had been necessary to draw on the bank to a greater extent than ever before.

PLENTY OF ORDERS.

After explaining various items in the accounts the chairman said that though the country was experiencing a very extensive trade depression at present, they started 1921 with a large order book, and their prospects were distinctly good. Their invoicing figures for January and February were 120 per cent. above those for January and February last year, but in 1920 they were much affected by the moulders' strike. The extensions to their machine shops, which commenced early last year, were now in occupation, and they had plenty of work to fill them, so that the full benefit of their expenditure would be obtained this year. While unemployment was so severe, yet they had more men employed now than ever before in the life of the Company. Owing to the moulders' strike they were forced to order considerable supplies of castings from abroad, as were other engineering firms, and that had had a distinct effect on the present unemployment in many industries. Though there was still unrest in certain quarters of the labour world, the condition in their own shops was very satisfactory. The output per man, from piece-workers, was practically up to the pre-war standard. There was, however, a need for greater co-operation amongst those in industry, for they must all surely realise that the artificial conditions of war-time and booming trade were no more, and if they were to hold their own against foreign competition all sections of the community must pull together and cut out extravagance, waste and restrictive measures, whether affecting labour, capital, government or trade as a whole. Mr. Mather concluded by moving the adoption of the report and accounts and the declaration of dividends for 1920 at the rate of 5 per cent. per annum (less tax) on the preference shares and at the rate of 10 per cent. per annum (tax free) on the old ordinary shares.

Sir Henry O. Bax-Ironside and Sir William H. Porter have been elected directors of the WESTMINSTER ELECTRIC SUPPLY CORPORATION, LTD.

The profit of the LLANDUDNO & COLWYN BAY ELECTRIC RAILWAY, LTD., for the past year was £3,559. A sum of £1,950 has been added to the sinking fund and £2,548 carried forward. Last year a dividend of 4 per cent. was paid.

The income of the MACKAY COMPANIES from investments for the year to Feb. 1 was $4,868,988; dividends absorbed $4,230,336; operating expense, including Federal income tax, transfer agents, registrars, auditors' and trustees' compensation, office rent, salaries, &c., were $535,400, leaving to be carried forward $103,251.

After appropriating to depreciation and reserve sums amounting to £20,361, the directors of the BROMPTON and KENSINGTON ELECTRICITY COMPANY, LTD., recommend a final dividend on the ordinary shares at the rate of 15 per cent. per annum, making 12 per cent. for the year 1920 (less tax), carrying forward £1,639.

The directors' report of the PAISLEY DISTRICT TRAMWAYS COMPANY states that after placing £1,500 to debenture sinking fund, £6,000 to reserve and £2,000 to preference share sinking fund, and providing for the dividend on the preference shares, the accounts for the past year show a surplus of £6,545 to carry forward.

At the meeting of the TRAMWAYS LIGHT & POWER COMPANY, LTD., on Tuesday, it was reported that the profit for 1920 was £53,697, making with £3,833 brought forward, a total of £57,530. Loan and debenture interest absorbed £17,645 and debenture redemption account £4,334, leaving an available balance of £35,551. Of this sum £5,000 was transferred to reserve; a dividend on the ordinary shares for the year at the rate of 6 per cent. per annum (£28,294) was declared and £2,257 carried forward.

Lord Anslow, who presided over the recent meeting of the NORTH STAFFORDSHIRE RAILWAY COMPANY, stated that the electrical department had in hand the new light and power plant at Stoke, which when completed, would give them three times the capacity of their present plant. Other work had been carried out by the electrical department, both in lighting and connection of the telegraphs, and the directors were well satisfied with the energy and enterprise which had been shown by Mr. A. F. Rock and his staff.

The net profit of the MANSFIELD and DISTRICT TRAMWAYS COMPANY, LTD., for 1920 was £6,000 more than in 1919. After meeting all expenses and making provision for reserve and depreciation the balance was sufficient to justify the payment of a balance dividend on the ordinary shares of 6 per cent., making, with the interim dividend already paid, 9 per cent. for the year, leaving to be carried forward £1,851 odd. It has been decided to increase the capital by the creation of 50,000 additional ordinary shares of £1 each to provide for future developments.

The directors' report of the Mersey Railway Company for 1920 states that the amount available for interest is £48,815, which has been applied as follows: Interest on new first perpetual debenture stock, £26,775; interest at 4 per cent. on 1866 debenture stock (£4,664), at 3 percent. on 1871 debenture stock (£3,000), at 3 per cent. on 1882-3-5 debenture stock (£10,800), and at 1¼ per cent. on the "B" debenture stock (£3,518), leaving a balance of £58 to carry forward. In regard to the proposals for grouping railways, the directors are satisfied that it would not be in the interest of company or of travelling public that the undertaking should be included in the grouping scheme, and they have applied to the Ministry of Transport that it should be excluded.

It was reported at the annual meeting of the Rushden and District Electric Supply Company, Ltd., last week that there had been a great increase in the connections during the year, the number of consumers (chiefly for lighting) having risen from 223 to 308, but owing to the depression in trade during the last six months the output of electricity had remained stationary. The increased connections were equivalent to 2,035 32-watt lamps, making a total of 7,352, and motors had increased from 685 h.p. to 761 h.p., of which 319½ h.p. were let out on hire. The maximum load on the plant was 365 kw. and the number of units sold was 584,220. A final dividend of 4 per cent., making, with the interim dividend already paid, 6½ per cent. for the year, was declared, leaving £315 16s. to be carried forward.

The 1920 income of the Underground Electric Railways Company of London, Ltd., from investments was £566,944, and with miscellaneous receipts the total was £579,678, a decrease of £112,686 compared with 1919. After deducting the expenses (£120,065), adding balance brought forward (£22,939) and deducting the interest plus income tax on the 4½ per cent. bonds (£117,797), interest on the three-year secured notes (£40,250), the amount paid under guarantee on Central London Railway assented stocks (£47,130) and the interest on the 6 per cent. first cumulative income debenture stock (£76,380), the balance available for interest on the 6 per cent. income bonds and reserves was £200,995 (a decrease of £183,661). Interest at 2 per cent. (plus tax) on these bonds for the year requires £180,859, leaving a balance of £20,136, or a decrease of £2,803.

The report of the Charing Cross, West End and City Electricity Supply Company, Ltd., for 1920, states that the net earnings of the West End undertaking were £102,830, plus balance brought forward and interest accrued (£14,389), making £117,220. After providing for interest on debenture stock (£17,829), depreciation (£22,000), the directors recommend a final dividend on the ordinary shares at the rate of 5s. 6d. per share, making 8 per cent., placing to general reserve £15,000, and carrying forward £12,390.

The net earnings of the City undertaking were £63,684, plus balance brought forward (£7,217), making £70,902. After providing for interest on debenture stock, 6½ per cent. 5-year secured notes, loans and advances (£38,411), and dividend on preference shares (£18,000), the directors recommend placing £10,000 to general reserve, carrying £4,490 forward.

The gross receipts of the Liverpool Overhead Railway Company for 1920 amounted to £229,130, and the working expenses (including appropriation to reserve funds) to £199,881. The number of passengers carried during the year was 21,020,839, against 22,440,103 in 1919. The receipts from passenger traffic amount to £226,446, and miscellaneous receipts to £2,684. The working expenses, appropriation to reserve funds and amount written off investments were £199,881, and after deducting interest on debenture stock (£6,755) and adding balance brought forward (£6,015) the amount available is £28,508. Interim dividends were paid for the half-year ended June 30 last at the rate of 5 per cent. per annum on the preference shares and 2½ per cent. on the ordinary shares, leaving available £18,293. Dividends for the half year ended Dec. 31 at the rates of 5 per cent. per annum on the preference shares and 3½ per cent. per annum (making 3 per cent. for the year) were declared on the ordinary shares, leaving £5,577 to be carried forward.

At the meeting of the Electrical Distribution of Yorkshire, Ltd., last week the chairman, Mr. R. W. Wickham, stated that for the ninth year in succession they were able to pay a dividend of 6 per cent., tax free. During the past year over £33,000 had been expended in extending the mains, and in other works for supplying the large number of consumers who had applied for electricity. The company were the authorised undertakers for the supply of electricity under 24 Electric Lighting Orders, and they were giving a supply to 16. The issued capital had been increased during the year by the receipt of applications for 12,707 shares, and it was proposed in a few days to allot provisionally to present shareholders 50 per cent. of their holdings. The report was adopted, and £1,000 was added to the reserve, £1,696 being carried forward, subject to directors' remuneration. The shareholders authorised an increase in the capital from £100,000 to £150,000, with authority to borrow up to one-third of the share capital.

The gross revenue of the Metropolitan Electric Supply Company, Ltd., for 1920 was £516,594, an increase of £103,535. The working expenses were £318,638, increase £76,015. The directors have set aside £90,000 to depreciation and reserve account, which now stands at £615,000. Amount carried to net revenue account is £107,956, which, with balance brought in, interest and dividends on investments, makes £130,858. A further dividend of 5s. per share (being at rate of 10 per cent. per annum) is recommended on the ordinary shares, making 7s. per share, or 7 per cent., for year, carrying forward £4,514. New connections, representing 3,374 kw., were added during the year, making the total 48,800 kw. Owing to continued increase in demand, particularly in the western area of supply, contracts have been placed for additional plant at Willesden of 20,000 kw., and for trunk mains to link up with the generating station at Uxbridge, where further plant has already been installed.

It was reported at the annual meeting of the Bournemouth & Poole Electricity Supply Company, Ltd., yesterday (Thursday), that the net capital expended during 1920 on account of the Bournemouth, the Poole and Branksome, the Christchurch and District, and the Pokesdown Orders amounted to £31.514, making the total expenditure at Dec. 31 last £540,077. The balance from revenue account (after deducting generation and distribution costs, rent, rates, taxes, wages, directors' fees, &c., was £39,066, and after adding profit on trading account (£3,410) and balance from 1919 (£4,628), the total available was £47,104. Deducting interest on debenture stock and 7½ per cent. seven-year and interest on temporary loans (£9,659) and leasehold and special redemption funds and interest (£2,396), writing £500 off preliminary expenses, and carrying £12,000 to reserve for depreciation, &c., the balance available was £22,549. The interim and final dividends on the 4½ and 6 per cent. preference shares and the interim dividend on the ordinary shares at the rate of 5 per cent. per annum absorbed £12,337. 10s., leaving for further distribution £10,211, out of which a final dividend on the ordinary shares at the rate of 7 per cent. per annum, for the second half-year (making 6 per cent. for 1920), was declared, and a balance of £6,536 was carried forward. Lord Erskine has been appointed a director in place of the late Mr. F. E. Savory. The total applications received at Dec. 31 last amounted to the equivalent of 16,233 kw., an increase of 1,942 kw. for the year, compared with 1,695 kw. for 1919. The total number of units sold was 6,198,302.

Mr. Geo. Balfour, M.P., presided over the annual meeting of the Fife Tramway, Light and Power Company, Ltd., last week, and in moving the adoption of the report and accounts, he said that the gross receipts of the Fife Power Company, the Dunfermline Tramways Company, and the Fife Electric Lighting undertakings for the year amounted to £207,445. Adding the receipts of the Falkirk Tramways Company for its last financial year and of the Scottish General Omnibus Company for its first accounting period, the grand total of gross receipts was £303,904. The passengers carried by the various transport undertakings in the same periods reached the large total of 18,243,510, and the mileage run in the like period by the various tramways and omnibus undertakings aggregated 2,041,773 miles. The dividend on the ordinary shares was at the rate of 8 per cent. per annum as in 1919.

The gross receipts of the Dunfermline & District Tramways Company were £92,540, against £86,790 in the previous year, the net profit being £25,862, compared with £26,589. Last year's Act enabled them to increase the fares, and they were now overtaking the accumulation of increased charges. Prior to the fares being increased, the earnings for the portion of the year which had elapsed actually showed a considerable decrease compared with those of the corresponding period of 1919.

During the year the Fife Electric Power Company showed a substantial increase in net revenue due to the large expenditure on capital account which had been made during previous years. The gross receipts were £114,905, compared with £73,560 for 1919. The net trading profit, including the profit under the Electric Lighting Orders, amounted to £36,998, compared with £21,920. 19,579,000 units were sold from the power station at Townhill, against 14,891,000 in 1919. The consumers connected were 2,955, an increase of 449. During the last three years the number of consumers connected had been more than doubled. The demand for electricity continued unabated and at the moment 150 consumers were awaiting connection. The total load connected was 11,840 kw., compared with 8,830 kw. Various extensions to the plant had been carried out to cope with the increasing demands and for the purpose of effecting economies in supply. The electric lighting orders in Cowdenbeath and in various parts of the County of Fife did not call for much comment. Those undertakings were granted direct to the Company, and a supply of electricity was given over a large and scattered area under those orders, the supply being obtained in bulk from the Fife Electric Power Company. The net revenue from that source was included in the Fife Power Company figures.

With regard to the Falkirk Tramways Company, the whole share capital of which they had now acquired, the system covered some 7½ miles of route, and serves the important centre of Falkirk, connecting it with Larbert, Stenhousemuir and other industrial districts in Stirling, and by a branch line with Laurieston. For the year to Oct. 16, 1920, which was formerly the fiscal year of the Falkirk Company, the car-miles run were 407,458, against 349,476; the passengers carried 5,317,326, against 5,303,961, and gross receipts £33,613 (£32,439).

New Companies.

The following list has been compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, Chancery-lane, London, W.C. 2:—

JAMES ANTI-FOULING APPLIANCES, LTD. (173,121).—Reg. Feb. 12. Capital £3,000 in £1 shares, to manufacture, sell and deal in any secret or other information as to any invention in relation to improvements in electrical apparatus for protecting the hulls of ships. Directors, J. E. James and J. B. Wilkie. Reg. office: 1a, Cockspur-street, S.W.

SANDIFORD, CONRAD & CO., LIMITED. (173,192).—Reg. Feb. 16. Capital £5,000 in £1 shares, to carry on business of electrical, mechanical, hydraulic, sanitary and general engineers. Directors, J. Sandiford 78, Orchard-lane, Leigh, Lancs. (governing director) and J. P. Conrad.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics" (Special Engine Number): British Aero Engines; "Aeroplane and Seaplane Transport Efficiency," by H. White Smith, chairman S.B.A.C.; "Handley Page Wing," by F. Handley Page.

"The Cabinet Maker": Annual Dinner of the Furnishing Trades' Benevolent Association; "National Furnishing Trades' Convention"; and "Practical Upholstering and the Cutting of Loose Covers."

"Chemical Age": The first of a special series of articles by Dr. Philip Schidrowitz on "Recent Progress in Rubber Chemistry and Technology."

"Farm and Home": "Cost of Horse Ploughing"; "Effect of High Wages in Agriculture"; and "Hunter Horse Show."

"The Fruit-Grower": (Empire Trade Issue): "A Self-Contained Empire Fruit Supply"; "Packing and Grading in Dominion Fruit Export"; and "Refrigeration System for Fruit on Board Ship."

"Gardening Illustrated:" "Growing Cyclamens"; "The Bolder-growing Snowdrops" (illustrated); and Apple Newton Wonder (illustrated).

"The Gas World": Monthly By-Product Coking Section; Board of Trade Inquiry as to the future quality of Gas Supply; and Reports of numerous Gas Companies' Meetings.

"Hardware Trade Journal": "Agricultural and Dairy Appliances"; "Some Saleable Sidelines"; and "The Future of Leather Goods Exports."

Forty Years Ago.

(THE ELECTRICIAN, MARCH 5, 1881.)

THE TELEPHONE AT NEWPORT (MONMOUTHSHIRE).—We hear that communication between Cardiff and Newport by means of the telephone is nearly complete and will be shortly opened.

SOCIETY OF TELEGRAPH ENGINEERS AND THE PARIS EXHIBITION.—The Treasury having declined to send a Commissioner to Paris, the Society of Telegraph Engineers are about to form a Committee to organise some arrangement that will meet the requirements of British exhibitors.

ELECTRIC LIGHTING EXTRAORDINARY.—The Brush Electric Light Company were able to accomplish during the recent long sitting in the House of Commons a feat hitherto without a parallel in the annals of electric lighting. They lighted Westminster Palace-yard for 16 hours with a single carbon.

PROF. TYNDALL AND THE PHOTOPHONE.—*L'Electricité* has received "a very important letter from the celebrated successor of Faraday concerning his (Prof. Tyndall's) recent splendid series of experiments. They prove, says *L'Electricité*, "that the phenomena hitherto erroneously described as *photophonic* are due not to the direct action of light, but to the heat rays conveyed by the light."

Prices of Metals, Chemicals, &c.

		Price.	TUESDAY, Inc.	Mar. 1. Dec.
Copper—				
Best selected.........	per ton	£71 0 0	—	£3 0 0
Electro Wirebars ...	„	£75 0 0	—	2 0 0
H.C. wire, basis ...	per lb.	0s. 11$\frac{5}{8}$d.	—	$\frac{3}{16}$d.
Sheet	„	1s. 0$\frac{7}{8}$d.	—	—
Phosphor-bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	„	1s. 3$\frac{5}{8}$d.	—	$\frac{3}{16}$d.
Brass 60/40—				
Rod, basis	„	0s. 8$\frac{1}{2}$d.	—	—
Sheet, basis	„	1s. 1$\frac{3}{4}$d.	—	—
Wire, basis	„	1s. 1$\frac{3}{4}$d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£11 0 0	£1 0 0	—
Galvanised steel wire, basis 8 SWG	„	£29 0 0	—	—
Lead Pig—				
English	„	£19 10 0	—	£2 0 0
Foreign or Colonial	„	£17 10 0	—	£1 15 0
Tin—				
Ingot	„	£160 0 0	—	£10 5 0
Wire, basis	per lb.	2s. 2$\frac{3}{4}$d.	—	1$\frac{3}{8}$d.

Salammoniac.—Per cwt. 100s.-95s.
Sulphur (Flowers).—Ton £14 10s.
„ (Roll-Brimstone).—Per ton £14 10s.
Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.
Copper Sulphate.—Per ton £35.
Boric Acid (Crystals).—Per ton £74.
Sodium Bichromate.—Per lb. 10d.
Sodium Chlorate.—Per lb. 4$\frac{1}{2}$d.

Rubber.—Para fine, 0s. 11$\frac{1}{2}$d.; plantation 1st latex, 1s. 1$\frac{1}{4}$d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by Messrs. W. T. Henley's Telegraph Works Company, Ltd.

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Arrangements for the Week.

FRIDAY, March 4th (to-day).

INSTITUTION OF MECHANICAL ENGINEERS AND THE SOCIETY OF CHEMICAL INDUSTRY.

6 p.m. At the Institution of Mechanical Engineers, Storey's-gate, London, S.W. Paper on "Degassing and Purification of Boiler Feed-Water," by M. Paul Kestner.

INSTITUTION OF ELECTRICAL ENGINEERS.—STUDENTS' SECTION.

6.30 p.m. At Faraday House, Southampton-row, London, W.C. Paper on "Telephonic Transmission through Submarine Cables," by Mr. A. Rosen

BIRMINGHAM AND DISTRICT CLUB.

6.45 p.m. At Grand Hotel, Colmore-row, Birmingham. Tenth Annual Dinner.

ROYAL INSTITUTION.

9 p.m. At Albemarle-street, Piccadilly, London, W. Discourse on "Severn Crossings and Tidal Power," by Mr. W. A. Tait.

SATURDAY, March 5th.

ROYAL INSTITUTION.

3 p.m. At Albemarle-street, London, W. Lecture on "Electricity and Matter," by Sir Ernest Rutherford, F.R.S. (Lecture I.)

MONDAY, March 7th.

UNIVERSITY OF LONDON.

5.30 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Lecture on "Recent Engineering Works in Italy." Lecture I., "Sanitary Engineering and Water Supply," by Prof. Luigi Luiggi, D.Sc.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS.

5.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Paper on "The Relay System of Automatic Switching," by Mr. H. Dipple.

INSTITUTION OF ELECTRICAL ENGINEERS.—WESTERN CENTRE.

6.30 p.m. At the South Wales Institute of Engineers, Park-place, Cardiff. Lecture on "Prospects of Electricity in Agricultural Centres," by Mr. W. Kerr.

ROYAL SOCIETY OF ARTS.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "X-rays and their Industrial Applications," by Major G. W. C. Kaye, O.B.E.

TUESDAY, March 8th.

INSTITUTION OF CIVIL ENGINEERS.

5.30 p.m. At Great George-street, S.W. Paper on "The Amritsar Hydro-Electric Irrigation Installation," by Mr. S. Leggett.

INSTITUTION OF ELECTRICAL ENGINEERS.—SCOTTISH CENTRE.

7 p.m. At Prince's-street Station Hotel, Edinburgh. Paper on "The Long-distance Telephone System of the United Kingdom," by Sir W. Noble.

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH-WESTERN CENTRE.

7 p.m. At the Engineers' Club, Manchester. Paper on "Electric Driving in the Paper Mill on Heat-Economy Lines," by Mr. A. B. Mallinson.

WEDNESDAY, March 9th.

INSTITUTE OF METALS.

10.30 to 1 and 2.30 to 4.30. At the Institution of Mechanical Engineers, Storey's-gate, London, S.W. Annual General Meeting.

UNIVERSITY OF LONDON.

5.30 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Lecture II., "Agricultural Hydraulic Engineering," by Prof. Luigi Luiggi, D.Sc.

NATIONAL ASSOCIATION OF SUPERVISING ELECTRICIANS.

6.30 p.m. At St. Bride Institute, Bride-lane, London, E.C. Discussion on "Gas *v.* Electricity," by Mr. F. W. Goodenough and Mr. W. A. Gillott.

INSTITUTE OF COSTS AND WORKS ACCOUNTANTS.

7 p.m. At the Institute of Chartered Patent Agents, Staple Inn, London, W.C. Lecture on "Economies in Relation to Costing," by Mr. Wilfred Grainger.

INDUSTRIAL LEAGUE AND COUNCIL.

7.30 p.m. At Caxton Hall, London, S.W. Lecture on "The Ex-Service Man and his Reinstatement in Industry," by Mr. C. Latham.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

7.30 p.m. At St. Bride Institute, Bride-lane, London, E.C. Paper on "The Economic Utilisation of Exhaust Steam," by Mr. A. J. Assheton.

THURSDAY, March 10th

INSTITUTE OF METALS.

10.30 a.m. At the Institution of Mechanical Engineers, Storey's-gate, London, S.W. Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Lecture on "Feebly Magnetic Materials." Lecture III., "Practical Applications," by Prof. E. Wilson.

OPTICAL SOCIETY.

7.30 p.m. At the Imperial College of Science, South Kensington, S.W. Lecture on "The Story of a New Star," by Prof. H. F. Newall, F.R.S., and a communication on "Note on a Handy Form of Measuring Microscope," by Mr. T. F. Connolly.

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Notes.

The Public and Electricity Supply.

MR. LLEWELYN ATKINSON is to be congratulated on seizing the opportunity offered by the presence of the laity at the Annual Dinner of the Institution of Electrical Engineers of putting before a wider audience than it is usually possible for a President of the Institution to address some salient facts regarding the present position of electricity supply in this country. We hope he was equally successful in removing certain fallacies from the minds of his hearers. He warned those present that the new heaven and the new earth (electrical pattern) that were to result from the passing of the Electricity Supply Act were not at present even within measurable distance of being created in spite of all that had been said and done, and that on the contrary the old struggle between municipal and company interests had broken out afresh. Electrical engineers, he continued, must on the other hand realise that the public were expectantly awaiting that cheap electricity which they had been so definitely promised, and that while we now had an opportunity of showing what we can do towards meeting this demand that opportunity once missed would never recur. He added that it was not the Commissioners who were to blame for this state of things, but those who failed to put forward schemes for the re-organisation of electricity supply which could be quickly accepted.

The Real Forces of Reaction.

WE are glad that Mr. ATKINSON made these remarks to an audience which was not entirely composed of electrical engineers. For while the latter will admit the essential truth of the indictment there are certain points in the argument to which the widest attention must be called. For an Act of Parliament is only a beginning, and a small beginning at that, in any scheme of reform. The thinking public, among whom those who are interested in electricity supply must be numbered, realise this, and realise too that a tremendous amount of work is necessary before that vital re-organisation of our electricity supply can be achieved. They realise also that circumlocution and delay are dear to the bureaucratic and legal minds. That being so, they should know that a miasma of legal quibbles and bureaucratic preciousness are being cast over all attempts to simplify and co-ordinate the electricity supply of this country. With that knowledge they will award the blame for the lack of cheap electricity supply not to the Electricity Commissioners or to the electrical engineer, but to the lawyer who produces half-a-dozen meanings for each simple phrase and to the politician who views every problem from the exiguous shade of the parish pump. For it is not the electrical engineer who is running the cost of the Electricity Inquiries into thousands of pounds or delaying the reorganisation of a district, but those forces of procrastination and darkness which seem to flourish so luxuriantly in this country. It is a question to whose solution the Daily Press might give their assistance, but those great organs of public opinion view the whole matter with profound indifference, or when they deal with it at all treat it with an almost equal wrong headedness. For ourselves we feel sure that if the whole question could be dealt with by engineers, and engineers only, a satisfactory settlement would be speedily arrived at.

More Joint Electricity Authorities.

PARTICULARS of two additional schemes for the constitution of Joint Electricity Authorities have been published during the week, and an outline of the engineering proposals which accompany them are given elsewhere in this issue. Both schemes contain features of interest, more especially that for the London and Home Counties. The district as defined by the Electricity Commissioners is adopted, but certain slight adjustments on the frontiers of the area are suggested. In this important district there are at present 41 municipal and 45 company undertakings supplying electricity, and the proposed Joint Authority combining them is to consist of 28 members distributed as follows. Six members will be appointed by local authority undertakers and six by companies; the London County Council will have eight representatives, purchasing authorities and other local councils outside the London area four, railway companies and other large consumers two, and workers in the electric supply undertakings two. This last is an interesting departure, and both in debate and in practice is likely to cause trouble. Provision is also made for the constitution and working of the authority, and for the control and operation of existing undertakings, the erection and working of new generating stations,

&c. Certain clauses of the Electricity Supply Act, 1919, and of the Electricity Supply (No. 2) Bill, of 1920, are reproduced, and in Schedule 3 there is an outline of the technical scheme for the improvement of the organisation of the electricity supply in the district.

The Technical Scheme.

The system of supply will be three-phase, at 50 cycles on the north side of the Thames, and at 25 and 50 cycles on the south side of the river, where the 25-cycle system is extensively used at present. This difference is a pity and we should like to have seen a rather more valiant attempt at uniformity. The primary transmission pressure will be 33 000 V, and the secondary 6 600 or 11 000 V. The cables will be three-core, paper-insulated, lead-covered and armoured, and will be generally laid direct in the ground, though in certain outlying parts overhead transmission appears to be contemplated. The arrangements regarding existing generating stations will be carried out in two stages. During the first stage 34 stations will be shut down, and by means of interconnecting cables bulk supply will be given from the remaining stations. At the same time certain capital stations will be erected, and as soon as they are ready for working 26 of the remaining generating stations will be closed. Of the remaining 17 electricity works two will be reconstructed as capital stations, seven will be permanently used as auxiliary generating stations, and the other eight, which are on the outskirts of the area, will have to be retained for a considerable period to meet local demands. Six capital stations are proposed, four being on new sites of which the precise localities are not indicated for fairly obvious reasons. Three of them will, however, be north of the Thames, and one on the south side. The installed capacities of the capital stations would vary in the first instance from 70 000 to 200 000 kW, mostly in units of 25 000 kW, but there will be ample room for extensions. No works are to be constructed by the Minister of Transport, and the existing tramway and railway generating stations are not to be interfered with.

The Position of the County Company.

Such in brief is the engineering scheme prepared by Sir Alex. Kennedy and Messrs. G. W. Partridge, J. H. Rider and C. H. Wordingham, in consultation with Sir Philip Dawson for the railway companies. The ground appears to have been well covered, and as the municipal interests and the majority of the companies appear to be working in harmony the proposals will, we sincerely hope, meet with general approval. The County of London Electric Supply Company, which has an ambitious scheme of its own, and is applying for further statutory powers for its Barking station, seems to be opposed to the formation of a Joint Authority, and it may submit alternative proposals. But we trust it will see its way to join forces rather than to create opposition.

The West Riding District.

The second scheme relates to the formation of a Joint Electricity Authority in the West Riding (Aire and Calder) District, and has been prepared by a committee of local authorities in the area, under the leadership of Bradford. It is an alternative to the plan of the Leeds Corporation, recently published in The Electrician, and differs from it mainly in the fact that any financial deficit could be met out of the rates. As both schemes would be carried out in stages, there ought to be very little risk of a charge upon the rates if extensions are made gradually and in a businesslike manner. In view, however, of the tendency of local burdens to increase there is a fear, though we think it groundless, that the operations of a Joint Authority might involve a loss in its initial stages, and hence Leeds Corporation and a few of the minor local councils do not wish to incur any risk in the matter. Both the Leeds and Bradford proposals contemplate the purchase of the undertaking of the Yorkshire Electric Power Company, and the erection of new electricity works by the Minister of Transport. As the Yorkshire Electric Power Company has also submitted its own scheme, which is based on the extension and development of its existing system, the local inquiry to be held by the Electricity Commissioners will be particularly interesting, especially as the company's powers extend into three electricity districts.

Technical Details.

The proposed West Riding Joint Authority would consist of 40 members, all representative of local authorities, including the County Council. The basis of representation, the appointment and election of members, and the powers and duties of the Authority, are set out in detail. The purchasing powers of local authorities are to be vested in it; powers would be sought to act as authorised distributors and to purchase the undertaking of the Yorkshire Electric Power Company, and the generating stations of local authorities. The technical scheme proposes the adoption of the three-phase system at 50 cycles. The main transmission pressure will be 33 000 V and the local secondary pressures 11 000 and 6 000 V, but 11 000 V will be adopted wherever possible. The generating stations at Bradford, Halifax, Huddersfield, Leeds, Thornhill and Wakefield will ultimately become distributing centres, and they will be interlinked by main transmission cables. Extensions from these centres will be made to sub-distributing centres as required. Two new capital stations (near the existing Wakefield station and a new one near Apperley Bridge on the Aire) will, it is proposed, be erected by August, 1924, but in the meantime extensions will be made to the stations at the distributing centres in order to keep pace with the demand for energy. The new capital station will, it is suggested, be erected by the Minister of Transport and then taken over by the Authority and paid for within five years.

Electricity Supply in Rural Districts.

From the reports of the proceedings at recent meetings of urban and rural councils it would appear that some strange views are held as to the powers and duties of the Electricity Commissioners. Many of these authorities are of opinion that it is the duty of the Commissioners to take steps not only to provide a "cheap and abundant" supply of electricity wherever it is needed, but also to provide the necessary capital for developing water power. No doubt the extravagant language used by the framers of the Electricity Supply Act is partly responsible for this idea, though it is assisted by the peculiar difficulties inherent in the establishment of small electricity supply undertakings, particularly hydro-electric works, which naturally make the local authorities look to some government department or to some local landowner to remove the obstacles from their path and is aided by the supposition that the Treasury is a sort of widow's cruse for supplying money for this or that deserving object.

Light Required.

For instance, in one district in Scotland a proposal to adopt electricity supply has been postponed as it was thought that the Electricity Commissioners, in the course of their duties, would provide this commodity without being asked. At Braemar, a scheme for the erection of a hydro-electric station has been deferred, partly owing to the opposition of the owners of fishery rights and partly owing to a statement made by the County Clerk that no rules and regulations had yet been made for the conduct of such undertakings by the Electricity Commissioners. It is interesting to note that the Commissioners themselves do not appear to have been consulted in the matter, and, as many similar projects for hydro-electric development in Scotland are being held up on this plea, we suggest that the subject is one upon which an early official announcement should be made, so that light may be thrown across these people's darkness.

A Way Out of the Difficulty.

Knowing what one of the chief characteristics of Scotch birth is we are not surprised to learn that the proprietors of fishing rights in rivers are keen opponents of any proposal to utilise water power in the generation of electricity. At Ballater, in fact, threat of opposition from this source has induced the promoters to abandon a hydro-electric scheme in favour of a steam-driven station. Of course, the proper way to deal with water power is to lay down certain definite principles and then to entrust its development in an extensive area to a large power company or to a Joint Electricity Authority. Of these the former would seem to be the better course as water power is scattered over such wide areas and public opinion does not seem to be sufficiently ripe for Joint Authorities. In this connection it is interesting to note that the two large Scottish hydro-electric projects of this season—the Grampian scheme, of which we gave particulars in a recent issue, and the Lochaber Power Company—are to be proceeded with as private bills and not as provisional orders. The share capital of the Lochaber Company is £3 000 000, which may be issued in equal proportions of ordinary and preference shares, with borrowing powers up to one-half of the capital. The proposed works are all in the County of Inverness and the promoters and directors are the present directors of the British Aluminium Company. Both measures, which are fortunately receiving good public support, are conceived on bold progressive lines, and, if passed in anything like their present form, should add greatly to the material prosperity of the districts they will serve.

The Poulsen Wireless Patent.

The judgment of Mr. Justice Sargant on the application for an extension of the term of the Poulsen arc patent of 1903, which is reported elsewhere in this issue, is a good illustration of the difficulties encountered by patentees in the exploitation of their inventions. The history of this interesting patent is complicated. Various attempts were made to develop it commercially in this country, and some progress had been made before the outbreak of the war, but great financial and other difficulties were encountered, with the result that the patent expired in the normal course in July 1917. It was contended, however, that as the invention was one of great merit, and that as the war had interfered with its commercial development, an extension of the original term ought to be granted under the provisions of the Patents and Designs Act, of 1919. But, after reviewing the whole of the circumstances, his Lordship refused to grant the application, as certain persons, including the Post Office and other Government Departments, had been using the system on the understanding that the patent had expired, and also because the arrangements made by the Poulsen Company with the Marconi Company had placed the former in a position to find the necessary capital for developing the system. As Mr. Hage's claim had been merged in that of the syndicate formed to exploit the patent, the claim of the three applicants failed. While refraining from commenting on the legal aspects of the case we are of opinion that the decision is one which will be to the general benefit of wireless communication.

Symbols.

Electrical engineers have always been interested in the question of the best symbols to adopt for indicating certain generally used quantities, and some of them have gone so far as on certain occasions to exhibit a good deal of misplaced ingenuity, and to give printers and typefounders many a bad half-hour by introducing symbols which were neither easy to read, to cast, or to print; while, to add insult to injury, they did not immediately indicate what they were supposed to represent in the way every good symbol should. We are therefore glad to see that the tendency of the symbols for electrical quantities now authorised by the International Electrotechnical Commission is in the direction of simplicity, as will be gathered from a study of the complete tables published in the current issue of the "Journal" of the Institution of Electrical Engineers. The majority of the quantities are represented by a single plain letter, and these letters are to be found in either the English or the Greek alphabet, while the temptation to use special types has been commendably avoided. As, however, the symbols suggested in some instances run counter to the style that has for many years been used in The Electrician, we have decided, for the sake of international uniformity, to come into line in this matter. Generally we are in agreement with what has been proposed both from the electrical and typographical points of view. Our one criticism is directed to the advisability of omitting the comma which usually appears in English printing between any three digits constituting a whole number. This will cause no confusion when followed by an abbreviation for an electrical unit, but is likely to look a little strange when preceded by the usual symbol for pounds sterling. We are, however, making the experiment and shall be pleased to have the opinion of our readers as to its advisability, reserving to ourselves the right to go back to our old style if we find that the disadvantages outweigh the advantages.

Industrial Conditions and Welfare Work.

The realisation, as the Duke of York said, at a recent conference on Industrial welfare work, that the question of human factor in industry must be dealt with in a new spirit is an encouraging sign of progress in our psychological development. From this point of view alone the work of the Industrial Welfare Society is to be encouraged, for while not interfering in any way between employers and organised labour, it does its best to develop those industrial, educational and especially recreational aspects of commercial life which are so compendiously indicated by its title. The task of the members of the Society is therefore not only a very important, but a very difficult one. For while taking every care of the employee in the ways indicated, there must be every insurance against those fatally easy courses of too much policing and too much mothering. It must never be forgotten that the worker of to-day is neither a child, nor a savage, and that while he or she appreciates real help he equally resents any attempts in any way to limit his freedom. We are not therefore surprised to learn that while in some works "welfare" has been an outstanding success, in others it has been an equally hopeless failure. For its success or failure depends equally on the welfare worker, and the success of the movement in future is therefore closely bound up with the mentality and education of that worker. Without that proper education the establishing of that co-operation and good feeling between all sections of the industrial community cannot hope to be achieved. We look to the Industrial Welfare Society to provide the necessary means to this end.

Combination and the Slump.

Under present-day conditions the virtues of combination in the industrial community should be sufficiently clear; and great as these virtues are in times of prosperity they become greater still in periods of adversity. This is equally true, whether the combination be on the purchasing or on the selling side—to maintain the quality of the product, or to lay down conditions of contract. Yet so little does this seem to be recognised in certain sections of the electrical industry that we hear of firms whose one idea at the moment is to break away from their association so as to indulge either in an orgy of price-cutting or in a reduction in the quality of their products, or in both. Could anything be more foolish? If there is anyone who doubts this let him study the history of the electrical industry 10 years ago, when its constituent firms lived not on taking in each other's washing, but by cutting each other's throats. Now that the British electrical industry has a reputation to maintain, and a market to supply, it would be fatal to jeopardise either by adopting a policy of "funk."

Magnetic Susceptibilities of Low Order.

The series of three lectures recently delivered before the members of the Institution of Electrical Engineers by Prof. E. Wilson shows once again the tremendously important part that magnetism plays in the application of the phenomena of electricity and magnetism to industrial development. Indeed we sometimes think that electrical engineering would be more appropriately termed magnetic engineering, for apart from one or two phenomena the object of the generation of electricity is the production of magnetic forces. Even for generation we have to rely on magnetic changes unless we are content to depend upon the primary cell or the thermopile!

This line of reasoning suggests that we should give much more attention to the study of pure magnetism and the magnetic effects of electricity than we did in our student days. Not a few of us are conscious that we looked upon such matters as magnetic susceptibility and the intensity of magnetisation as being a thought too dry and academic, and not the sort of strong meat upon which a budding electrical engineer could be expected to thrive. Of course, we have learnt wisdom since then, but it is possible that some of us who listened to Prof. Wilson's lectures wished that we had heeded our earlier masters more diligently so that we could have appreciated the subtleties of susceptibility with greater ease and interest.

The Separation of Minerals.

The lectures were designed to show how certain minerals might be separated one from another, magnetically, by utilising the knowledge that they have different magnetic susceptibilities. The basic idea may be best illustrated by the case of monazite. The deposit in which this mineral occurs contains also ilminite and zircon; the ilminite having a higher susceptibility than the monazite, whilst the zircon is non-magnetic. Thus a comparatively weak magnetic field can be used to separate the ilminite from the other two subtances, and then a stronger field will pick out the monazite from the zircon, which passes on unaffected by the magnetic separators. The problem is to so adjust the magnetic fields of the separators that only one mineral at a time will be picked out—starting obviously with the weakest field and picking out the substance having the highest susceptibility.

Treatment and Susceptibility.

The complete application of this idea to the magnetic separation of minerals clearly involves a full knowledge of the susceptibilities of the various minerals which can be dealt with in this way, and the first lecture of the series was descriptive of the methods employed for measuring susceptibilities of low order. In addition to this there is the possibility that the susceptibility of a substance might be altered by some treatment or other—for example, by oxidation or by temperature variation or by the alteration of the magnetic force. Such variation would be of very great value in the separation of two minerals whose normal susceptibilities were so nearly equal that no adjustment of the magnetic separator could sort out one apart from the other. If, however, heat treatment caused the susceptibility of the one to change appreciably from that of the other then magnetic separation would become possible.

The Effect of Heat.

The second lecture was an examination of the results obtained of the susceptibilities of different substances normally and after various treatments. It was shown that some substances had their susceptibility increased whilst others were decreased by heating in air: that a substance like copper has a negative susceptibility whilst its salts are positive, whereas a substance like magnesium is positive and its salts negative: that paramagnetic salts when hydrated have a higher susceptibility than anhydrous salts, although water itself is diamagnetic!

The final lecture dealt with the practical applications of magnetic separation. Prof. Wilson pointed out that the whole subject was also of great importance in its bearing towards magnetic survey work, and in the construction of scientific instruments; and he indicated that there were also possibilities of its application in other directions.

We congratulate the Institution on inaugurating this series of lectures on fundamentals and hope on future occasions the policy will be extended into other fields.

International Cable Communication.

So many important points relating to the laying and working of international submarine cables in peace and war were dealt with in the long statement made some weeks ago by Mr. Clarence Mackay, President of the Commercial Cable Company, before the American Committee which is considering a Bill for the regulation of cable landing rights in the United States, that we give elsewhere a fairly long abstract of his evidence. We do this for two reasons. In the first place the demand for the extension of submarine cable facilities, due to the effects of the war, has raised the question of cable landing rights in the United States in an acute form, and it is well to know something of the American attitude. In the second place, the full history of the method of dealing with the late German-owned cables has not yet been published and the American version is now given for the first time.

Britain's Dominant Position.

The reasons given by Mr. Mackay for the dominant position of Great Britain in the manufacture and laying of submarine cables, though they are not unknown to some of our readers, are a highly flattering testimonial to British foresight and commercial enterprise. The trading and strategic value of adequate cable connection between the mother country and her overseas possessions was quickly understood by us, and cable extensions were steadily made until at present British companies own about 130 000 miles of cable, compared with the 71 000 miles owned by American companies, and the 23 855 miles possessed by companies of all other nationalities. This exceedingly satisfactory state of affairs is mainly due to the skill and commercial acumen of those who organised and built up the splendid system now owned by the Eastern and Associated Companies.

Cable Laying Rights.

A good deal of Mr. Mackay's evidence related to the conditions imposed by various countries on the landing of cables; on the opening of telegraph offices and other similar facilities. He contrasted the former practice of this country with that of France and Germany to our advantage, but he maintained that the present British rule of limiting the duration of the concession to five years, and the desire to control international rates, would kill private cable enterprise. He appeared to favour the use of a more liberal form of landing permit, the general principles of which could be settled by international agreement on the basis of reciprocity, as laid down by President Grant in his Message to Congress in 1875. Of course every State must retain the power to control, and in cases of necessity such as in war, to use all means of telegraph and telephone communication; but subject to this we are in favour of the claim for a more liberal form of concession. Otherwise private enterprise in submarine telegraphy will be killed, because the capital required for laying new cables or for extensions to existing systems cannot be found. This would be a calamity—a serious check to progress. It must be remembered that all the pioneering work and more than three-fourths of the existing cables have been laid and are operated by companies.

Telegraph Monopolies.

It is well known that there is no Government telegraph system in the United States, all the land lines as well as the transatlantic cables being owned by companies, and these undertakings appear to be afraid of the new claim by Great Britain to control the rates, as by means of the Imperial Cable system a tariff war might break out with the view of ruining the American companies. We think the companies concerned are needlessly alarmed on this point. Submarine telegraphy, like any other commercial undertaking, succeeds by efficiency, enterprise and progress, and we have never known any Government department to be equipped with these virtues. Monopoly and progress are mutually antagonistic. Progress is essential for the social well-being and comfort of the world, and as competition is the greatest stimulus to progress we believe that there is not only room for, but it is essential that there should be, reasonable competition in means of submarine telegraph communication in the future as in the past.

The International Telegraph Convention.

Mr. Mackay thinks no advantage would accrue to the companies or to the American public by formally adhering to the International Telegraph Convention. This step would involve the recognition by the American land-line companies of the right of the public to direct their messages intended for cable or wireless transmission by any desired route and also compliance with "burdensome" regulations imposed by foreign Governments for the purpose of destroying, as it is said, the competitive enterprise of companies. Hitherto the telegraph companies have attended International Conferences not as a matter of right, but as an act of courtesy, and they have had no voice in the framing of the regulations attached to the Convention. The demand for the adherence of the companies to the Convention, therefore, seems to arise from an anxiety on the part of European Governments to reduce the private companies to the conditions of Government ownership. Incidentally Mr. Mackay complains of the demand upon the Company by the British Government to hand over all messages 10 days after they have been sent or received. Though this claim is made under the terms of the landing licence it is not more burdensome than the control exercised by other countries, and he suggests that some plan should be devised, by treaty or otherwise, whereby cable messages passing from one country to another in peace times should be rendered inviolate.

The Late German Cables.

The most debatable part of Mr. Mackay's evidence is that which relates to the cutting and appropriation of the German transatlantic and Pacific Cables. The final allocation of these cables in accordance with the Peace Treaty is in the hands of a specially appointed Committee, which has not yet been able to find a solution of the question. The Commercial Cable Company has a double interest in the matter, for it made an investment in the cables, and it also had a working agreement with the Deutsch Atlantische Gesellschaft, of which 20 years are unexpired. How the cables were cut, and how they stand at present, can be seen by a perusal of the statement of Mr. Mackay, who, quite naturally, is critical of anything likely to be detrimental to his company's interests. Owing to the modern character of submarine cables, there are scarcely any rules or definite practice in International Law which can be appealed to or which may be said to govern the present case. There is no precedent to guide us, for in the Hispano-American and Russo-Japanese wars there were only cables owned by neutral companies to be dealt with. Yet in both wars the United States and Japan did not hesitate to cut the cables, and the claims for compensation for the damage done led to prolonged negotiations between the companies and the Governments in question.

International Law and Cables.

In support of his case Mr. Mackay quoted the rules adopted by the Institute of International Law at its Brussels Meeting in 1902, the first of which states that "a submarine cable connecting two neutral territories is inviolable." We would point out, however, that the rules drawn up by a body of jurists, such as the Institute of International Law, do not constitute International Law. No doubt the views of such a body carry great weight, but the utmost that can be said of them is that they indicate what International Law *ought* to be, and that international practice ought to be so moulded as to embody the suggested rules. It is true that the rule just quoted has been incorporated into the U.S.A. Naval War Code, indicating that the American Government would probably act upon it, but it has not been generally adopted by other countries. In fact Article 15 of the International Convention for the Protection of Submarine Telegraph Cables, of 1884, expressly reserves freedom of action to belligerents, and in our opinion there can be no ground of complaint for putting out of action a cable which may be of use to an enemy.

However, the appropriation of the cable is quite another matter. There is no precedent to serve as a guide, and as International Law is mainly built up on precedents and on the practice of nations, it is to be hoped that the subject will receive the most careful examination, so that whatever decision is made it will stand the test of time and the criticism of neutral jurists. According to Article 53 of the Hague Regulations private movable property, including telegraphs and telephones, which can serve as war material, may be seized; but they must be restored at the conclusion of peace and indemnities must be paid for them. The Treaty of Peace must settle upon whom the burden of meeting compensation is to fall, and except for the Commercial Cable Company's claim for the New York-Azores section of the cables there is no doubt upon whom the burden of compensation ought to fall, and that is upon the German Government.

A New Method of Testing Current Transformers.

By R. S. J. SPILSBURY, B.Sc., A.C.G.I.

The increased demand for accurate measurement of the characteristics of current transformers at the National Physical Laboratory has rendered any improvements which will increase the accuracy and diminish the time required to make the necessary observations of importance. The direct electrostatic system previously in use, which has been described by the author elsewhere,* while capable of the necessary accuracy, demands great steadiness in two circuits, and very careful observation, the deflections obtained being small; the time required is also considerable. The method about to be described overcomes these difficulties and has the advantage that it employs only apparatus already available.

Testing Circuit.

The circuit used is that given in Fig. 1. Here C.T. is the current transformer under test, its primary winding being connected in series with the primary shunt R_p, and with an ammeter A (with a transformer if necessary), and supplied through suitable power transformers (not shown) by the alternator L; the secondary winding of C.T. supplies the secondary burden (or loading) B through the shunt R_s. The inner potential points of R_p and R_s are connected as shown, while the outer potential points are connected to the primary of the step-up transformer T, ratio 1/100, so that the shunt potential drops are in opposition. The secondary of T is connected to the quadrants Q_1 and Q_2, of a reflecting electrostatic wattmeter. The alternator M, whose rotor is on the same shaft as that of L, but whose stator can be slowly evolved by a motor, controlled from the instrument cabin, maintains a pressure of 100 V (V) measured by the electrostatic voltmeter E, between the needle of the wattmeter and the centre point of the secondary winding of T, in accordance with the usual system of connecting electrostatic wattmeters. An alternative circuit is also arranged, as shown in dotted lines, in which the wattmeter quadrants are connected directly to the primary shunt R_p, and a pressure of 100 V is maintained between the wattmeter needle and the mid-point of R_I. The wattmeter can be instantly changed from the dotted to the full line circuit, or vice versa, by a special switch.

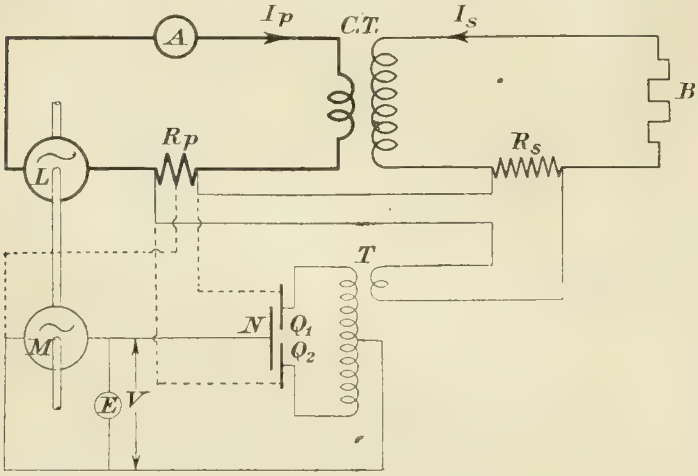

Fig. 1.

Procedure in Testing.

The method of making a test is as follows :—The wattmeter is connected as shown by the dotted lines, and the current I_p set to the desired value by means of the ammeter A; the phase of the pressure V, relative to that of I_p, is then varied, by rotating the stator of M, until the reading of the wattmeter is a maximum, say Δ_U, that is V is in phase with I_p; the wattmeter being now transferred to the full line circuit a reading Δ_R is obtained which will be shown to give the ratio error of C.T. The whole of the readings for ratio at a given secondary burden are taken thus in succession before measuring the phase angle.

For the latter the wattmeter is replaced in the dotted circuit, and the phase of V advanced until the reading is zero, that is V is in quadrature with I_p; the wattmeter is then transferred to the full line circuit, and its reading Δ_β taken; from this reading the phase angle β of C.T. can be calculated.

Theory of the Method.

The vector diagram for the circuit is shown in Fig. 2. Here E_p and E_s are potentials proportional to I_p and I_s, produced in the shunts R_p and R_s, which are so chosen that $E_p = E_s$ when the ratio of C.T. is correct. The potential applied to the primary of the transformer T is therefore AB, and that across the secondary is $OD = 100AB$. (The diagram is not to scale.) This may be resolved into $OE = 100\ AC$, proportional to $E_s \cos\beta - E_p$ that is to the ratio* error of C.T., and $OF = 100\ CB$, proportional to $E_s \sin\beta$, that is to the sine of the phase angle of C.T.

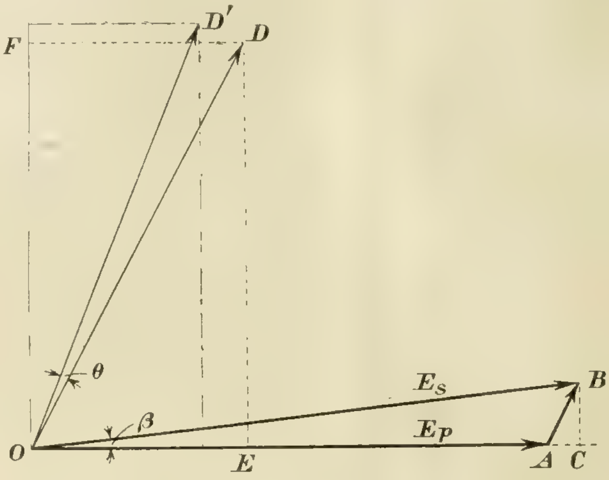

Fig. 2.

Now during the ratio test V is in phase with E_p, and therefore with AC; accordingly the reading of the wattmeter gives the ratio error of C.T. Similarly in the phase angle test V is in quadrature with E_p, and therefore in phase with CB, the wattmeter reading therefore gives the sine of the phase angle.

Thus if Δ_U is the reading on the dotted circuit, as described above, and Δ_R and Δ_β the readings in the ratio and phase angle tests respectively, we have

$$\Delta_U = KV\ E_p \text{ where } K \text{ is some constant,}$$
$$\Delta_R = 100\ KV\ (E_s \cos\beta - E_p),$$
$$\Delta_\beta = 100\ KV\ (E_s \sin\beta).$$

Therefore

$$R = \text{Percentage ratio error,}$$
$$= \left(\frac{E_s \cos\beta - E_p}{E_p} \times 100\right) = \frac{\Delta_R}{\Delta_U}$$

$$\beta = \tan^{-1}\frac{\Delta_\beta}{100\Delta_U\left(1+\frac{R}{100}\right)}$$

$$= 34{\cdot}38\ \frac{\Delta_\beta}{\Delta_U\left(1+\frac{R}{100}\right)} \text{ if } \beta \text{ is small.}$$

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* " B.E.A.M.A. Journal," Vol. VI., p. 508, 1920.

* The ratio considered here is that between the primary current and the in-phase component of the secondary current, that is the " wattmeter " ratio.

In good transformers, where R and β are small the factor $\left(1+\frac{R}{100}\right)$ may be neglected and

$$\beta = 34.38\frac{\Delta_\beta}{\Delta_R} \text{ minutes.}$$

The expressions for R and β are thus very readily evaluated. The signs of the quantities are usually obvious, but can readily be deduced from the effects of increasing the secondary burden; this increases the transformer ratio, and advances the phase of the secondary current.

It will be seen that the method is a combination of the well-known potentiometer principle with the electrostatic wattmeter used as a very sensitive discriminating voltmeter.

Sensitivity.

The sensitivity of the method as usually employed at the National Physical Laboratory, with a secondary shunt of 0·4 O, is such that at full load current a deflection of 280 cms. is obtained for 1 per cent. ratio error in a current transformer, and about the same amount for 30 minutes of phase angle; as a deflection can be read to the nearest half-millimetre it will be seen that the sensitivity is more than is ever likely to be required (indeed, a much less sensitive wattmeter could be used), and it remains to consider the possible sources of error and the magnitude of their effects. It may be said that the degree of accuracy aimed at in these tests is of the order of ±0·1 per cent. for ratio and ±1 minute for phase angle, and the effects of the sources of error are considered on this basis.

Sources of Error.

1. *Due to* 1/100 *Transformer.*—The transformer T introduces two errors, one due to the departure of its ratio from 100, and one due to the phase angle between the voltage applied to the primary and that developed in the secondary. The transformer used is one originally designed for the accurate measurement of current* with a primary voltage of 2, derived from a shunt. The ratio has been redetermined for the present tests, in which the voltage is less than 0·02, and it is found that the value may be taken as 100 at all commercial frequencies, the resulting errors being quite negligible.

The phase displacement, say, θ, has the effect of swinging the vector OD to the position OD', where $\angle DOD'=\theta$. It may easily be shown that this introduces an error in Δ_R equal to $\Delta_\beta \sin\theta$, and an error in Δ_β equal to $\Delta_R \sin\theta$. The angle θ has also been determined under various conditions, and it is found that the resulting errors are inappreciable for any reasonably good current transformer, but in case this should not be so the necessary correction is very easily applied.

2. *Due to Inaccurate Setting of V.*—A precisely similar error is introduced by incorrect setting of the phase of the auxiliary voltage V for the ratio measurement. When V and I_p are practically in phase the reading of the wattmeter changes only 0·1 per cent. for 3° alteration of the phase of V, and setting is therefore difficult. It is intended to overcome this difficulty by taking V from an accurate phase-shifting transformer. The quadrature setting for the phase angle test, which is very sensitive, would then be made first, the vector V being then swung through 90° by the phase shifter dial for the ratio test. The error is in any case not serious, as can be shown by repeating the setting a number of times.

3. *Due to Magnetising Current of Transformer.*—The current taken by the primary of transformer T for a reading corresponding to 1 per cent. ratio error (at full load) of the current transformer is less than 0·001 ampere at 50 cycles per second. The resulting errors are negligible for precision transformers.

4. *Due to Stray Field Effects, &c.*—A small deflection of the wattmeter is sometimes obtained when the primary of T is short-circuited, due to stray fields acting on the transformer and its leads; this is easily reduced to zero by slightly turning or moving the transformer. The insulation of T should also be good in order to prevent deflections due to leakage from the 100 V pressure circuit through the secondary winding to earth.

5. *Errors due to Shunts.*—The resistance error of the shunts is easily made negligible; the phase angle is negligible except in the heavy current types, where it amounts to a few minutes. The correction is a constant for all readings, and can be determined by measurement and by calculation.

It may be said that errors (1) and (2) could be eliminated by converting the method to a zero deflection system. This could be done by making R_s variable, and using a mutual inductance to balance the quadrature component of the out-of-balance potential. It is not proposed to adopt this system, since additional apparatus would be necessary, and tests would probably be much less rapidly conducted.

Comparisons with Other Methods.

The pressure of other work has prevented any exhaustive comparison with other methods; in one case, however, in which a current transformer showed somewhat unusual characteristics its constants were determined at several points by the above method, and also by an independent test. The latter consists in determining the error, at zero and unity power factors, of a sensitive dynamometer wattmeter, with and without the current transformer, by comparison with an electrostatic instrument, and is quite sensitive, but of limited scope. The discrepancy between the two determinations of ratio at quarter load was slightly less than 0·1 per cent., while the mean discrepancy in phase angle for three loads was 0·7 minute; this agreement is considered very satisfactory. With regard to the time consumed, the observations for a determination of ratio and phase angle at five currents, with one secondary burden, occupy about ten minutes. It is hoped that a further economy of time will be effected by the adoption of the phase shifter already mentioned, and the consequent elimination of the phase setting for the ratio test. Thus the difficulty of securing steadiness of circuits is eliminated by the use of the potentiometer principle, and that due to the smallness of deflections by the multiplying transformer, the time consumed being correspondingly reduced; the resulting method appears very suitable for the testing of precision current transformers in standardising laboratories.

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* Paterson, Rayner & Kinnes, "I.E.E. Journal," Vol. LI., p. 316, 1913.

The Electric Lamp from Inside.

Mr. C. C. **Patterson**, of the Osram Research Laboratory, recently gave a lecture on "The Electric Lamp from Inside," before the North Eastern Students' Section of the Institution of Electrical Engineers, in which he dealt mainly with the manufacturing side of electric lamps.

The vacuum necessary in lamps is of a very high order. One difficulty is the removal of the gas actually held in the glass walls of bulb, which, curiously, consists largely of water vapour given off by the glass, although the bulb has previously passed through several heating processes. About $7{\cdot}4\times10^{12}$ molecules per cubic centimetre are left after the final exhaustion, the average distance between the molecules being equivalent to 1 000 times their diameter. When the filament becomes heated there is also present a tendency for electrons to leak from the negative to the positive filament. If all the electrons succeeded in doing so the positive limb would be rapidly destroyed by the rise in temperature incurred. Fortunately the electrons appear to obstruct each other, and few actually succeed in escaping. When a molecule of vapour which has been ionised by collision approaches the negative limb it assists to liberate the electrons. The number of ionised molecules is small compared with the number of electrons, but the effect is therefore accumulative until the stream of electrons grows into an appreciable flow of current and destroys the lamp. Hence the importance of achieving the utmost limit of exhaustion, and dominating the number of residual molecules.

The gasfilled lamps were developed to prevent the volatilisation of the tungsten filament at the higher temperatures at which it was desired to work, the gas, of course, being of a chemically inert character, such as nitrogen or argon. With a straight type of filament the dissipation of heat was so great as to reduce the efficiency to about ½ c.p. per watt. This difficulty was overcome by winding the filament in very close spirals. Efficiencies have not yet reached the anticipated figures.

Magnetic Susceptibility of Low Order.[*]

By Prof. E. WILSON.

Introduction.

In these notes on magnetic susceptibility of low order, the author deals primarily with the subject from the standpoint of practical applications. The magnetic properties of certain minerals can be changed by oxidation or reduction. Rock susceptibility deserves study in view of its bearing on magnetic survey work. A knowledge of the subject is necessary to those engaged on the construction of scientific instruments, and there are applications in other directions.

The author presents a table showing the wide range of volume susceptibilities met with in nature. Magnetite yields values of 0·12 to 3·07, in the impure state values as low as 0·056. Pyrrhotite gives a volume susceptibility of 0·000337 to 0·00575. Other minerals are arranged in descending order of values down to apatite (−0·00000072). Among metals manganese iron, as received, yields a value of 0·0004, after heat-treatment 0·530. Then we have chromium (0·000031), platinum (0·000029), and other relatively low values, the lowest quoted being for tin (0·00000019). Amongst fluids we have manganese sulphate (0·000017), ferrous sulphate (0·000015), and water (−0·00000075).

I. Instrumentation.

When the volume-susceptibility (κ_v) is larger than about 0·15, the correction for "end-effect" with short thick bars becomes too uncertain with a magnetometer. Weiss working on magnetite crystals prolonged the specimen by soft iron bars, the whole being placed in a solenoid. In another method the specimen was inserted in rectangular holes cut in the pole-pieces of a ring-shaped yoke of Stalloy. A ballastic galvanometer was placed in a secondary circuit wound on the specimen, and the yoke was wound with a magnetizing coil.

The Magnetometer.—In testing for metals it is customary to use a long thin wire wound with a magnetizing coil, the specimen being vertical. When testing rock specimens, where κ_v varies from about 0·15 to 0·001, the magnetizing solenoid is placed horizontally with the needle in a prolongation of its axis.

The Torsion Balance.—Torsion balances have been used by Wiederman (1865), Tyndall (1851), and Curie (1895). With the latter's apparatus the upper limit was about 0·1, the lower limit about 1×10^{-6}. End effect was considerable, and it was necessary to use a weak field. For such an apparatus to have a wide field of utility the magnetic field must be variable. In the original Paper the author presents a description of this instrument.

A portable torsion balance has been developed[†] in which the test-piece hangs between fixed soft-iron pole-pieces magnetised by two concentric rings of hardened tungsten steel with N and S poles at opposite ends of a diameter. By varying the relative azimuths of the rings the field between the pole-pieces can be varied. A variable field is thus obtained without the use of a magnetising coil and battery.

An Electromagnetically Controlled Balance.—In the torsion balance the deflection varies as the square of the magnetic force impressed upon the test-piece. It is difficult to measure susceptibility outside a narrow range of magnetic force of about one to four or five. An instrument has been developed[‡] which permits of a wide range. The force due to torsion is replaced by an electromagnetic control. The mechanical force exerted is due to two components—one proportional to the magnetic force impressed upon the test-piece, and the other variable if the susceptibility varies. In the original Paper the instrument is illustrated and described in detail.

Susceptibility Values.

Magnetite.—The magnetic properties of magnetite have been examined by Abt (1894) and Weiss (1896), who show that the volume-susceptibility of magnetite crystals can have a maximum value of the order of 10 C.G.S. units. This is the largest susceptibility of any known natural substance, if one excludes meteorites and traces of metallic iron.

The term "magnetite" includes rock specimens ranging from the crystal itself to compact or massive specimens and detached particles, and exhibits a wide variation of magnetic properties. In all cases the susceptibility varies with the magnetic force, the variation being small in the lower grades. In the original Paper data relating to specimens of magnetite from various countries are assembled in tabular form. Crystals from Traversella furnish a high value of volume-susceptibility (κ_v). Arkansas magnetite exhibits high retentivity and coercive force. The value of κ_v for this variety was increased about 42 per cent. on heating to 1 000°C. The residual magnetism was also increased, but the coercive force was reduced, as happens in the case of hardened steel.

Arkansas magnetite is highly retentive and may possibly be found useful for the purposes of permanent magnets. The ergs per cycle per cubic centimetre were 90 000 when the value of $H_{max.}$ was 525, whereas they are of the order 200 000 in tungsten steel. The coercive force of the tungsten steel is roughly half that of this magnetite, but the retained magnetism is much larger (10 000 for tungsten, and 1 300 for this magnetite). That reverse force H which, being less than the coercive force gives a maximum value to the product BH, is about 39 in tungsten steel, as against 80 in this magnetite, and the maximum values of BH are 270 000 and 46 000 respectively. The intensity J retained by a 4-cm. bar after being in a magnetic field H of 18 000 C.G.S. units diminished 20 per cent. in 2¼ years. The effect of heating Penryn magnetite to 1 000°C. is to increase the susceptibility, coercive force and retentivity. The intensity of magnetisation J in the unheated (C) 4-cm. bar has only diminished 3·5 per cent. in 2¼ years. Of the remaining specimens, that from Altenfjord contains felspar, that from Lake Champlain contains pyrites. The specimen from South Manchuria is comparatively poor in magnetite. Owing to these impurities the susceptibility values have fallen.

The author refers briefly to other minerals of somewhat similar composition. Franklinite in which FeO is replaced by oxides of Zn or Mn gave values of 2 270–3 200 $\times 10^{-6}$. Specimens of chrome iron yielded values for about 1/10th of these. Other still lower values are recorded for other materials, including red hæmetite, while specimens of specular hæmetite yielded values as high as 2 530 $\times 10^{-6}$. Such values, however, are smaller than those obtainable from Fe_2O_3 prepared by natural or artificial processes.

Ferric Oxide.—It is generally believed that the susceptibility of ferric oxide is very small in comparison with that of magnetic oxide. But a recent determination of iron rust, proved to be free from ferrous oxide, gave a value of κ_m equal to 0·0044, and this was reduced to 0·003 after heating to redness. Iron rust can thus have a value 250-fold. The value of κ_m ($17 \cdot 5 \times 10^{-6}$) found for dehydrated brown hematite. Ferric oxide obtained by the ignition of magnetic oxide or ferrous oxide has a κ_m value of 0·036, which is 2 000 times the above. It would be of interest to examine a true hematite produced from magnetite by natural processes. It would appear that the high susceptibility found in ferric oxide is associated with the passage through the stage of magnetite during its production. For the mineral chalybite (ferrous carbonate) κ_m is increased by heating, whereas chrome iron ore and hornblende show a reverse effect.

Ferrites.—It has long been known that certain "ferrites," in which the ferrous oxide is replaced by that of other elements as in franklinite, are magnetic. Recent experiments with copper ferrite show that its susceptibility can be reduced by slowly cooling. Values for various ferrites and ferric oxides are given by the author in tabular form.

Sulphides.—Susceptibilities of a number of sulphides are also given in the original Paper. Artificial iron sulphide (FeS) is well known to have a high susceptibility, and is extraordinarily retentive. Pyrrhotite, or magnetic iron pyrites, has a variable susceptibility and also is very retentive. Iron pyrites (FeS_2) occurs in the rhombic and cubic varieties, and the susceptibility in each case is remarkably small. This cannot be accounted for by iron content. The susceptibilities of nickel sulphide (native), copper pyrites, arsenical pyrites, cobaltite in descending order of magnitude are all positive, and antimony pyrites (native) has a very small negative susceptibility.

The effects of heating and cooling freely in air certain of the above minerals in powder form are next dealt with. Some rhombic iron pyrites (FeS_2) was tested after it had been heated for 30 minutes in a closed vessel. When cold the value of κ_m was found to be 600×10^{-6}, but a remarkable increase occurs after a few minutes' heating at 450°C. The susceptibility subsequently falls until ultimately it has a comparatively low value. This then is the value of κ_m for ferric oxide produced in this manner, assuming complete oxidation of the sulphur and pure FeS_2 initially.

Other experiments showed that a different susceptibility can be obtained by heat treatment according to fineness of division and access of air—an important matter in the event of large quantities having to be dealt with.

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[*] A summary of three lectures delivered before the Institution of Electrical Engineers.

[†] "Proceedings" of the Physical Society, 1919, Vol. XXXI., p. 338.

[‡] "Proceedings" of the Royal Society, A, 1920, Vol. XCVIII., p. 274.

Metallic Salts.—The magnetic properties of salts were investigated by Faraday, followed by Wiedemann, Quincke, Meslin, S. Meyer, Curie, Cheneveau and many others.

The mass-susceptibility (κ_{m1}) of a solution of a salt in water is given by the formula –

$$\kappa_{m1} = \frac{p}{100}\kappa_m + \left(1 - \frac{p}{100}\right)\kappa_{m0}$$

where κ_{m0} is the mass-susceptibility of water; which may be taken as $-0{\cdot}75 \times 10^{-6}$. κ_m is the mass-susceptibility of the water-free salt, and p the percentage weight of salt in solution. Manganese sulphate (anhydrous) has proved to be a valuable standard of reference. A solution of this salt containing 0·055 grm. of manganese, or 0·151 grm. of sulphate per cubic centimetre was found, with the use of the balance to have a value of κ_v was $93{\cdot}6 \times 10^{-9} \times 190 = 17{\cdot}8 \times 10^{-6}$. For this solution $p = 15{\cdot}1$, and using the mean value of κ_m (99×10^{-6}) we obtain by calculation $\kappa_{m1} = +14{\cdot}5$ C.G.S. units. The density of the solution is 1·17, so that the volume-susceptibility κ_v is $+16{\cdot}95 \times 10^{-6}$, and this is slightly smaller than the value $17{\cdot}8 + 10^{-6}$ obtained with the balance. Similarly for ferrous sulphate a mean value of $\kappa^{m} = 82 \times 10^{-6}$ was obtained.

It is an interesting fact that copper has a negative susceptibility and its salts are positive, whereas magnesium is positive and its salts are negative. Wiedemann showed as early as 1865 that paramagnetic salts when hydrated give a higher value than the anhydrous salts, although water itself is diamagnetic.

PRACTICAL APPLICATIONS.

The history of magnetic separation would appear to have commenced in 1792, when Fullerton obtained certain patent rights in England. The first important commercial undertaking was commenced in 1858 by M. Stella in the Traversella Mines in Piémont, the object being to separate magnetite from copper pyrites. The subject was taken up in 1880 in Scandinavia and later in America in connection with extensive magnetic deposits. In 1896, at Franklin, New Jersey, U.S.A., Wetherill demonstrated the possibility of dealing with the magnetic separation of feebly magnetic materials, the minerals concerned being franklinite and zinc-blende. At the present time magnetite is of the first importance, but magnetic separation has found applications in other directions. Statistics given by Prof. Henry Louis at the Inter-Allied Chemical Conference in Paris, 1919, show that in 1914 in Northern Norway about 2 200 000 tons of ore were dealt with, yielding 900 000 tons of concentrates. At Mineville,* New York State, U.S.A., about 1 200 000 tons of ore were dealt with in 1916, and in 1917 in Sweden 2 500 000 tons of ore, yielding 1 000 000 tons of concentrates, are recorded. (These figures do not refer to such important applications as the separation of wolfram from tinstone ores, or the separation of monasite for use in the gas mantle industry.)

The following particulars of various materials capable of magnetic separation are of interest :—

Magnetite.—The susceptibility of even low-grade magnetite which may be of the order 0·1 is still so high as to overwhelm that of any other rocks. It is largely associated with apatite, the negative susceptibility of which gives rise to trouble, because it adheres as an impalpable powder to the magnetite. Its removal has to be specially dealt with by washing or by air-blast.

Wolfram.—In the separation of wolfram ore from tinstone there is none too large a margin in favour of the wolfram ore. A great field is open for treatment.

Monazite.—The deposit in which monazite is found contains amongst other minerals ilminite and zircon. The ilminite is extracted by a weak field, and the monazite by a strong field, the zircon going forward as a non-magnetic mineral. Great care must be taken, if grinding of the ore has to be resorted to, that the zircon, which is very hard, is not rendered magnetic by minute traces of iron.

Spathic Ore.—In the separation of this ore from zinc-blende or copper pyrites, there is a fair margin in favour of the former, and there is scope for treatment.

Franklinite.—The separation of this material from zinc-blende was one of the early problems solved by Wetherill.

Specular Ore.—When occurring with magnetite, as in the Norwegian schists, a double separation is involved, the magnetite being first removed by a weak field, and the hematite by an intense field.

Much ingenuity has been spent upon the construction of the machinery used in magnetic separation. In the case of magnetite, the preliminary rough dry process (Wenström or Gröndal) is followed by either a dry or wet fine separation. The Edison separator is an example of the dry process, and that of Gröndal is extensively used in wet separation. In the case of feebly magnetic materials, *e.g.*, monazite, the double separators of Wetherill, the Rapid Magnetic Machine Company or Humbolt are available.

Degassing and Purification of Boiler Feed-Water.†

By **PAUL KESTNER**

(Of Paris)

The necessity for enabling boilers to steam for long periods without scale or corrosion becomes more urgent every day. The old lime and soda apparatus has been improved and reduced in size, heat has been used to accelerate the operation, but not always with success, for in some instances a concentrated soda solution is formed in the boiler.

The author deals in this Paper with the process of continuous blowing down used in conjunction with hot purification. Hot purification effects a thermal saving, and has the further advantage of eliminating the gases dissolved in the feed-water, by reducing the solubility at high temperature. The speed at which the reaction takes place in the purification of water by soda alone or lime and soda can be accelerated by heat, and the settlement of the precipitate can be hastened by agitation, the effect of which is to cause accretion and increase of size of the particles. If the agitation is caused by a stream of water carrying air with it the water becomes saturated with oxygen and corrosion results.

In water-softening processes generally rise of temperature ensures : (*a*) Increased speed of reaction ; (*b*) reduced viscosity of the water ; (*c*) the reduction of the bicarbonates of the alkaline earths to carbonates ; (*d*) reduced solubility of calcium sulphate and partial precipitation without the use of reagents.

CONTINUOUS BLOW-DOWN.

Whatever method of purification is employed, all the salts carried into the boiler by the feed-water become concentrated in it. In general some calcium carbonate remains in solution in the water, and when the concentration produced by evaporation becomes sufficiently high it is deposited on the walls of the boiler or in the tubes forming incrustation, which is harder the more slowly the deposit is made. In boilers generating steam very rapidly the deposits are also formed rapidly, and may accumulate in the tubes notwithstanding the violence of the circulation. The usual remedy is periodic blowing-off from the lowest point in the boiler, and, to be effective, a large actual quantity of water must be blown off at each operation, even though such should not form a large proportion of the boiler contents. The continuous blow-down allows the calories to be saved by passing the blow-down water through a feed-water heater, the mud being deposited in a trap during the process, together with the salts that had been retained in solution owing to the high temperature of the liquid. The only loss occurs in the actual removal of the mud and salts which forms a relatively small quantity. The blow-down water freed from the impurities is then returned to the boiler. This prevents the concentration of the soluble salts to an extent at which they would constitute a danger.

The process of continuous blowing-down permits the contents of the boiler to be renewed frequently ; it eliminates mud before it has time to accumulate, and at the same time allows the use of soda for the reduction of the calcareous bicarbonates. The feed-water, therefore, contains sodium carbonate and bicarbonate ; the latter is decomposed in the boiler into carbonate, and the carbonate in its turn is dissociated in the presence of water with a reversible condition of equilibrium in functions of the initial concentration and the temperature, thus :

$$CO_3Na_2 + H_2O = 2\ NaOH + CO_2$$

hydrolysis giving more caustic soda the higher the temperature. With continuous blowing-down the water containing caustic soda and carbonate of soda is used to purify the make-up feed, the caustic soda reacting more rapidly on the calcium bicarbonate than would calcium oxide. It is of great importance, therefore, to combine purification by soda with the continuous blowing-down process.

The author describes the Kestner continuous blow-down apparatus, consisting of a steam separator, a central reservoir receiving the blow-down liquid, an annular chamber surrounding this reservoir, from which it receives heat and into which the purified blow-down water is decanted. The steam passes into a reheater in which it heats the feed. The heated feed mixes with the blow-down as it leaves the central chamber, and then passes to the annular chamber in which precipitation and settlement take place. Soda is added through a water-meter in proportion to the make-up feed. Valves are provided for separating the mud.

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† Abstract of a Paper read at a joint meeting of the Institution of Mechanical Engineers and the Society of Chemical Industry.

* "Transactions" of the American Institute of Mining Engineers, 1916, Vol. LVI., p. 928.

Central Stations Using Distilled Water.

The distilled water of industrial appliances differs greatly from that of the laboratory. Owing to the rate of evaporation particles of water containing salts are carried over, so that the distilled water contains numerous soluble salts in small but by no means negligible quantity, and in the boilers using distilled water it becomes in time a fairly concentrated liquor. Boilers working with distilled water therefore require to be blown down occasionally, but it is not necessary to remove a large amount of liquid, the amount being usually only one or two per cent., the saline solution being replaced by distilled water. Even when an evaporator is used the continuous blowing-down method can be adopted, and in conjunction with degassing enables a complete closed water circuit to be arranged in a central station using distilled water.

Corrosion and Its Causes.

Where distilled water is used there can be no doubt as to the cause of corrosion. Oxidisation of the plates can only be produced by oxygen dissolved in the feed-water and set free in the boiler, and the effect is greater with intermittent working. The Author discusses the theories of corrosion and points out the need for degassing purified water. He explains that the critical concentration, at which maximum corrosion by salts is effected, must be exceeded after a few hours work in ordinary boilers. Electrical and electrolytic action are considered as well as the hydrolysis of magnesium chloride. The action on steel of carbonic acid gas alone and in the presence of oxygen is then considered, as well as the formation of oxy-salts under certain conditions. The elimination of oxygen in solution in the feed is considered, and the author shows that the air dissolved in water contains roughly 33 per cent. of oxygen. A titration method for controlling the degassing, which has been devised by M. Gaston Paris, of the Kestner Laboratory, is described.

Degassing.

The elimination of the oxygen dissolved in water may be effected either by physical or by chemical methods, or by both. Of the former the principal methods are: agitation of the water, the action of temperature and the action of vacuum; these may be used separately or in the majority of cases in combination. Of chemical methods, the only one that is important is the action of highly oxidisable iron which absorbs the oxygen from the feed-water. The author gives descriptions of methods and appliances for degassing by physical means, and proceeds to discuss the more important classes acting by:

(*a*) Combined physical and thermal means. The Cochrane, Webster, Weir and Chevalet heaters are placed in this class. The Aerex has certain advantages over these, which are adopted also by Siegmon-Schmitt.

(*b*) Vacuum degassing. The vacuum appliances of Meihof (Halvor Breda) and Griesheim Elektron Lauta (Balke & Company) as well as that of the Deutsche Sanitäts Werke are described. The degassing apparatus of the Elliot Company, of America, working at about 100°C., is also mentioned.

(*c*) Chemical degassing. The chemical methods in use are all based on one principle of using very easily oxidisable iron, which, under suitable conditions, enables degassing to be obtained down to only traces of oxygen. As the result of much experiment the author has found that for this purpose manganese is a catalytic agent of great importance, and a suitable manganese cast-iron has been found.

Two German degassers, the Seiffert and the Halsmeyer, work with rusted iron, and there is also an American apparatus, due to Prof. W. H. Walker, styled a "deactivator."

The author's experiments have led to the design of an apparatus due to the discovery that when an iron degasser that had become completely rusted was left at rest, it was found after a day to have undergone a change, and from red rust to have become greenish-black, due to the reduction of ferric hydrate under the influence of the iron. This has led to the invention of the Paris degasser, which works on the regeneration principle: in one form by means of two vessels containing iron turnings, through which flow takes place alternately, and in the other form in a single vessel with filters at each end and a valve arrangement for permitting the direction of flow to be altered. The amount of iron used in the apparatus is stated to vary from 1 to 3 grammes per ton of water treated, and the amount so used corresponds to the weight of boiler-plate saved from destruction. The suggestion of a water circuit closed from atmospheric contact is discussed, and the combination of a degasser with such a system is recommended as a means for preventing any harm due to access of oxygen from accidental causes.

Where Capital is Chiefly Needed.

Lack of Money Saps the Enterprise of Contractors.

By "ELECTROCYNIC."

It seems to me that the electrical industry is in need of more capital on its lower levels. The large manufacturing firms and factors are no doubt well provided with money, but it is a notorious fact that the retail section of the business is and always has been handicapped by inadequate finances.

After all, the future of electrical progress is very largely in the hands of contractors and others who come into actual contact with the public. They are in the best position to initiate and execute effective propaganda; they alone are able to bring the prospective user down to the dotted line of a wiring contract. And yet, in spite of the admitted importance of the retail side, it does not seem to have attracted an adequate share of capital. Of course, the contractors themselves are responsible for this state of things, but since it concerns us all very intimately it would appear necessary in the general interest to diagnose and treat this financial lesion.

It is, I think, quite evident that the manufacturing interests cannot by themselves do very much to extend the use of electricity. They can, of course, improve and cheapen domestic appliances, but although such charmingly unusual phenomena would naturally *incline* people to use electricity, they can hardly persuade in the face of the extortionate demands and general obstructiveness of contractors.

Not Intentionally Obstructive.

Contractors are not intentionally excessive in their charges, nor do they obstruct progress purely in a spirit of devilment. These characteristics are simply the inevitable outcome of lack of capital, with all that it implies in the way of stifled enterprise, insecurity of credit, low stocks and a general atmosphere of penny wisdom and squalid huckstering. The suburban contractor cannot afford to advertise, or to canvass, or to hold proper stocks of fittings and apparatus. He therefore does not get any business worth talking about, and is compelled to charge high prices for the little he does sell or do.

As already indicated, there is plenty of money floating about in the upper reaches of the business, and especially on the manufacturing side. There is capital and to spare, although it may not always be earning as much interest as the holders consider themselves entitled to. Well, manufacturers need capital, but it is bad for them, for the industry in general, and for the poor long-suffering public, that this capital should not be more widely diffused than it is. There is an obvious want of balance in the financial organisation of the industry, which provides a sufficient explanation of many of the ills from which the body electric is at present suffering.

Look at the Rag Trade.

Money is to business what water is to agriculture; and to expect business to fructify by keeping all the money in one department is rather like expecting good crops in a parched Sussex farm because there has been rain in the market town from which the seeds came. One has only to consider, say, the drapery trades to realise where the capital is wanted. I should think that the bulk of the total capital invested in soft goods is held by the retailers—amongst whom I would, of course, include firms like Harrods', Whiteley's, Barker's, &c. The retail shops make the running, and create the demand—the manufacturers are content to produce what the retailers require. The point is that the majority of the advertising and other propaganda work is carried out by the retailers, who are the direct beneficieries; and it is they who need and get the greater part of the invested capital.

I admit that the electrical and drapery trades are not on all fours. Lingerie is, perhaps, more of a staple than an electric iron; but, taking one thing with another, I think that the two businesses are equally essential although they are not generally so regarded. And, mark my words, the day *will* come when it will be considered just as unconventional to boil water over a gas burner as to go about in a costume of leaves or newspaper. (In the latter event the question of net sales would acquire a new significance, since a slight drop in circulation might deprive hundreds of people of their daily clothes.)

Money and Brains Wanted.

What I want to see is a large influx of capital and brains (the one would, of course, follow the other) into the retail section of the electrical business. I would like to see large and elaborately equipped electrical stores in every important neighbourhood. These stores would hold large stocks of every conceivable sort of domestic apparatus and would be staffed by knowledgeable assistants and polite shop-walkers. Money would be spent like water in newspaper advertising. One imagines full page announcements in the "Daily Press," drawing attention to particular lines, or to the wonders of electrical bargain basements.

And sales—seasonal and otherwise; why should there not be electrical sales? In the late spring, vacuum cleaners could be profitably and extensively sold at prices below manufacturing cost—at least, I presume they could, if one may judge from drapery dividends. After Christmas there might be a clearance of the material which had been previously advertised as suitable for Christmas gifts.

No doubt an electrical store conducted on these enterprising lines would also interest itself in certain collateral lines, like aluminium saucepans, &c., for use on electric cookers, while the broad-minded trader might even go so far as to stock gas and oil appliances. Such a store would naturally sell anything it could find a market for, but it would never lose its essentially electric nature.

An Immense Potential Demand.

It may be objected that there is not a sufficient demand to justify the organisation of these electrical emporia. Of course there isn't at present. The demand has to be created, and surely no one in the electrical business would question the immensity of the potential demand for electrical apparatus, and the super-immensity of its cash value. At the beginning of the 19th century there was no demand for large drapery stores, but the enterprising Whiteley (or was it Harrod?) soon showed how such a demand might be created. It is the sort of problem which is automatically solved in action. Of course, I do not suggest that the retail side of the electrical business can be exploited in quite the same way, to quite the same extent, or by quite as many people as the drapery business; but it can certainly be expanded very considerably along parallel lines.

Now all this means money. It would clearly be a very futile form of mockery to recommend the average contractor to open a large store and take space in the daily papers. He hasn't the money, and he doesn't know how. The manufacturers have the money and the knowledge, but they are apparently afraid of entering the retail field. There is, however, no good reason why they should not form independent companies to exploit the retail business. Or, at all events, they might finance the more enterprising of the existing contracting firms.

It Must be Financial

There are a hundred ways in which manufacturers can interest themselves in the ultimate selling of their products, but effective stimulation must take a financial form. Supplying literature to contractors and lending them material for demonstrations are well-tried and thoroughly futile substitutes for the direct financial interest which is obviously necessary.

Manufacturers combine with one another to protect themselves from competition or to divide up the existing volume of business. Why don't they combine with retailers to *increase* business? They appeal for fresh capital in order to enter new fields of manufacture. Why don't they ask for capital for the purpose of multiplying the sales of their present product? If they think—as they appear to think—that the concentration of most of the money and brains in the business upon manufacturing is likely to assist materially the cause of electrical development, then they are wilfully blinding their eyes to the facts of the situation.

There must be an efficient sales organsiation in contact with the public, and to attempt to elaborate the manufacturing end, while ignoring the patent inefficiency of the retail end, is foolish and wasteful. Let the manufacturers divert money, technical knowledge and organising ability into the retail business, and their reward shall be immeasurably great. At this stage in the development of electrical service I should estimate that a soveriegn invested in retail enterprises would do more good than a fiver spent on what have hitherto been regarded as the legitimate activities of manufacturers.

The domestic field is still essentially virginal, and it can only be brought to worthy and profitable fertility by a generous application of the financial watering-can to the arid beds of retail tradng.

Some Thermal Characteristics of Electric Ovens and Hot Plates.

A discussion on Dr. E. Griffiths and Mr. F. H. Schofield's Paper on "Some Thermal Characteristics of Electric Hot Ovens and Plates" took place at Leeds recently. We give an account of this below. An abstract of the Paper appeared in our issue of February 18.

Mr. C. E. **Allsop** said the Paper was not very instructive from the users' point of view. The tests on ovens were inconclusive, and vastly different results would have been obtained had the ovens been filled. The temperatures taken were little guide to what would be got in practice. He had found that with vessels with a thick wall a quantity of liquid could be more quickly boiled on a hot plate for the same expenditure of energy than with a thin vessel. From this he deduced that the hot spots were not allowed to get so hot as with a thin vessel. In the Paper an oven was shown with bottom heating only with a baffle above. He thought this was wrong, as the baffle would soon be lost or wear out.

Mr. J. G. **Gracie** called attention to some of the efficiency figures given, and the wide variation between those for copper discs and steel discs. He asked why the closed type of heater was used at all if the open was so much more efficient. He asked for information as to water heaters, as apparently they were very inefficient, and he mentioned a new arrangement of which he had heard in which the heater was in direct contact with the water. He thought there was a great objection to open elements in an oven as the oven could not be so easily cleaned.

Some Good Criticisms.

Mr. A. E. **Jepson** gave experiences of his house, in which he burned no coal at all. His immersion heater for heating water took 3 kW and would give sufficient hot water for three baths in about half an hour. The electrical engineer was very much to blame for not taking up this matter of domestic electric appliances with greater fervour. His own installation only cost him for heating, cooking and lighting about £5 per quarter. He was disappointed to see that only two sizes of disc were mentioned in the Paper and that no reference was made to the double bottom pan or the polished top and sides. Polishing an ordinary kettle on the top would increase its efficiency by 16 per cent. He suggested that aluminium would have been preferable to copper for the discs, as it did not oxidise so quickly. The Paper seemed to suggest that an even temperature was required in the oven, but he thought this was not so, more particularly for roasting. Roasting need not be done with a low temperature and convection currents. The first essential was a good radiant heat. The figures given were misleading in some instances. They did not refer to electric cooking or heating, but rather to plate absorption of heat. An oven with a polished interior surface was better than one with a dull surface, and this had an effect on the question of the lagging of the oven.

Mr. W. **Jones** thought that until electrical domestic apparatus was capable of withstanding rough usage as a gas cooker, it was not much use marketing it. His experience was that the electric utility apparatus was not pushed very much. The first cost was high, and something ought to be done as to hiring by supply authorities.

Canadian Experiences

Mr. A. N. **Wood** said that the use of electricity for domestic apparatus was very much more general in Canada than in this country. Top and bottom heat gave the best results. With a water heater of 3 000 W loading, three hours were required to heat 35 gallons of water to 180°F. with an immersion heater. He thought that the more extended use of electrical apparatus in this country was only a question of pushing the apparatus.

Mr. W. D. **Lovell** said he did not think the Paper went far enough, and did not help the person who was selling the apparatus at all. It was generally easier to sell large plants than it was to get rid of even an electric iron. He agreed with Mr. Jones as to the necessity for a housewife to work on the practical end, as at present there was not very much practical experience available.

Dr. **Griffiths**, in reply, said he had found it difficult to discover anyone having actual experience of the apparatus who was not biased against it. They were generally cooks who had not given it proper usage. He was pleased to meet so many who had had practical experience, and had evidently taken great interest in its working. He considered that the immersion heater was the solution of the water heating problem, but thought that it had a long way to go yet in the matter of development before it became absolutely reliable. The nichrome wire used was very good as far as it went, but it was a question of temperature limits. Immediately those limits were passed it was no use at all. As regards insulation mica was a perfect insulator, but on the grounds of greater mechanical strength he thought a first class refractory clay would give better results.

Heating and Cooking Notes.

The results of the British Engineering Standards Association's labours in the standardisation of cooking appliances have recently been issued in the form of a specification for a standard oven, while even more recently an instructive paper was read before the I.E.E. by Messrs. Griffiths and Schofield on "Some Thermal Characteristics of Electric Ovens and Hotplates." This Paper, which was published in abstract in THE ELECTRICIAN, was the result of labours at the National Physical Laboratory to ascertain the efficiency of ovens and hot plates.

NEED FOR WORK ON IRONS.

Progress in this direction is all to the good and shows that really serious efforts are being made to develop this section of the industry on sound lines. It is to be regretted, however, that no such development has so far taken place in regard to that humble but serviceable appliance—the electric iron. The iron is a missionary piece of apparatus which often forms the stepping stone to a demand for a power load in place of a lighting load only on consumers' premises. If the iron gives satisfaction, the kettle, the toaster, &c., and then the heater and cooker eventually follow. But the iron is the article that first appeals to the lady of the house. It is therefore of the highest importance that every effort should be made to improve and develop this appliance.

At the moment, for instance, there is no standardisation regarding the most serviceable weight of iron for household use, and there is ample room for improvement and progress in the internal design. We have not yet reached finality in the method of conducting the heat from the element to the sole of the iron; in the method of connecting the element to the terminals, in connecting the flex to the terminals; or in overcoming the difficulties of heated and ultimately perished flex. All these points are electrical or mechanical problems which call for solution. Questions appertaining to use and abuse have also to be considered—such as shape and position of the handle and total weight. Because the old flat iron was a certain shape it does not follow that its shape can never be changed. Some people like a pointed iron for lace work, and others will tell you that if the base portion is pointed and too thin it catches in the lace. There is evidently room for enquiry and investigation even into this small detail. We live in an age of progress, and it is not good enough to produce a sound article and then rest. Continual thought and investigation is still required to make that which is good, better.

THE AQUA ELECTRIC WATER HEATER.

The Aqua water heater is an American device, for which it is claimed considerable success and popularity has been gained on the other side of the herring pond. The heating element is of porcelain, through which are run a series of twenty-nine perpendicular tubular passages, interconnected at top and bottom to provide a continuous tubular passage, through which a coil of non-corrosive resistance wire is run. By means of suitable connections and gearing it is arranged that when the operating handle is turned to the right the cold water inlet valve is opened and the electric current switched on simultaneously; and on turning the handle back to the vertical position, both current and water are switched off. If, however, the handle is turned to the left, cold water can flow clear through the apparatus and the electrical circuit is not switched on; neither does cold water pass over the elements. The apparatus is so constructed that it is impossible to drain off all the hot water, there always remaining sufficient to cover the elements. It is claimed that this allows the element to cool slowly with the water and prevents those sudden changes of temperature which are so detrimental to the life of the element's resistance. A screw adjustment is provided to allow for the regulation of the inflow of water to suit varying water supply pressures and individual requirements in the rate of flow of hot water.

TRICITY STANDARD OVENS.

Pioneers in the early days of electric cooking and numbered amongst the stalwart enthusiasts of the present time, it is only to be expected that the TRICITY COMPANY should be the first firm to produce a standard oven which conforms to the requirements of the British Engineering Standards Committee's specification. This standard range comprised two pieces—the oven and the cooking table—each of which can be used separately. As a commencement the Tricity Company have designed and made the oven, and it is possible that the table to accompany it will be forthcoming at an early date. The oven does not show any radical changes from Tricity practice. The standard dimensions for the oven have been complied with, the slag-wool, heat-insulated, sheet walls of previous types retained, and the elements are as before at the top and bottom. Cast-iron legs and the specified recesses to accommodate the table have been added, and we note that the shelf racks are now of cast instead of sheet metal, the door and door frame being more substantially designed than previously.

Solid nickel wire is employed throughout for the connections, which are supported on mica insulators. The earthing specification is not entirely met. In this case the flexible metallic tube which carries the connecting leads from the terminal box at the back of the oven to the wall switchboard serves the purpose of an earth wire. Earthing is such an important matter that it is a pity that the specification is not entirely complied with. The oven is made in two sizes, one having a loading of 1 500 W and the other of 2 000 W. In the smaller size heat regulation is provided for by an "on and off" switch for the top elements and a three-heat rotary switch for the bottom element.

In the larger size, three-heat control is arranged for both top and bottom elements. We do not quite see the consistency in the provision of less control in the smaller size of oven. The rating is less, but so also is the size in proportion, therefore if three-heat control on the top element is an advantage in the larger size it should also be in the smaller. The time required for heating up to 400°F. is about half an hour, which, although it fully meets the B.E.S.A. specification, seems to be rather a long while for the housewife to wait. People are getting less patient, if anything, as labour-saving appliances are developed and improved. Besides, quick cooking is a decided advantage to the housewife who has to provide a mid-day meal and do the shopping as well. This need for more rapid cooking could, of course, be met by providing the same oven carcase with heavier leads and switches and employing a more highly-loaded set of elements. The Tricity Standard oven is certainly a sound job and its introduction is likely to be of considerable interest to those who worked in preparing the specification and also to supply engineers and contractors. It will be interesting to hear how this oven meets the users' requirements, which form, to a large extent, the final court of decision regarding the merits of domestic apparatus.

The Relay System of Automatic Switching.

Those attending the meeting of the Institution of Post Office Electrical Engineers on Monday last, when a Paper was read by Mr. H. D. Dipple on "The Relay System of Automatic Switching," had an opportunity of seeing the improvements that have been made in the equipment manufactured by the RELAY AUTOMATIC TELEPHONE COMPANY, LTD., since 1914. A demonstration was given on a small board which has been designed and manufactured for use by the India Office for instructional purposes, though the arrangements therein embodied also fulfil requirements of the British Post Office. It will be remembered that we gave a detailed description of this system in THE ELECTRICIAN for May 23, 1913, and again referred to the equipment employed in THE ELECTRICIAN for July 10, 1914.

The operation of the system generally remains the same as described in these articles, though certain interesting improvements have been introduced until it now can perform any operation performed by any other automatic system. One of these improvements is that the design of the relay has been altered so that the coil can be disconnected separately, while the spring banks are made in separate units, thus facilitating removal in case of need. A dial is used for calling instead of a series of levers, not that the latter arrangement was found unsatisfactory, but in order to bring the system into line with Post Office practice. The earth connection formerly employed has been done quite away with, in favour of complete metallic connections. In the old type of board a special searcher was employed, but now the calling mechanism searches for a disconnected trunk itself. Lines are also arranged for auxiliary working so that in the event of one line of a group being busy, the call is automatically transferred to the second. A very complete system of traffic registers has also been installed for recording the calls from each group of stations and to show what calls, if any, are being lost owing to any insufficiency in the line arrangements provided. Indeed, it may be said that during the years every addition has been made to develop the system from being suitable solely for private branch-exchange operation to the more extended sphere of town operation. The demonstration given the other evening sufficiently indicated that this aim has been achieved.

Severn Crossings and Tidal Power.

The much-discussed problem of utilising the tidal power of the Severn will hardly be presented to the electrical engineer for some time to come in a definite shape. The limitless vistas "of the World's Greatest Power Scheme," to which the Ministry of Transport drew attention last December, are still in far too indefinite a condition for the designer of turbine driven dynamos to be interested in the conversion of tidal power into electrical energy. Nevertheless the problems are of high importance as well as difficult, and they had best be carried out on a small practical scale before risking failure on something a good deal larger.

Mr. W. A. **Tait** put the case very plainly when delivering his discourse on "Severn Crossings and Tidal Power," before the Royal Institution last Friday. If the traffic problem and the power problem could be solved together, the chances of success at a reasonable expenditure would be much better than if we had to keep the two problems apart. The tides on the Severn are almost the highest known; that makes the problem tempting. But shipping interests must not be interfered with, the low-lying shores of the estuary must not be exposed to floods, its industries not be disturbed, and its railways not unnecessarily be forced to adopt steeper gradients for their crossings. We have no experience, moreover, with low-fall turbines actuated not by clear water but by a turbid water of tidal currents. The traffic problems alone have been overcome on the Thames, the Forth and the Tyne with more or less success. The Wapping Tunnel was finished in 1843; it was converted into a railway tunnel after 1865, and the Tower Bridge and three other tunnels have since been added between London Bridge and Blackwall. On the Firth of Forth a railway ferry taking 400 wagons was running between Granton and the neighbouring Island before the great Bridge was built. Similar ferries were crossing between Richborough and Dunkirk and between Southampton and Dieppe during the war. On the Severn we have below Gloucester only a single-track railway bridge and 14 miles further down the Severn Tunnel. Further facilities might be obtained by another tunnel, a train ferry, a barrage or a bridge; a suitable barrage would solve the combined traffic and power problem.

Two Extremes.

Mr. Tait outlined two extremes now under consideration, that of Messrs. Addenbrooke, Meik and Twinberrow, and that of the Ministry of Transport. Both the proposals involved the construction of a dam, converting the river above the dam into a reservoir to be filled at high tide and to be emptied through low-pressure turbines in the dam at ebb tide; the further construction of high-level reservoirs and the equalisation of the tidal power over a fortnight by means of water pumped up into the high-level reservoirs and drained from them at times of slack water to drive high-pressure secondary turbines; provision of a lock for navigation and of improved facilities for navigation above the barrage. The first scheme favours the site near Beachley, the second a site near the Severn Tunnel, the first a low-level bridge necessitating an opening span, the second a high-level bridge.

There are advantages and disadvantages in either projects. The tidal currents running up to 8 ft. per second, the Severn floods, the foundations of the high-level reservoirs, eddies and tidal alternators set up by the building of the dam, the silting of the passages and an archway, and other points will cause serious difficulties. Many of these will have to be studied at the spot, but a good deal can be tried elsewhere. The performance of low-pressure turbines, Mr. Tait would like to test on the Isle of Lewis where on the Seaforth Loch a basin of 1 square mile might advantageously be compounded, the tidal range there being 13 ft. Additional experiments would have to be made in the Bristol Channel, of course, to see how the turbines would wear. The Government, Mr. Tait remarked in conclusion, might spend money on investigations, and during that time the turbine manufacturers might devote their attention to the improvement of low-pressure turbines.

The Platinum "Metals," by A. D. Lamb, A.R.S.M., is the latest of the interesting monographs issued by the Imperial Institute on Mineral Resources, with special reference to the British Empire, and deals with the question of platinum metals. In 1917 the world's production of platinum was 5 000 000 ounces, of which 250 ounces were used in electrical devices, and over a million ounces in chemical and physical apparatus, so that the subject is one of interest, not only to electrical engineers, but to scientists generally. The book deals with the currencies, characters and use of the platinum group of metals and their source of supply, and concludes with an interesting reference to the literature on the subject. The price is 3s. 6d. net, and it is published by Mr. John Murray.

The Institution Dinner.

The annual dinner of the Institution of Electrical Engineers was held at the Hotel Cecil, London, on Thursday, March 3, the President, Mr. Llewelyn B. Atkinson, being in the chair. The number present numbered between four and five hundred, among them being: Mr. A. W. Berresford (President, American Institute of Electrical Engineers), Prof. Sir W. H. Bragg (President, Physical Society), Mr. J. W. Gilbert (Chairman, London County Council), Sir F. Heath (Secretary, Department of Scientific and Industrial Research), Brig.-Gen. Sir W. T. F. Horwood (Chief Commissioner of the Police), Mr. G. W. Humphreys (Chief Engineer, London County Council), Major-Gen. G. D. Jeffries (G.O.C., London District), Dr. R. Knox (President, Röntgen Society), Brig.-Gen. C. P. Martell (Chief Superintendent Ordnance Factory, Woolwich Arsenal), Sir E. Murray (Secretary of the General Post Office), Sir C. Perry (Principal Officer, London University), Sir J. E. Petavel (Director, National Physical Laboratory), Sir W. Pope (President, Society of Chemical Industry), Prof. A. W. Porter (President, Faraday Society), Capt. F. Riall Sankey (President of the Institution of Mechanical Engineers), Dr. S. Gilbert Scott (President, Electro-therapeutic Section, Royal Society of Medicine), Prof. C. S. Sherrington (President, Royal Society), Sir J. Bland Sutton (President, Royal Society of Medicine), Lieut.-Col. Sir F. Younghusband (President, Royal Geographical Society), and Mr. P. F. Rowell (Secretary)

Telegrams of greeting were read from the American Institute of Electrical Engineers, and from the Associazione Elettrotecnica Italiana.

In proposing the toast of the "Institution of Electrical Engineers," Sir W. H. **Bragg** said that electrical engineers could be proud of what they had done in the past, and he was sure that great triumphs would be placed to their credit in the future. Physics and electrical engineering had been closely allied from the very earliest days, and one of the first tasks of the physicist had been to measure the standards employed by electrical engineers. Nowadays physicists were again in close touch with the electrical engineer owing to the problems connected with electronic magnitudes which had come up for solution.

The President on the Future.

Replying to this toast the **President** said that the total roll of the Institution now exceeded 9 400. They had 14 committees sitting regularly on departmental work, and in addition they took part in the proceedings of over 40 bodies, the endeavour being to uphold the interests of their members in all spheres. All this voluntary and co-operative effort could not be without its effect on technical and industrial progress. Such interchange of thought must result in the pushing forward of the industry, while the co-operation, fellowship and good-feeling that it indicated could not fail to be of the greatest assistance to the Institution at the present time. During the last few months industry generally had suffered a great change for the worse. The fundamental reason for this had been variously explained, but was that as a whole we were spending more than our total income, and consuming more than our total production. The full effects of these conditions on the electrical industry had not yet been felt. The immediate future was by no means rosy, and with a majority insisting on a higher scale of living or, if they could not obtain that, existence on a lower level with the assistance of doles, a point would soon be reached when buyers would hold off until more normal conditions obtained. The electrical industry perhaps more than most others depended on new production, and new production depended on new capital, which in its turn depended on savings.

A year ago they had had high hopes of the reorganisation of the electrical industry, but at the present time no one could help feeling disappointment at the progress that had been made. The schemes which had been put forward under the Electricity Supply Act did not reflect that intensive study which would carry general conviction of their soundness to engineers or to financiers. It was a further disappointment that the old struggle between municipal and company organisations had broken out afresh, and that economics had once again succumbed to local politics. In this connection it was necessary to sound a grave note of warning. The public were expecting a wide and efficient distribution of electricity, and if, with the help of the Commissioners, that wide and efficient distribution was not achieved, the public would make arrangements for it over the heads of the electrical industry, and in so doing would receive the support of manufacturing interests and of employees who would think that that was the only way of obtaining the necessary end.

The Institution and the Commissioners.

An endeavour is being made in part of the Press to belittle the efforts of the Commissioners but the Institution members would not support such an effort. It had been said in some quarters that they were a costly body, and were doing nothing, but as regards cost he thought the balance was on the right side when the duties taken over by them were fairly considered. In the Commissioners the electrical industry had a sympathetic body, and the only fear was that the industry would not put forward schemes which the Commissioners could quickly accept. It was certain that only by concerted effort could we achieve success in the directions he had indicated.

Mr. A. A. **Campbell Swinton** in proposing the toast of "Our Guests," said that though there were no politicians there to-night that was perhaps no matter for commiseration. The Institution of Electrical Engineers was mostly concerned with people who did things, while politicians belonged to that class of the community who only talked about doing things.

Sir Frank Heath (Secretary, Scientific and Industrial Research Department), in reply, said that he could conceive of no one less fitted to reply to this toast than the mere civil servant whose business it was to carry out policies not to initiate reforms. Impressions could, however, sometimes be made on civil servants, and he had been much struck with the electrical engineers' capacity for long-sighted statesmanship as indicated by the suggestion to establish a National Proving House for the industry. That movement sooner or later was sure to come to fruition. The formation of a research association for the electrical industry was another example of the same sort of thing, and among the 26 research associations that had been established the electrical one was not likely to be the least successful.

Sir John Bland Sutton (President, Royal Society of Medicine), who also replied to the toast, said that electrical science had rendered conspicuous services to surgery since his early days when operations were carried out by gas or by candle light. It was now possible not only to work in a light which almost rivalled daylight, but to examine by electrical means the hollow organs of patients. X-rays enabled shrapnel bullets to be discovered in curious places, and it was most interesting from the surgical point of view to watch the movement of these bullets in such an organ as the heart. He had recently heard a lecture on the possibility of supplying electric power to this country from Canada, and he speculated on the day when this would be achieved at a cheaper rate than it was now possible to obtain it from Marylebone or Westminster.

About half-an-hour behind the time table those present adjourned to the reception room, where a most successful evening was brought to a conclusion in conversation with old friends.

We would suggest before next year's function that electrical operation might be introduced into the cloak room arrangements at the Hotel Cecil. Both before and after the dinner great delay was caused to the numerous company by the quite inadequate organisation which the restaurant authorities concerned had thought fit to provide.

Correspondence.

THE ELECTRIC WASHER—IS IT A TOY OR A TRIUMPH?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: An article in The Electrician of November 26, entitled "The Electric Washer—Is it a Toy or a Triumph?" has been circulated in this country and has occasioned considerable comment among American housewives, on account of its assumption that apparently American women buy washing machines for the fun of spending money. Granting that Americans may look foolish, politically, at present, still we rather object to having that same foolishness attributed to our domestic economy.

Possibly your readers might be interested to learn some of the circumstances which explain the extraordinary popularity of electric washing machines in this country, as evidenced by a sales total of $100 000 000 for 1920, according to the statistics quoted by your writer, "Electrocynic." I regret to state, however, that that figure does not represent the sale of a million machines, as he assumes, for unfortunately the present price average is much nearer $200, than $100. Probably $175 would be a fair figure. But, at that, the production and sale of 550 000 washing machines in one year is in itself a fact worth pondering, for whatever we may be in other directions, Americans are not lacking in financial or mechanical astuteness.

Early in "Electrocynic's" dissertation he writes as follows: "I am informed that most of the work (certainly if measured by time) in connection with clothes-washing, lies, not in rubbing or otherwise maltreating the clothes, but in lighting fires, boiling water, filling, emptying and carrying tubs, hanging the things up to dry, taking them down again, ironing them, airing them, and putting them away. The electric washer does not carry out any of these processes, for the simple reason that they cannot be done otherwise than by hand." Now to the first sentence of this assertion, I take no exception; it is only too sadly true, if English women are still filling and carrying tubs by hand. But his statement that the possession of a washing-machine makes no difference in the performance of the other enumerated tasks, is greatly in error, as I can testify by my own experience as owner and sometimes operator of a machine, together with that of many of my friends.

Washing Analysed.

Let us take these tasks item by item:—

1. *Hot Water.*—The washing-machine does not use as much hot water as the old open tub method, because it is enclosed, and thus the heat does not escape so readily. One machine-full of hot water will do the average regularly weekly wash of a family of four, unless the clothes are especially dirty or unless there are included many large articles, such as curtains, bed-spreads, and so forth. If one wishes to rinse in hot water as well, another machine-full will usually suffice for this performance.

2. *Filling, emptying and carrying tubs.*—Filling is usually done by siphon from the faucet. Several types of machines have gas heaters attached, making it possible, if necessary, to fill from a cold water supply, and then heat in the machine; certainly, we empty by siphon; we do not carry tubs any more, but wheel our machines on castors into position next to a rinsing tub, if one is available. If not, we wring clothes from the machine into a basket, and then afterwards rinse by machine.

3. *Hanging out to dry.*—Much of this time and labour is absolutely eliminated by the power ringer, which is the most valuable element of the electric washing-machine, and one which ought to be still more valuable in England, where the climate is popularly supposed to tend towards the moist. Proper use of the power wringer will easily halve the time and labour of drying, and what this means in the orderly management of a home, only a housekeeper can appreciate. In the United States where an electric ironing machine (power mangle, usually gas-heated) costs about the same as a washing-machine, some women use their power wringer as a cold mangle for the smaller pieces of "flat-work."

The Extinction of the Charwoman.

The great point of difference, however, between the two countries as regards the larger electric household labour-saving devices, is the almost total extinction in this country of the genus char-woman. It is true, in the big cities there are still a few laundresses left, but they charge on the average $4.00 for an eight-hour day, which, if the day-worker is coloured, begins with breakfast, usually eaten "in the employers' time." It includes, of course, both luncheon and car-fare, and meat is demanded for one, if not for both meals. "Ah eats nothin' but lamb chops," announces the dame-of-colour, as she begins to stipulate her conditions of servitude. Frequently, also, sheets and bed-covers are taboo; blankets must be made a "special" wash by themselves. Should the clothes be slow in drying, the laundress sits and folds her hands waiting for nature to take its course; should one request her to wield a dust-cloth in the interim, she either demands extra pay or refuses to come again. An average family of two adults and two children will pay out about $5.00 a week in hire, soap, food and car-fare, and then have a bill for "flat-work" and collars from the steam-laundry besides. Should all the clothes be sent to a laundry, where good hand work is done, the cost will average from $7 to $9 a week, while at the same time, the garments are wrecked by too liberal use of cleaning powders.

"Chars" versus Children.

If this is the condition in the large cities, in the suburbs and in the country, there is practically no household help to be had at any price. Among my own personal acquaintanceship, is the wife of a man earning $7 000 a year. She has to do all the work for her family of three adults and one child; another friend, a chemical engineer, earns about $6 000 a year, and his wife does all the work for himself and two young children. These instances are taken from suburbs outside of large cities, where conditions are supposed not to be quite as bad as in the country. Incidentally, on the farms, where for a generation household help has been almost extinct, the families average but two children apiece, according to government reports. The women can't do all the work and bring up large families of children; as the work continues, the children don't.

On this last account, I rather hope that the race of char-women will survive the needs of rising generation in England, especially till some of her fearful war loss has been at least partially replaced. On the other hand, merely shifting the burden to someone else's muscles is not a very logical disposal of a form of heavy and distasteful work, and a mere household drudge is not a very satisfactory element of population for a progressive democracy such as your country must be counted. Along with social reform of various sorts, the home must not be neglected—that home, which we are told many times is the test of our civilisation, should not for ever rest upon the back of the unfortunate char-woman.—I am, &c.,

An American Housewife.

A LOUD SPEAKING OPTOPHONE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Having recently been asked by Mr. C. P. MacCarthy, who is teaching a class of blind soldiers to read with Dr. Fournier d'Albe's Optophone, whether it would not be possible to magnify the sounds sufficiently to enable them to be heard by a number of persons simultaneously, without the necessity of each listener being furnished with a separate telephone receiver, I have recently applied to the Optophone a thermionic amplifier of the note magnifying type used in wireless telegraphy and telephony.

Dr. Fournier d'Albe's very ingenious and wonderful instrument, as now improved and manufactured by Messrs. Barr & Stroud, was fully described in The Electrician for August 13, 1920, page 183, so it is unnecessary for me to repeat the description. In my experiments the amplifier was simply connected in place of the usual head telephone receivers, and coupled to a Brown loud speaker.

The amplifier used was one of the French military type, with three "R" valves coupled by audio-frequency iron-core transformers, with a two-cell accumulator to supply current for the filaments, and a battery of dry cells giving some 70 V to the plate circuit. Particularly when the Optophone was arranged for what is known as "black" sounding, when the white paper is represented by silence and notes are sounded as the beam of light passes over the black letters, the results were very successful, the distinctive sounds being clearly audible, all over a moderate sized room.

The experiments having been brought to Dr. Fournier d'Albe's notice, I suggested to him that better results could probably be obtained with an amplifier specially designed to suit the particular conditions, but that, anyway, it would, be well to try other makes and types of amplifiers in order to see which worked best. Dr. Fournier d'Albe now informs me that using an amplifier supplied to him by the Marconi Company he has obtained excellent results both with "white" and with "black" sounding and that two blind ladies have been able to read with it with ease, without the usual headgear.

This application of the amplifier to the Optophone should, I think, prove valuable, especially for teaching and demonstration purposes. I am, &c.,

London, March 7th. A. A. Campbell Swinton.

WIRE RADIO—A QUESTION OF NOMENCLATURE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The correspondence appearing in the columns of The Electrician, relating to the proper nomenclature for what hitherto has been commonly referred to as "wired wireless" method of communication, brings up a question which deserves consideration and action.

In view of the diversified character of the recent progress of this new art, and of the various suggested names which have been offered, I beg to submit the following remarks: In the opinion of the writer, a name, to describe effectively this method of communication, must convey to the reader the impressions:—

(1) Of communication by means of interconnected wires, as distinguished from pure radio.
(2) Of communication by means of frequencies other than voice or telegraphic frequencies.
(3) That such frequencies may either be low or high, viz., be either in the audio or super-audio or radio range.
(4) That by means of such frequencies a number of distinct channels of communication may be established.

In addition, the name should be as simple as possible and to the electrical engineer, other than radio or telephone engineer, should be almost immediately intelligible without having to search his memory for the meaning of foreign language terms or prefixes.

The original term of "wired wireless" or the later adaptations of "wired radio," or "wire radio," as has been suggested by General Squier, come very close to fulfilling these requirements. They have the disadvantage, however, of implying that the frequencies are confined to the higher ranges which are normally used in radio and, except indirectly, do not emphasise the multiplex feature. The same objection may be raised to the term "high frequency," which, if used alone, may be further objected to on the basis of (1) above. The term "carrier current telephony" is not at all descriptive of the system and may be objected to for a number of reasons. The terms MF., Kuma, Linon, Cymoline, &c., which have been proposed, I believe are open to objections raised above, and also tend to confuse the non-radio or non-telephone engineer.

With a view to fulfilling the various requirements as outlined, I would submit for consideration the name "Multiple Frequency Wire Telephony" or "Telegraphy," as the case may be. Furthermore, with the progress of the pure radio art the terms "Duplex" or "Multiplex" radio telephony may become inadequate, in which case the general heading "Multiple Frequency Radio Telephony" or "Telegraphy" would be more descriptive.—I am, &c.

Washington, D.C., R. D. Duncans, Jnr.
February 24, 1921.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Dealing further with the matter of nomenclature raised by your correspondent Major-General George O. Squier, may I suggest that the high-frequency system employed in line telegraphy and telephony be designated either as a "Carrier Wave Morse System," or, if desired, "Carrier Wave Wave Squier System." The corresponding abbreviations could then be C.W.M. or C.W.S.—I am, &c.,

Washington, D.C.,
February 19, 1921. A. Press.

The British Industries Fair.

(*Concluded from page 282.*)

Messrs. Berry's Electric, Ltd., are displaying an interesting collection of switchgear, instruments and domestic appliances. These include the new "Masta" midget 10-ampere 250-volt fuse switch. This is completely fool-proof, and is so arranged that with the lid of the switch opened it is impossible to touch any live metal with the hand. There are also complete ironclad fool-proof switchboards. Two and three-pole fuse switches with and without interlocked detachable plugs, a range of Berry's "Magicoal" electric fires and of braziers, and of N.C.S. electrical measuring instruments, for which Messrs. Berry's Electric Company are the sole Midland agents.

Messrs. Hollings & Guest, Ltd., the well known hydraulic engineers are exhibiting several representative types of hydraulic machinery, including their noted hydraulic tyre fitting press which has been supplied in hundreds to all the leading motor and tyre companies, as well as garages all over the world. There is also an hydraulic bending press capable of bending steel plates cold up to 6 ft. in width, and an insulating press suitable for many purposes in the electrical industry, a wheel forcing press for removing wheels from shafts, also a set of motor operated pumps suitable for driving these machines.

The insulating press is fitted with steam-heated platens and is used for making moulded rubber goods and insulating materials. It is also used for the manufacture of artificial horn fibre and similar materials. These presses are supplied with any number of steam platens, and of any size or power. An important point is the construction of the platens, which are so made that it is impossible to burst them with any steam pressure that may be put on.

Fuller's United Electric Works, Ltd., are exhibiting plate and block type accumulators suitable for electric light installations and general purposes. The plate type cells shown are provided with the hanging type plates erected in glass containers, and are semi-Planté plates, consisting of pure lead grids pasted with specially hardened active material. The negative plates are of the lattice type, pasted under pressure. Another interesting exhibit on this stand is "The Electric Miner's Lamp Equipment," which consists of a charging rack and lamp stand each accommodating 160 lamps, an opening magnet and a pedal switch. The Fuller mining lamp gives a light of high candle-power, which will last for at least 20 hours. The case is massive, strong and comparatively light. The lamp is switched on and off by turning the top, and is supplied with either magnetic or lead lock.

Messrs. Electric Heating & Hardware Ltd., Birmingham, display on the stand samples of the Company's "Komet" productions which include electric irons, heaters and ovens. A special feature is their new cylindrical type oven, on which the consumption is only 1 000 watts at full heat, the temperature being raised from 60 deg. to 300 deg. in about 10 minutes. The oven is made entirely of aluminium, is lagged and has a special air-tight fitting door.

Messrs. W. Sanders & Company, Wednesbury.—The various samples exhibited on this stand give at once a clear conception of their manufactures. They include samples of ironclad switch and fuse gear ranging from 10 to 200 amps. capacity, ironclad distribution boxes both double and triple pole suitable for voltages up to 600, fuse boxes, knife switches, handle type fuses, and samples of ironclad unit type distribution boards. Samples of unit type ironclad switchgear are also shown.

The Birmingham Mica Company, Ltd., Hockley, have a very interesting display of mica products for electrical purposes, such as washers, discs, strips, bases, screens, tubes, bushes, channels, segments, division plates, rings for commutators, reels for resistance coils, ventilator flaps and general moulded work.

Ebonestos Insulators, Ltd., are showing electrical insulators which can only be supplied in a moulded form. The samples shown are such as are used in switchgear manufacture, and are capable of withstanding high temperatures.

Messrs. Herbert Terry & Sons, Ltd., display a very comprehensive range of springs and presswork specialities for all trades.

Messrs. Springs, Ltd., also show a complete range of springs, and a special exhibit of small springs such as are used in the electrical industry.

Electrical Conduits, Ltd., have a pleasing display of conduit, and fittings for electric wiring purposes, also some excellent samples of multiple switch boxes.

The Excelsior Shade Mfg. Company exhibit a very fine range of artistic electric light fittings and pendants, fitted with silk shades.

LONDON SECTION.

The exhibits of electrical interest at the British Industries Fair at the White City could be counted almost on the fingers of one hand, and there is nothing startlingly novel to be seen at any of them. Such exhibits as there are are distributed between Section 4, which includes scientific instruments, and Section 2, which comprises fancy goods, brushware, &c. In this latter section are to be found one or two electrical exhibits, such as batteries, portable electric lamps, &c.

Primary Batteries.

Messrs. Siemens Bros. & Company, Ltd., show exclusively primary battery material, including dry battery lighting sets for motor cycles and cycles, and a full display of fluid cells and batteries. The cycle and motor cycle dry batteries are encased in substantial leather cases. The lamp bulbs are of the ordinary flash lamp type, and spares can be obtained from any accessory dealer. The manufacture of primary galvanic cells and batteries has formed a large and important portion of the manufactures of Siemens Bros. & Company at Woolwich for over 50 years, and the results of this experience, which at first was concentrated on larger sizes, is now embodied in the smaller types which are coming into such great use on bicycles and motor bicycles. Important improvements have been effected from time to time, both in Leclanché type and Daniell type cells, and the present type of Siemens' dry cell is based upon extensive researches carried out many years ago by the late Dr. Obach, chemist of the Woolwich works.

Messrs. S. G. Brown, Ltd., London, make a prominent feature of the Brown Gyro compass, the details of which are well known to readers of The Electrician. Super-sensitive telephone receivers are also shown, such as are in use by the War Office, Admiralty, Air Force, the Marconi Company, and others. The electrical construction of these receivers is quite different from that of any other make. The receiving coils are wound on the pole pieces of a permanent magnet as usual, but the ordinary diaphgram is replaced by an iron reed tuned to a suitable note to which an aluminium diaphragm is screwed. In type A, these receivers are fitted with a milled head adjusting screw at the back of the receiver case for setting the reed to the position of maximum sensitiveness. Two instruments for enabling deaf people to hear are based on quite an interesting principle. In the case of a totally deaf person, a mouthpiece, like that of a pipe, is gripped between the teeth, and the effect on the vibratory nerves enables another person speaking into the transmitter to be heard quite distinctly. The other instrument is for a person partially deaf, and can be placed anywhere in the room, the sounds from which can be picked up by the hearer by holding a contact piece pressed to the face close to the ear. Among the other exhibits on this stand is a small dynamo run off a bicycle wheel for the purpose of supplying the lamps, front and rear.

Messrs. James Pitkin & Company show a chronograph for measuring the speed of projectiles from a large shell to a revolver bullet. The projectile passes through two sets of light wire screens, and as it passes through each a record is given on the chronograph by the electrical connection made at the moment of breaking the screens. After the second record is given it is then easily possible to calculate out the speed of the shell or bullet.

Portable electric lamps of various descriptions are shown by the Ever-Ready Company (Great Britain), Ltd, whose dry batteries are now well known. Here again is to be seen a combination cycle lighting set run from dry batteries. A novelty on this stand is the application of the dry battery and flash lamp to photographic development purposes, a battery and lamp of this type being made up into a dark room lamp. Wall bracket lamps for intermittent use are also shown, together with many other applications of these batteries and lamps.

Messrs. H. G. Slingsby are showing a new type of electric power-driven elevator. This is a movable piece of apparatus, which will lift loads up to 15 cwt. to a maximum height of 12 ft. The principle of the machine is contained in a rising and falling platform driven by an electric motor situated in the base of the framework. A number of advantages are claimed for this arrangement.

Pocket lamps and batteries are also exhibited by the Semaphore Engineering Company, Ltd., with cycle and motor cycle lighting sets. Portable electric fountains for dinner table use are shown by Needham Bros., of Hammersmith.

Messrs. Alfred Graham & Company, well known for loud speaking telephones and general naval equipment of this character, have a special display of permanent magnets.

Messrs. F. Darton & Company show a large number of their usual small size motors and electrical apparatus.

Some attractive shades for electric lighting are to be seen at the stand of the Artistic Shade Company and a number of others.

British Electrical Development Association.

At the adjourned annual general meeting on Friday last the following gentlemen were elected as members of the Council of the British Electrical Development Association for the ensuing year and at a Council meeting which followed those marked with asterisks were elected as members of the Executive Committee: Messrs. C. H. Wordingham, C.B.E., *H. Hardie and B. Welbourn (representing the Institution of Electrical Engineers); *A. P. Ambler, C. O. Bastian, *A. F. Berry, *D. N. Dunlop, *W. A. Gillott, *H. C. Palmer and A. E. du Pasquier (British Electrical and Allied Manufacturers' Association); *S. T. Allen, *F. Ayton, S. E. Britton, J. Christie, *A. C. Cramb, E. E. Hoadley and *T. Roles (Incorporated Municipal Electrical Association); *R. S. Downe and F. J. Walker (Conference of Chief Officials of London Electric Supply Companies); *E. T. Ruthven-Murray and W. B. Woodhouse (Incorporated Association of Electric Power Companies); *T. W. Cole (Provincial Electric Supply Committee); *Ll. B. Atkinson and *W. F. Bishop (Cable Makers' Association); *J. E. Edgecombe, S. H. Callow and *E. A. Marx (Electric Lamp Makers' Association); *L. G. Tate, *H. Marryat and S. H. Webb (Electrical Contractors' Association).

At the adjourned general meeting, Mr. J. W. Beauchamp (director and secretary) said it would be remembered that the general meeting had been adjourned because a small alteration had to be made in the Articles of Association to enable a larger Council to be elected. The scheme enabled the Council to be increased from 24 to 35 members, and provided for the addition of members in such a way as to balance the electricity supply and the manufacturers' associations.

On the motion of Mr. Ll. B. Atkinson, seconded by Mr. F. Ayton, the scheme was adopted.

Mr. Beauchamp said the constituent associations had been asked to make nominations, and those received were as set out above. The power companies had the right to another one. The Provincial Electric Supply Committee had given its blessing to their work and Sir Harry Renwick had decided to start by nominating Mr. Cole.

Mr. Ayton moved, and Mr. H. C. Palmer seconded, a resolution that the representatives whose names were on the list read out (as above) be elected as members of the Council for the ensuing year, and this was carried unanimously, Mr. Beauchamp remarking that the London companies could propose a third representative.

Mr. Beauchamp said the Council which had just passed away had been working for one year and nine months, and consisted of 24 members, with an executive of 11. The larger Council now elected would be able to consider proposals for a larger executive than they had had in the past. That was desirable, as they could not usually get a larger attendance than 50 or 60 per cent. The activities of the Association had developed largely in the past 12 months, and the bigger Council would be advantageous. The Council was glad to welcome Mr. Cole. He represented the last of the nine associations of the industry, which made the B.E.D.A. absolutely representative of the three branches of the industry—supply, manufacturing and contracting. He appealed to members, particularly in provincial districts, to do all they could to bring in more electricity supply undertakings.

Mr. Ruthven-Murray moved a vote of thanks to the chairman, Mr. A. F. Berry, for his whole-hearted work on behalf of the Association. In certain directions they could not have done without him. He had brought in the sinews of war in the shape of funds which were badly needed.

Mr. J. E. Edgcombe seconded the motion, and it was carried unanimously.

A vote of thanks was also accorded the B.E.A.M.A. for the use of its rooms, and Mr. Atkinson also expressed appreciation of the assistance given to the Association by the Electrical Press, in which sentiment Mr. Berry concurred.

At the Council meeting, which followed, the gentlemen whose names are marked with asterisks in the above list were elected to the Executive Committee, and Mr. Atkinson proposed the re-election of Mr. Berry as chairman.

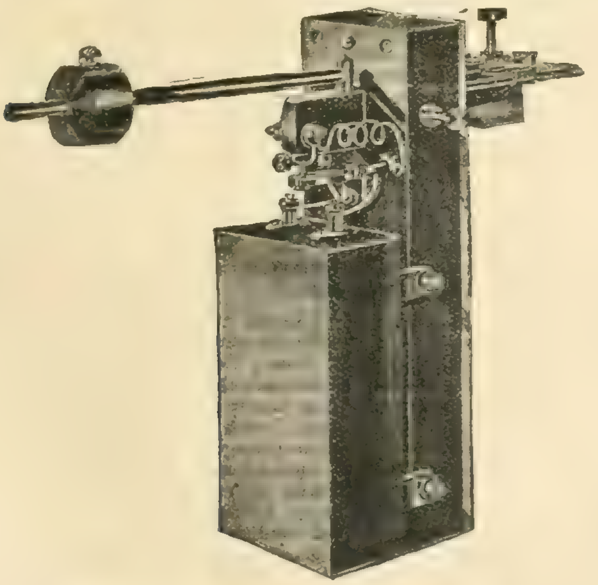
Mr. Berry said he did not wish to stand, and compared himself to a squeezed-out orange, so far as his work as chairman was concerned. He suggested Mr. Ruthven-Murray as his successor.

Mr. Ruthven-Murray appreciated the compliment, but said he felt more of a squeezed-out orange than Mr. Berry.

In the end Mr. Berry was induced to permit himself to be formally re-elected.

Controlling Temperatures of Electric Ovens.

The increasing demand for a closer automatic temperature control of electric ovens and other apparatus has resulted in the production by Messrs. Automatic and Electric Furnaces, Ltd., of a new thermostat, which can be set for temperatures up to 400°F. A capsule filled with a volatile fluid by its expansion is made to switch off a part of the heating element as soon as the full temperature is reached. Afterwards the full current is switched on and off intermittently so that a very steady temperature is maintained in the oven, or other device controlled. The exact temperature to be maintained can be adjusted to a nicety by altering the position of the weight on the lever which projects outside the oven. Contact is made outside the oven so as to guard against an explosion or ignition should the articles being dried give off an inflammable gas. This type of Wild-Barfield thermostatic temperature control with slight modifications can be adapted to numerous electrically heated devices.



Thermostat of Controlling Electric Ovens.

International Cable Communication.

We have received a copy of the evidence given by Mr. Clarence H. Mackay, president of the Commercial Cable Postal Telegraph system, of New York, on the question of permits for landing submarine cables in the United States. The statement was made before a sub-committee of the Committee on Inter-State Commerce on January 10 last, and as it deals with an important subject we give some extracts from it, in order that our readers may be acquainted with the American point of view.

Mr. Mackay commenced by giving a brief history of submarine telegraphy, and pointed out out that submarine cable manufacture and communication had its birth in England, and from the time that the first cable was laid across the English Channel in 1851, England was the first to grasp the importance of cable communication. She quickly recognised the strategic and trade value of linking up by cables the mother country with her possessions and colonies in all parts of the world. The first transatlantic cable was laid in 1858, followed by those of 1865 and 1866, and although conceived and carried out by Mr. Cyrus W. Field, the capital was principally found in England (where the enterprise received its greatest support) and the cables were made in England and laid in the name of an English company. The first American-owned transatlantic cables were laid by Mr. Jay Gould in 1881 in the name of the American Cable and Telegraph Company and subsequently came under the control of the Western Union Telegraph Company through a long-term lease. Those were followed by cables laid in 1884 by Mr. John W. Mackay and Mr. James Gordon Bennett in the name of the Commercial Cable Company, and about that time the All America Company was extending to Mexico, and Central and South America. The total cable mileage owned or controlled by American companies is 70 943; British companies own or control 128 976 miles, and 23 855 miles are owned and controlled by companies of all other nationalities. All of the cables operating between the United States and England were controlled by American companies. The system of American cables was developed by keen aggressive competition between the American companies. Some of the English cables were laid under the inducement of large subsidies and guarantees, but American cable companies had built up their large systems without subsidies or guarantees of any kind. American cable companies would keep well in advance of the expansion of American trade with foreign countries and would increase their facilities as rapidly as the conditions required. To accomplish that, however, it was important that the American Government should support them vigorously in securing equitable and similar privileges in Europe and elsewhere to those which foreign companies were granted in America.

On the inception of submarine cables, British cable manufacturers built large plants devoted to the manufacture of long submarine cables, namely, the Telegraph Construction and Maintenance Company, the India Rubber Gutta Percha and Telegraph Works Company, and Siemens Brothers & Co. They acquired special skill and experience in the manufacture and laying of cables, which assured purchasers of the security of their investment. That was one reason why Great Britain was the centre of the submarine cable manufacturing industry. The British manufacturers had had a monoply of cable manufacture because they had built cables from the early days of cable communication, and they had the plants and the experience required to assure the successful manufacture of cables. Atlantic cables required gutta percha insulation. The market for that material was very limited; it must be of the most refined quality, free from impurities. He was informed that the greater part of American manufacturers made India rubber cables. Those were all right in tropical waters of lesser depths. The Alaska cables of the United States Government were made in the United States of india rubber insulation, but he understood that they had not proved satisfactory. No one but a Government could afford to experiment with such cables, and no private company would be satisfied with the results. The construction and insulation of long cables must be perfect to assure success. The slightest imperfection in manufacture or impurity in materials would impair or destroy communication and mean costly repairs. If an air bubble should be left in the gutta percha insulation in the process of manufacture it would break down under the great pressure in ocean depths.

Landing Rights

Concerning conditions of landing and operating their cables in foreign countries, England in the past had been reasonable in her requirements, but of late was adopting a more restricted policy such as limiting the duration of the landing rights to five years and demanding control over international rates. France and Germany (and he presumed other Continental countries took the same attitude) had reserved with great jealousy their rights to absolute control of telegraph and cable operations within the boundaries of their own countries, and would not allow any private company to open public offices to deal directly with the public and control transmissions from origin to destination. France and Germany had regarded the cables of their own subsidized companies as part of their governmental communication systems, and had not encouraged private companies to land and operate cables on their shores. The conditions they imposed had the effect of stripping American companies of any advantages which private enterprise might have over Government systems. That was not conducive, but on the contrary was obstructive, to the free development of cable communication facilities between America and such countries, because, speaking for his own company, they could not regard with satisfaction conditions which confined them to the mere physical landing of a cable, and compelled them to rely upon the Government telegraph system to perform the inland operations. He would therefore say that one of the fundamental principles that each country signatory to any convention for the development of cable communication should agree to was not only the right of any bona fide cable company to land its cables, but also the right of operating the same and of opening offices in such countries for the handling of cable business wherever they considered it would be of public interest to do so, such as was allowed in Great Britain. He understood that the Communications Conference had considered the very important question of establishing a standard form of landing permit, and while he realised the difficulty of amalgamating in one form all of the various conditions which might be applicable in one country, but not in another, it would be a great step towards obtaining prompt action, if certain fundamental principles could be agreed to by treaty.

After referring to the reciprocity principles laid down by President Grant in his message to Congress in 1875, Mr. Mackay said there should be some legislation to clarify the situation, and to vest the authority to impose landing conditions in some department of the Government. The Secretary of State would be the proper official of the Government to deal with such permits.

Periods of Concessions.

There was another important point requiring consideration, namely, the substitution of some fixed period in the permit in place of the present power of revocation. At present the President had the right to revoke a permit at any time or for any reason he might decide. He did not assume that the President would ever exercise such rights without good cause, but there was a large element of risk in accepting landing permits containing such arbitrary powers. He was quite willing to admit the propriety of a stipulation giving the Government the right of revocation for any violation of the conditions imposed, but the powers of revocation should not be as broad as those contained in the present form of permit. Cables were not like portable machinery, which could be shifted about from place to place without more damage than ordinary expense, but once they were laid in a certain position, and perhaps millions of dollars had been invested on the security of receiving a landing permit, it might very well be impossible to remove or divert the cables if the Government decided to revoke the landing permit. The present practice imposed a risk which he did not think private companies should be required to accept. Once the conditions were agreed upon with the Government they should stand for a definite period, unless there was a deliberate violation of them, or national interests in time of war made revocation or suspension justifiable. In England landing permits had always been issued for a specified period. The original permits to his company in England were issued for 31 years, and naturally gave the company a feeling of security. The present permits were issued for five years and they felt that that period was entirely too short and should be extended. They hoped that as a result of the general discussion of encouraging the development of cable communications, it would be possible to prevail upon England to let landing permits run for longer than five years.

Another objection they had to the present proposed form of landing licenses issued by Great Britain was the right to control their rates. That was a new departure. They had no objection to a stipulation prohibiting any increase in rates without Governmental consent, but in considering a proposition to give the British Government control over their rates they were not unmindful of the fact that the British Government was now engaged in competing with them in the transatlantic cable business and that England could then discriminate against American-owned cables to the advantage of her Government-owned cables.

His company was in hearty sympathy with any programme to discourage exclusive or preferential rights. Their policy had always been anti-monopolistic, and strongly in favour of competition. The question, however, as to whether the United States Government should adopt a rigid policy against companies which had monopolies, or exclusive rights, or link up with companies having such exclusive rights, was one which required careful consideration. Each case must be decided on its merits. He believed that any company which desired to land cables in the United States, or on American territory, which had exclusive or preferential rights, should be required to waive such rights, but where it was found necessary to link up with companies having exclusive rights, in order to reach territory which could not otherwise be joined up with the United States, due consideration should be given to the particular facts in each case. Unless they had received the co-operation of foreign companies the Pacific cable could not have been laid when it was, and it was doubtful whether it would have been laid up to the present time. After the cable was laid messages passed only through three American stations to the Philippines and Japan (namely, Hololulu, Midway, Guam), and four American stations to China (namely, Hololulu, Midway, Guam and Manila). The rates were also reduced and other advantages accrued.

Cable Landings at the Azores.

Mr. Mackay said there were no exclusive rights at the Azores which would prevent an American company from obtaining rights to land. The Portuguese Government took up the position that all landing rights at the Azores should be made to the British company, which was the pioneer company at the Azores, and that the British company might in turn assign its rights to any American or any other company. The question of obtaining landing rights was therefore one of negotiation between the United States and Portuguese Governments, and as the Azores was the natural gateway to southern Europe, they trusted that the United States Government would succeed in inducing the Portuguese Government to grant landing rights direct to American companies.

German Cables in the Atlantic.

Referring to the former German cables, seized by England and France during the war, he said his company were largely interested in the question by reason of their actual investment in the cables and contract relations with the German Cable Company. The two German Atlantic cables were laid in 1900 and 1904 and ran from Emden to the Azores (1 960 miles), and thence to New York (2 357 miles), where they were brought into their cable station and operated by the Commercial Cable Company under a contract dated August 3, 1899. That contract had still 20 years to run, and it was not only valuable to them for its financial benefits, but those two cables, operated with the greatest efficiency, were great assets to American trade with Germany and North Europe, as was evidenced by the fact that 32 per cent. of their total cable traffic was transacted between the United States and Germany. The sections of those cables between Emden and the Azores were cut originally in the English Channel immediately following the declaration of war between Germany and England. In March, 1917, they were cut at points 648 and 610 miles respectively from New York, and one of them was diverted by the British Government into Halifax, Nova Scotia, and since July 1, 1917, had been used by the British Government as part of its Imperial telegraph and cable system. The French Government did not remove the other German cable from their shores, but in August, 1917, the French Cable Company communicated to them a request from the French Government to turn the cable over to the French Company in New York. A protest was lodged against the proposed seizure with the Department of State on August 9, 1917, but in November, 1917, the French cableship "Jeramec" arrived at New York, and cut both of the German cables approximately 5 miles from their landing place at Far Rockaway, New York, and diverted one end into the French Company's landing place at Coney Island. What became of the other end, namely, the end which was part of the 648 miles of cable cut out of circuit by the diversion of the cable by the British into Halifax, he did not know. In the meantime the French Cable Company applied for and received a permit from the United States Government to land a cable in the United States, ostensibly for connecting with the German cable seized by the French Government. It was only necessary for the French company to lay a short length of cable from the French Cable Company's landing place at Coney Island to the point where their cableship cut the German cable off Far Rockaway and establish connection. The German cable seized by the French Government was taken from their terminal station at Far Rockaway, New York, to the French Cable Company's terminal station at Coney Island, New York, before that company had the necessary equipment to operate it, and it remained idle for over 12 months during the war. In fact, it was not put into operation by the French Cable Company until March, 1919, and even now it was not able to operate it with the same efficiency with which it was operated by the Commercial Company prior to the war.

Appeal to International Law.

He was advised that under international law there was grave doubt as to the legality of seizing enemy cables during war, but there must be some differentiation made between the legality of seizing enemy cables connecting an enemy country (Germany) with neutral territory (the Azores) and seizing enemy cables which only connect neutral or allied nations, namely, the United States and the Azores. There was no rule of international law or practice of nations allowing belligerents to appropriate the property in cables, even though they had been cut and diverted in the course of military operations.

There might be a division of opinion as to whether enemy cables between neutral and belligerent territory might be cut on the high seas, but as to enemy-owned cables between two neutrals or allies, such as between Portugal (the Azores) and the United States, there could have been no necessity of war justifying the cutting and diversion of either of those cables, as they were not susceptible of use by Germany for the conduct of war. Both cables were cut between 600 and 700 miles from New York, indicating that they were not cut for interrupting communication under the necessity of war, but for their subsequent diversion and appropriation. The actual diversion of the cables took place in July, 1917, by the British, and November, 1917, by the French, after the United States had entered the war. Neither England nor France could justify the seizure of those two German cables between the Azores and North America as a war necessity.

German-Dutch Cables in Pacific.

Mr. Mackay dealt briefly with the situation in the Pacific respecting the cables seized by Japan between Guam, Yap and Shanghai (2 340 miles laid in 1905). The Deutsch-Niederlandische Telegraphengesellschaft, a company formed in Germany, but largely supported by Dutch capital and subsidised by the German and Dutch Governments, owned cables running from Guam to Yap, there diverging, one line going south to the Dutch Indies, and the other going north to Shanghai. The Commercial Company operated the Guam end of that cable under a contract with the German-Dutch Company. All messages for the Dutch Indies were sent via Yap under normal conditions, and during interruptions of their cable between Guam and Manila, which cut off all communication with the Phillipines and China by their route, they diverted traffic via Yap to Shanghai over the German-Dutch system. Hence, those cables were very important in maintaining uninterrupted communication with China and the Philippines, and the seizure of Yap by the Japanese, and the diversion of the cable into one of the Japanese islands, deprived them of that alternative route. There was only one other alternative route to China, and that was via Japan. If Japan continued to retain the Yap-Shanghai cable, it would mean that all traffic destined to China and the Philippines during interruptions of their Guam-Manila cable would have to transit Japan. No part of these cables in the Pacific touched Japanese soil, but one end touched American territory (Guam), and yet the Japanese had seized that German Pacific cable system to the detriment of American trade with China and the Philippines.

Control of Messages and Extensions.

The remainder of Mr. Mackay's statement was devoted to an examination of the censorship and control of messages to and from Europe, the recognition of route indications and the reasons why America and the American cable companies should not adhere to the International Telegraph Convention. In conclusion, he said his Company was fully alive to the importance of providing ample facilities, and its past policy had been to furnish facilities in advance of requirements. Before the war the Company had made all arrangements for laying another transatlantic cable from New York via the Azores, either to France or England. Its preference would have been to lay it to France, to provide additional communication with the Continent, but as the conditions which France imposed were not as liberal as those under which they could lay and work their cable in England they had come to the conclusion to lay it to the latter country. They had obtained landing permits at the Azores through the Europe and Azores Company; they had prepared specifications and obtained bids from the contractors, and were on the point of concluding arrangements when war intervened. That made it impossible to complete the laying of the new cable within the time stipulated in the Concession. Since the war the cost of cables and laying them had increased about 250 per cent., and labour conditions were still abnormal. Prior to the war the volume of traffic and the various classes of cheap services resulted in revenues considerably less than they had been during the war, and it was his belief that long submarine cables could not be laid across the Atlantic at present prices and pay their way under normal traffic conditions. However, they fully intended to increase their facilities both in the Atlantic and Pacific.

Electricity Districts.

The adjourned inquiry into the schemes for the reorganisation of electricity supply in the West Lancashire and Mersey District was resumed by the Electricity Commissioners on Tuesday.

The time for submitting schemes for the improvement of electricity supply in the Mid Lancashire District has been extended until May 31, for the South-East Lancashire District until July 30 next, and for the North-East Midlands Area until June 30.

West Riding District.

The Electricity Commissioners will hold an inquiry at Leeds, on Tuesday, April 12, and following days with reference to the area to be included in the proposed West Riding (Aire and Calder) Electricity District, and into the schemes submitted by the Leeds Corporation and the Conference of West Riding Local Authorities for effecting an improvement of the existing organisation for the supply of electricity in the district and for the formation of a Joint Electricity Authority; and also into certain proposals submitted by the Yorkshire Electric Power Company for effecting an improvement of the existing organisation for the supply of electricity, &c.

Representations or objections with regard to the said schemes or proposals should be addressed to the Secretary, Electricity Commission, Gwydyr House, Whitehall, London, S.W. 1, by the 31st inst.

The Commissioners will, at the same time, inquire into an application made by the Yorkshire Electric Power Company for consent to the establishment by the Company of a new generating station at Ferrybridge in the Rural District of Pontefract.

The technical scheme of the conference of Local Authorities owning and operating generating stations in the West Riding (Aire and Calder) district was adopted at a meeting on the 24th ult. It is based on the formation of a Joint Electricity Authority for the area and the purchase of the undertaking of the Yorkshire Electric Power Company. The main transmission pressure will be 33 000 V and the local secondary transmission pressures 11 000 and 6 600 V. The generating stations at Bradford, Halifax, Huddersfield, Leeds, Thornhill and Wakefield will ultimately become the distributing centres in the area, and extensions from these will be made, mainly by 33 000 V cables, to sub-distributing centres as required. A programme of main transmission cable extensions to be carried out each year, until August, 1926, is set out and also lists of the generating stations to be discarded and of those to be utilised during the reconstruction period, in conjunction with two new capital stations (at Wakefield and at Esholt, near Apperley Bridge on the Aire), which would be completed by August, 1924.

Certain extensions of plant are recommended as follows: Two 15 000 kW turbo-alternators at Bradford, two 10 000 kW sets at Halifax, one 10 000 kW set at Huddersfield, two 12 000 kW sets at Whitehall-road, Leeds, and three 12 500 kW sets at Thornhill, and when these additions are made the total capacity of the stations will be 229 500 kW Three 20 000 kW turbo-alternators will be erected at the Wakefield capital station and two similar sets at Esholt, but the ultimate capacity of each of these stations will be 100 000 kW. Provision is being made for the supply of energy in bulk for tramways and also for traction on railways when required. The capital stations would be erected by the Minister of Transport, but the money expended would be repaid within five years by the Joint Authority. There are no financial details, but there is an estimate of the capital expended by the Yorkshire Electric Power Company, which has submitted a scheme of its own. The company urge that there is no necessity for a Joint Electricity Authority, and that they are willing to co-operate in developing electricity supply and that they are prepared to meet all demands for bulk supply, &c. The position of the company is ably set out and it is urged that they should be allowed to erect their proposed generating station at Ferrybridge.

Greater London Area.

At a special meeting on Tuesday the conference of local authorities owning electricity undertakings in the Greater London district considered proposals for the formation of a Joint Electricity Authority and also a technical scheme prepared by Sir Alex. Kennedy and Messrs. G. W. Partridge, J. H. Rider and C. H. Wordingham, in consultation with Sir Philip Dawson. The Electricity Commissioners have fixed March 31 for the deposit of, and June 7 (provisionally) for the inquiry into, schemes for the area, which contains 1 700 square miles and has 84 electricity undertakers, apart from railway and tramway stations. In 1919-20 total maximum demand was 320 600 kW and the units sold amounted to 608 millions. The capacity of existing plant is 480 000 kW, but 255 000 kW is being erected or on order. Information is given as to the costs of production, fuel consumption, present and future demands, &c. By the time any new capital station is ready the total demand in the area will be 470 000 kW and by 1931 it will be 600 000 kW.

In preference to shutting down all existing local stations and taking the supply from new capital power stations erected on suitable sites the Engineering Committee recommends the retention and development of certain existing stations, the remainder being gradually shut down and new capital stations being established as required. It points out the improbability of any capital station being erected and made fully ready for work before the winter of 1925, and with the object of extending and, if possible, cheapening the supply from existing stations during the next few years it proposes a scheme in two stages. In the first stage 34 existing stations would be progressively shut down and supplied in bulk by means of inter-connecting cables from the remainder. Meantime, the erection of four new capital stations would be started, three on the north side of the Thames and one on the south side, on sites (three to the east of Blackwall Tunnel and one an up-river site), which have been selected not only as possessing the necessary features for cheap generation, but as being in such positions with regard to the load centres as to reduce the cost of trunk transmission mains to a minimum.

As these stations became ready for work the second stage would be reached, and 26 of the remaining stations would be progressively closed. Of the remaining 17 stations in the area two would be reconstructed and enlarged to act as capital stations, seven would be retained as auxiliary generating stations in conjunction with the new capital stations, and the remaining eight, near the outskirts of the area, would have to be kept at work for a considerable period to serve local demands.

The installed capacities of the capital stations would vary, in the first instance, between 70 000 kW and 200 000 kW, mostly in units of 25 000 kW. Several of the sites would permit of much larger stations if required. The estimated capital expenditure by the Joint Electricity Authority for the first stage (ending 1925-6) is put at £13 050 000, including the first portions of the capital stations with an installed capacity of 200 000 kW, and for the second stage (ending 1930-31) at £30 750 000, including an installed capacity of 875 000 kW in the capital stations.

Electric Driving of Rolling Mills.

At a meeting of the Sheffield Society of Engineers and Metallurgists to which the Local Section of the Institution of Electrical Engineers were invited, a Paper on "Electrically-driven Rolling Mills" was read by Mr. G. M. Brown. Discussing the question of the conversion of existing steam driven rolling mills, the author said it was extremely difficult to estimate the electrical power required, as on the introduction of an electric motor it was often found that the increased speed of rolling due to the non-pulling up of the motor necessitated more power than with the steam engine. Nevertheless, the electrically-driven rolling mill was undoubtedly in the long run the cheapest and best proposition, especially, as was not generally realised, for heavy cogging work. In considering flywheel design the inertia of the motor must be taken into account in the first instance, so that allowance could be made for the extra accelerating currents required, and the armature should, therefore, neither be too large nor too small. Very rapid acceleration or deceleration were not required or desirable. Reversing on ordinary installations from full speed in one direction to full speed in the other could be done easily in 2¼ seconds.

The Tramway Wages Inquiry.

We are not surprised to see that the Report of the Court of Inquiry into the recent application of the tramway employees for an advance in wages of 12s. a week does not support the claim. It is pointed out that the wages increases have not advanced at the same rate as the cost of living figure since July, 1914, and the application put forward in October, 1920, was intended to compensate for the rise that had taken place since the last wages settlement in March, 1920, and to meet the further increase that was anticipated. It is submitted that, in view of the unsatisfactory condition of the industry and under all the existing circumstances, the claim would be met by the following recommendations:—

(1) That the Industrial Council should examine the position of those undertakings which have not observed previous agreements and arbitration awards in regard to wages advances, and the undertakings should be advised that if possible the advances should be paid in full. (2) That the present wages standard should be maintained both as regards municipalities and companies until Dec. 31, 1921. (3) That the Industrial Council should consider the question of standardisation in the near future, dealing with the various grades of employees in relation to each other. (4) That the Council should examine the circumstances of the lower-paid grades.

Electric Lifting Magnets.

The employment of electric lifting magnets for handling loose metal sheets, plates and billets, lacks the element of novelty, but judging from the Paper which Major F. A. Hooper recently read before the Staffordshire Iron and Steel Institute, notable progress has been achieved in this field of electrical enterprise. The lifting magnet, he said, according to the account given in the "Hardware Trade Journal," made it possible to operate cranes at their maximum speeds continually, and in numerous cases as many as 60 to 70 trips per hour were being performed by magnet cranes.

Magnets first came into general use in America about 20 years ago, and Germany followed quickly. In this country a number of steelworks' engineers constructed magnets of their own, with varying success, until some enterprising electrical engineer, realising their possibilities, took up their manufacture seriously, and, after a considerable amount of experimental work, produced the lifting magnet similar to that now in use. Three types have been evolved, namely, the circular magnet for handling loose metal, the rectangular magnet for handling sheets and plates, and the bi-polar magnet for handling sections and billets.

The objective of the modern lifting magnet maker was to produce an appliance which combined great maintained lifting capacity with the least possible dead weight, and without an unduly high current consumption. In Germany a number of magnets were being constructed with aluminium instead of copper coils, the advantage claimed being that the oxidisation of the outer skin of the aluminium formed sufficient insulation, thereby cheapening the cost of construction considerably. Actual performances showed that when dealing with solid loads a magnet would lift as much as five to fifteen times of its own weight. A small magnet 26 in. in diameter, weighing 6 cwt., would lift a block of steel weighing 100 cwt., and a large magnet of 66 in. diameter, weighing 60 cwt., would lift a block of steel weighing 15 tons.

Legal Intelligence.

The Poulsen Arc Patent.

On Thursday last Mr. Justice Sargant heard an application for the prolongation of letters patent No. 15 599 of 1903, granted to Valdemar Poulsen for improvements relating to the production of alternating electric currents. The applicants were Mr. Christopher Hage, Copenhagen, the British & Overseas Engineering Syndicate, Ltd., and the Poulsen Wireless Telegraph Company. The Board of Trade, Mr. C. F. Elwell and the Radio Communication Company opposed the application.

Mr. J. Hunter Gray, K.C., and Mr. Trevor Watson appeared for the applicants: the Attorney-General and Mr. Jas. Whitehead for the Board of Trade; and Mr. Courtney Terrell for Mr. Elwell and the Radio Communication Company.

Mr. Gray said the application was made under the 1919 Act, and the subject of the patent was usually spoken of as the Poulsen arc. The arc lamp, with certain devices, was and had been used for many years for generating oscillations for wireless telegraphy. The Fleming valve was part of the receiving side of the apparatus, and the Poulsen arc was part of the transmitter. Having outlined the steps taken to make wireless telegraphy a commercial success, and referred to some of the leading patents, Counsel said that the Poulsen invention was a great advance, as they got a continuous oscillation of equal amplitude. Poulsen suggested the use of hydrogen or coal gas as an atmosphere in which the arc was to burn, and the result was that they obtained oscillations with two or three, or four times the energy, and consequently they were in a position to send those disturbances over much greater distances than was possible in the case of Mr. Duddell's invention, which was the beginning of the industry. Mr. Poulsen did more than that, because it was not merely a question of getting the oscillations bigger, but he wanted to get them so that the oscillation was such that the arc broke altogether. The method of obtaining the improved result was because Poulsen not only had hydrogen or coal gas, but also a strong magnetic field, and it was the combination of those two devices with the Duddell invention which was the invention claimed in Poulsen's specification.

The Attorney-General said they did not propose to make any attack upon the validity of the patent, and Mr. Terrell said that was also the attitude of the other opponents.

The Attorney-General: There is another point of a preliminary character. We shall have to submit that this is not a case within the Act of 1919, inasmuch as there has been no loss or damage suffered in consequence of the hostilities.

Mr. Gray said that Duddell's great invention was, no doubt, the beginning of the work Mr. Poulsen had done. Duddell's was not a practical system in any sense for wireless telegraphy; as often happened with a pioneer invention, they got the kernel of the idea which started people working out the idea into a practical one, and Mr. Poulsen had done that. The Poulsen arc, as worked to-day, was a most valuable commercial and industrial invention. During the war many aeroplanes were continuously sending telephone messages down to the ground, and now wireless telephony had extended very much. Telephonic messages had even been transmitted from here to America, and quite commonly for shorter distances. His lordship might wonder how it was that they were applying for an extension, especially when they had made no money up till now. He had a long affidavit by Mr. Corby, the secretary of the Poulsen Wireless Telegraph Company, and he would call Mr. Gandil and Mr. Hage, the legal owner of the patent. The British Overseas Engineering Syndicate were at the date of their summons the beneficial owners, but the Poulsen Wireless Telegraph Company were now, under an assignment, really the beneficial owners. For some years from the beginning of the life of the patent the owners apparently had not got the money, or possibly if they had the money, they did not take the proper steps to get it pushed; but many approaches were made to Government bodies and other people to take up the installation of the system, and also to other people to finance it; but there seemed to be a great reluctance on their part to venture money on a thing which, at the moment, had not been proved in a commercial way, especially as the Marconi system was then realised as being a commercial matter, and was used exclusively on board ships. When the war broke out there were altogether six stations which had been built, and were worked on behalf of the Poulsen Company under licence from the Post Office. Applicants said that if the war had not taken place they would have done a large business with the Admiralty, the War Office, the Post Office and the India Office. They would have established a system on shore to ship stations for telephonic communication with merchant ships, &c.

Evidence was then given by Mr. John St. Vincent Pletts, consulting engineer and formerly head of the patent department of the Marconi Wireless Telegraph Company; Prof. E. W. Marchant, Mr. V. Gandil and Mr. Francis A. Walrond.

In giving judgment his lordship said the summons was brought under very exceptional circumstances. The patent expired as long ago as July 14, 1917, and the originating summons was only taken out on July 5, 1920, or 3 years after the expiration of the patent and only two years from the utmost time to which he could possibly extend the patent. The Post Office had been working the system to some extent and he thought the evidence showed that Mr. Elwell had also been working under it. Therefore he ought to be careful before he granted an extension which might hamper persons who had been operating on the assumption that the expired patent was at an end. The earlier history of the patent was extremely complicated. At the outbreak of war, Mr. Hage was the sole owner of the patent. Then rather a complicated transaction was entered into under which the two petitioning companies—the British and Overseas Engineering Syndicate and the Poulsen Wireless Telegraph Company—came into the story. Under certain agreements the English patents and some foreign patents were sold to the Syndicate for the purpose of the Syndicate re-selling them to the Poulsen Company, and the Syndicate, which had a comparatively small capital, undertook some extraordinarily onerous obligations towards the Poulsen Company. Those obligations the Syndicate were not in a position to perform, but by a deed of covenant entered into between the Marconi Company and the Poulsen Company, the Marconi Company undertook to fulfil the obligations of the Syndicate as regards the provision of capital, &c.; the result was that the Poulsen Company became in a position to force from the Marconi Company the provision of no less than £150 000 cash for developing the patent. In fact, the Marconi Company had subscribed for 150 000 £1 shares of the Poulsen Company and they had paid up 6s. 9d. on each share; they had provided about £50 000, and they were liable for a further sum of £100 000. It seemed to him quite plain that by reason of the practical amalgamation with their rivals, or the practical cession of their rights to the Marconi Company, the Poulsen Company did become in a position to command the whole of the capital necessary for the adequate development of its patents; and that, therefore, there was no justifiable complaint of loss due to the Treasury restrictions. It seemed to him a curious state of circumstances that a company not carrying on business or in existence before the war, should claim loss or damage by reason of the war, and he thought that the section of the Patents & Designs Act of 1919, which was relied on did not apply to the application. As regards Mr. Hage, he, having been the previous owner, had merged any position that he had in that respect in his position as a shareholder of the Company, and he could only be compensated by reason of some extension of the patent being granted to the Company. But apart from that, he did not think that any substantial *prima facie* case had been made by the applicants for saying that they have had a smaller user of their patents than they would have had if the war had not broken out. His lordship then dealt with the user of the patent by Government departments. As far as the Admiralty and the War Office were concerned, the evidence led him to think that there was, in consequence of the war, a much larger use on the part of both those Government departments than if the war had not occurred, and, in his judgment, there was every reason for thinking that so far from the war having prejudiced applicants in that respect it enormously increased the user by the two departments in question. It was possible there might have been other users, but the applicants, or rather their predecessors in title, down to the time of the commencement of the war had not been making any considerable commercial use of their invention. He did not see any real reason to think that the result of the war was, as regarded general commercial user, to interfere with any reasonable prospects of the business that was enjoyed by applicants on the outbreak of the war. He dismissed the application with costs as towards the opponents, but without costs in regard to the Crown.

Commercial Topics.

Trade Catalogues for Guatemala.

According to H.M. Minister at Guatemala there is a great local demand for British machinery, especially for coffee estates, for bootmaking, cabinet-making and the metallurgical industries. There is also a demand all kinds of tools, that if firms will supply him with catalogues he will for be glad to see that they reach the right quarters. Catalogues should be addressed to Sr. Ministro de S.M. Britanica, Ciudad de Guatemala, Republica de Guatemala. H.M. Minister also states that his general impression is that conditions in Guatemala are about to become very favourable for British trade.

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International Credits.

It is announced that Sir Drummond Fraser has been appointed organiser, under the League of Nations, of the Ter Meulen scheme for the establishment of international credits. At Manchester on Monday he explained to the members of the foreign commercial missions the principles of the scheme and the methods by which it was proposed to put it into operation. Other steps are to be taken in order to make known the benefits to be derived from it.

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Development of International Trade.

Perhaps no greater service could be rendered to the country at the present time than the evolution of a really workable scheme for the restoration of international trade and the development of British exports. The two things are inter-related, and though there are great difficulties in the way, we feel that something should be done at once to revive and expand the export trade. We are, therefore, pleased that the subject, which is one of great urgency and importance, has been tackled by the Federation of British Industries.

In a memorandum by the Federation they declare their hearty sympathy with the efforts to devise workable schemes, whereby the unusually long trading credits essential to the recovery of the more impoverished importing countries might be financed and the individual exporter's risk of eventual loss be reduced to bearable dimensions. They entertain no extravagant expectations of a speedy restoration of world trade and prosperity by any such artificial means. The best that can be hoped for is that the special financial accommodation and facilities provided may have the effect of stimulating into activity the forces of wealth-productive industry by which alone the fortunes of impoverished countries can be repaired, and the requisite media of international exchange be continuously provided. The extension of special import credits should be governed by conditions calculated to impel the importing country to eschew the folly of trying "to print" prosperity and to pursue a policy that may reasonably be expected to place its finances and currency on a sound basis. It must be borne in mind that, no matter how ingenious and workable the measures of relief may be, their ultimate effect on our own export trade will depend upon our ability to sell our goods at prices which the importer can afford to pay, whilst deriving a fair profit from the transaction.

Subject to these provisos the Federation approve the principle of an international scheme to provide import credits to the impoverished countries of Europe. They also approve the general principles of the Ter Meulen scheme, and deplore the delay in organising and carrying a scheme into execution. They therefore urge H.M. Government, through their delegates at the conference now sitting in London, to bring strong pressure to bear in the proper quarter with the object of expediting the introduction of the Ter Meulen scheme with necessary amendments.

In addition, the Federation submit, that without waiting for the Ter Meulen schme to come into operation, which will probably take some months, prompt action should be taken to perfect and give effect to a scheme to finance export credits and insure the British exporter against eventual loss due to the failure of the importer to meet his obligations. Experience has shown that the scheme in operation under the Overseas Trade (Credits and Insurance) Act, 1920, does not fulfil the requirements of the exporter, owing to the following causes: (*a*) It throws as large a proportion as 20 per cent. of the risk on the exporter, as the insurance of the 20 per cent. risk is in practice most difficult. (*b*) The department's advances and expenses, until completely discharged, constitute a first charge on the proceeds of the bills accepted by the importer whereby the exporter has to bear the whole of any eventual loss in excess of 80 per cent. of the total amount payable by the importer. (In the opinion of the Federation payments received from the importer should be divided between the Department and the exporter, in the same proportion as their share of the risk.) (*c*) The bills of exchange deposited by the exporter with the department are required to be "accompanied by a letter of guarantee of the importer's bank to the effect that they will be accepted, and the stipulated security deposited immediately upon the presentation of the documents to the importer." (*d*) Merchants are not allowed to include their overhead charges in their costs for obtaining an advance.

Whether the Act be amended to meet the above objections, or be superseded by a new Exports Credits' scheme, the Federation think provision should be made for insuring the exporter against loss, in consideration of a suitable premium. Such an insurance scheme would involve the co-operation of the Government, banks, acceptance houses and insurance companies, through a central organisation set up for the purpose, which should assume the whole of the risk and take the whole of the profits accruing from the insurance business done. There is no reason why such an Export Risks Insurance Scheme should be limited to certain impoverished countries in Europe.

Electricity Supply.

HESTON and ISLEWORTH Urban Council is recommended to borrow £4 000 for prospective extensions of mains and about £2 050 for mains and services to specified premises in the district.

BURNLEY Watch Committee have refused a request of the Electrical Trades Union that all ELECTRIC AND CINEMA PLANT at places of amusement should be in charge of competent electricians.

DARWEN Town Council have applied to the Electricity Commissioners for sanction to borrow £1 524 for extensions of the supply mains. An agreement has been made with Blackburn Corporation for a supply of electricity in bulk to Darwen.

The proposal of the WORCESTER Corporation to form a separate district has been abandoned, as the authorities with whom they had been in conference refused to co-operate. The Council objected to the inclusion of the city in the South West Midlands area.

The BURTON ON TRENT Gas and Electricity Committee recommend the Corporation to approve a scheme for the extension of the electricity works, with a view to the supply of the South Derbyshire district, subject to the ability of the Finance Committee to find the money.

For the nine months ended Dec. 31 the profit of BIRMINGHAM Electric Supply Department was £39 500. Of that surplus, £32 500 was realised during the December quarter, when local trade was fairly active. Since the new year there has been a falling off in the consumption of current, due to trade depression, and in view of present conditions the Committee has decided not to make any contribution to relief of rates.

It is satisfactory to be able to announce a reduction in the charge for electricity in view of the high price of coal and other charges. SHEFFIELD is, however, able to reduce the charges for electricity on all units charged 2d. per unit and under by the equivalent of 0·17d. per unit. The reduction will apply to about 80 per cent. of the total units sold. The Electricity Supply Committee proposed to carry extensions at a total cost of over £54 000.

An interesting ELECTRICAL EXHIBITION will be held at the Town Hall, Aylesbury, from March 21 to 24 inclusive. There will be practical demonstrations of electric cooking, heating, washing, vacuum cleaning, &c., and there will be good displays of electrical appliances for the office and domestic purposes. On the 22nd inst. lectures will be given on "Electricity in the Home" by Mr. J. W. Beauchamp, and on the following day upon "Electricity applied to Agriculture" by Mr. W. T. Kerr. Electric-lighting sets, electric vehicles and small farm plants will be shown in operation.

ELECTRICAL DISTRIBUTION OF YORKSHIRE LTD., is applying to the Electricity Commissioners for SPECIAL ORDERS to authorise the company to generate and supply electricity for all purposes in (1) Guiseley and Yeadon urban districts; (2) Gildersome, Hemsworth, Birkenshaw and Drighlington urban districts; (3) Clayton West, Skelmanthorpe, Emley, Kirkburton, Farnley Tyas, Flockton, Lepton, Whitley Upper and Kirkheaton urban districts; and the parishes of Hartshead, Clifton, Norwood Green, Coley and Fixby, in Halifax rural district; (4) Knottingley, Ardwick-le-Street, Tickhill, Darfield, Monk Bretton and Royston urban districts; Thorne, Hemsworth, Pontefract, Doncaster, Rotherham, Wortley and Kiveton Park rural districts; and the parishes of Woolley, Notton and Carlton in the Barnsley rural district; (5) Denholme, Queensbury, Luddenden Fort, Mytholmroyd, Stainland-with-Old Lindley, Slaithwaite, Marsden and Meltham urban districts; and (6) a special order authorising amendment of the Selby and District, Stanley, Featherstone, Garforth, Horbury, Otley, Penistone and Rawdon Orders by increasing the prices which may be charged for current.

Electric Traction.

The conversion of the HASTINGS sea front tramway route to the overhead system has been completed, and the line has been opened for traffic.

For the ALL-NIGHT TRAMWAY SERVICE IN GLASGOW the fares are to be increased to double those in operation during the day, with a minimum fare of two pence. In order to provide work for the unemployed in the City, the Sub-Committee on Tramway Extensions recommend the Tramways Committee to proceed with several of the extensions of the tramway system which have received Parliamentary authority, but have not yet been constructed. It is also recommended that Parliamentary powers be sought for an extension of the existing system from London-road to Mount Vernon.

According to the Highways Committee, the CHEAP MIDDAY FARES on the L.C.C. TRAMWAYS have been successful, and they have stimulated traffic on the Council's tramways. During a five-day period, three months before the introduction of the twopenny maximum fare, 600 944 passengers were carried in the midday hours and the receipts were £5 988. During the five days, Monday to Friday, ended Jan. 26 this year, the number of midday passengers was 1 022 638 and the receipts were £8 769. Certain additional mileage was run during the slack hours of the day to meet the requirements of the midday traffic, but the cost of operating this mileage for the period ended Jan. 26 was only £229.

Increased fares came into operation on the Council's tramways in September last. While it is possible that receipts during the middle of the day, had the cheap 2d. fare not been introduced, would have gained to some extent, the Committee is satisfied that the innovation has been of substantal financial benefit. As regards rush-hour traffic, there is still insufficient accommodation for passengers; but although there has been a considerable increase in the number of passengers travelling at the cheap fares, there is still ample accommodation for more passengers.

Institution Notes.

Prof. J. A. Fleming, F.R.S., will deliver a course of six lectures on Wireless Telegraphy and Telephony by Continuous Waves at University College, beginning on Wednesday, April 27, at 5 p.m., and continuing on subsequent Wednesdays at the same time. Applications for tickets of admission, for which the fee is two guineas, should be made to Mr. W. W. Seton, at University College, Gower-street, London, W.C.

The British Research Association for Liquid Fuels for Oil Engines Industry has been approved by the Department of Scientific Research. The association is to be registered as a non-profit sharing company, the promoters have applied for a licence to omit the word "Limited" from the title. The secretary of the Organising Committee is Mr. Percy Still, M.I.E.E., 19, Cadogan-gardens, S.W. 1.

The University Colston Society Committee, Bristol, has changed its name to the Colston University Research Society. Originally its funds were applied to general help for the college, and later the university, but they are now devoted entirely to facilitating research work in the university. The society's annual dinner will take place on May 23, when Prof. Sir William Bragg will be the guest.

The Birmingham and District Electric Club held their annual dinner at the Grand Hotel, on Friday last, about 100 members and friends were present, Mr. H. C. Wynne, the President of the Club, was in the chair. In response to the toast of the City of Birmingham Mr. R. A. Chattock expressed his confidence in the future of electricity supply in Birmingham, notwithstanding the present financial stringency which had delayed their projected extensions.

The Prime Movers Committee of the National Electric Light Association are investigating methods of speedily uncoupling an alternator from a turbine in turbo-generator units, so that the generator may be used as a synchronising condenser to improve power factor during such times as its output as a generator is not available. Some such method might also be of advantage in the case of breakdown occurring on either the prime mover or the alternator.

The second annual dinner of the Newcastle and district section of the Electrical Power Engineers' Association was held last week, Mr. A. W. Crompton presiding over a company of about 100, and Mr. G. L. Porter was presented with a silver coffee-pot and gold watch in recognition of the valuable services he had rendered to the Association. The local membership was now 372. In reply to the toast of "The Guests," Mr. A. S. Blackman (electrical engineer to Sunderland Corporation) said that the need for co-operation between master and man was now being recognised throughout the country, and it was essential to the electrical industry that they should stand shoulder to shoulder from the lowest workman to the highest official.

Personal and Appointments.

Mr. A. J. S. Waddell, of Manchester, has been appointed generating engineer at the Valley Road Electricity Works of Bradford Corporation at a salary of £500 per annum.

Major Percy Simmons has been elected chairman of London County Council in succession to Mr. John Gilbert. Mr. F. R. Anderton becomes vice-chairman and Mr. Howell J. Williams is deputy chairman.

Mr. Harold E. Mortimer, A.M.I.E.E., has resigned his position as contracts engineer with Messrs. Edmundsons Electricity Corpn., Ltd., and has joined the board of directors of Messrs. Baxter & Caunter, Ltd., 219, Tottenham Court-road, W. 1.

Sir Andrew Ogilvie, late Second Secretary of the Post Office, who was a member of the Departmental Committee on Telephone Rates, has been invited by the London Chamber of Commerce to join its telephone advisory committee.

Business Items, &c.

The telephone number of the Automatic and Electric Furnaces, Ltd., is now Museum 4187.

The offices of Messrs. Brown, Boveri & Company, Ltd., and of their Associated Companies, Power Rectifiers, Ltd., Scintilla Ltd., and the A. S. Refrigerating Machines, Ltd., have been removed to Trafalgar House, Waterloo-place, London, S.W.1

The technical and commercial departments of the Electrical and Engineering Development, Ltd., are being removed to 1-3, Shelgate-road, London, S.W.11, where future communications should be addressed. Telephone number: Latchmere 4216. The company is retaining a private office at 82, Victoria-street, S.W.

Messrs. E. H. Bissell & Company, Ltd., 212a, Shaftesbury-avenue, London, W.C. 2, have been appointed sole agents for the following French manufacturers: Messrs. Salmon & Company, of Esternay, manufacturers of porcelains for the electrical industry, and the Manufacture d'Isolants et Objets Moules, of Paris, manufacturers of moulded insulated articles for the trade.

Owing to the lower cost of raw material, the Bastian Electric Company, Ltd., announce a reduction in their list prices of Bastian tanks and accessories by 10 per cent. These Bastian tanks are slow-running geysers, which feed into a heat-insulated storage vessel, and the arrangement is such that scalding hot water at a constant temperature is always obtainable; the heating element, which is arranged to be in circuit continuously, being guaranteed for four years. Upwards of 200 of these tanks have been installed and they are proving reliable and satisfactory under working conditions.

Miscellaneous.

The following companies were struck off the register of joint Stock Companies on March 4:—British Radium Corporation, Electric Wiring and Fittings Company, Radiumlamp.

The new Longham (London) telephone exchange was opened on Saturday, when about 1 300 telephone subscribers connected with the Mayfair Exchange were transferred to it. The new exchange, which has room for 1 900 circuits, is intended to relieve the pressure on the Mayfair Exchange.

At the 31st annual meeting of the British Corporation for the Survey and Registry of Shipping, at Glasgow last week, the chairman of the Technical Committee (Mr. Fred. J. Stephen) said that among the work built during the year or on order it should be noted that four merchant vessels had been or would be fitted with turbo-electric propelling plant.

The members of the Victoria Works Athletic Club (Messrs. Johnson & Phillips, Ltd., Charlton, London, S.E.) held their annual dinner on the 5th inst., in the Club-rooms attached to the works. The chair was occupied by the President, Mr. H. J. Sheppard, General Manager of the firm, supported by the vice-presidents (departmental managers). After dinner the usual toasts were given and a concert followed, the artists all being members of the club and firm.

The Air Ministry has got six radio-telephone stations in Great Britain for the communication of meteorological and other information to aircraft. The stations are at Castle Bromwich, Croydon, Didsbury, Lympne, Pulham and Renfrew. There are also four foreign stations—one each in Belgium and Holland, and two in France. The distances at which conversation can take place range upwards to 200 miles from ground to ground at Croydon and to 150 miles from ground to air at Le Bourget. Communications with French stations are to be conducted n the French language.

"The Mechanical World Year Book, 1921," published by Messrs. Emmott & Company, at 2s. 6d. net, which forms a useful pocket book and diary, now reaches its 34th year of publication. It contains new sections on cast iron tooth gearing, on ball and roller bearings and friction and lubrication. The matter on chain gearing has been re-written, and a new table has been introduced on the properties of saturated steam. To those who do not require or cannot afford a classic such as Molesworth, the book is a worthy compendium for the desk or attaché case.

Imports.—The following are official values of electrical machinery, apparatus and material imported into this country during January, 1921, and the increase or decrease compared with January, 1920:—

Electrical machinery, £111 001 (increase £2 000); telegraph and telephone cables, submarine, nil; other than submarine, £15 851 (increase, £14 677); telegraph and telephone apparatus, £28 816 (increase, £20 417); other electrical wires and cables, rubber insulated, £2 478 (increase, £564); with other insulations, £9 360 (increase, £7 474); carbons, including furnace electrodes, £18 107 (increase, £1 502); glow lamps, £19 719 (increase, £15,602); arc lamps and electric searchlights, £3 902 (increase, £3 782); parts of arc lamps and searchlights (other than carbons), £158 (decrease, £2 340); batteries, £17,764 (increase, £16 220); meters and measuring instruments, £16 329 (increase, £12 278); switchboards, £218 (decrease, £738); electrical goods and apparatus unenumerated, £109 941 (increase, £75 336). Total of electrical machinery, apparatus and materials other than uninsulated wire, £242 643 (increase, £164 774).

Exports.—The exports of electrical machinery, apparatus and material during Jan., 1921, and the increase or decrease compared with Jan., 1920, were as follows:—

Electrical machinery, £445 132 (increase, £271 206); including railway and tramway motors, £33 287 (increase, £30 376); other generators and motors, £243 397 (increase, £135 210); and electrical machinery unenumerated, £168 448 (increase, £105 620); telegraph and telephone cables, submarine, £93 498 (increase, £12 175); other than submarine, £197 482 (increase, £120 647); telegraph and telephone apparatus, £141 853 (increase, £43 097); other electrical wires and cables, rubber insulated, £185 307 (increase, £72 733); with other insulation, £206 943 (increase, £69 411); carbons, including furnace electrodes, £18 775 (increase, £16 453); glow lamps, £42 865 (increase, £32 369); arc lamps and searchlights, £1,295 (increase, £863); parts of arc lamps and searchlights (other than carbons), £664 (increase, £369); batteries, £86 008 (increase, £50 179); meters and measuring instruments, £49 141 (increase, £2 484); switchboards, £22,408 (increase, £10 361); electrical goods and apparatus unenumerated, £248,659 (increase, £147.363). Total of electrical machinery, apparatus and material other than uninsulated wire, £1 294 898 (increase, £604 504).

Obituary.

The death occurred at Birkdale, on March 3, of Geo. H. Barlow, an electrical engineer in the employ of Wigan Corporation.

The death also took place recently of Mr. Ebenezer Greek, late traffic superintendent on the Blackburn Corporation Tramways.

We regret to learn, as we go to press, of the death of Lord Moulton of Bank, one of the Lords of Appeal. In addition to being a great authority on patent law and practice, he was a good mathematician and scientist. While at the Bar he figured in many patent cases and actions relating to electrical and tramway matters. During the war Lord Moulton rendered eminent service in connection with the supply of munitions and high explosives.

Tenders Invited.

Burnley Guardians require tenders by March 22 for electrician's work. Form of tender from the Clerk.

Pontypridd guardians require tenders by March 22 for three months' supply of electrical materials. Forms of tender from the Clerk.

Tenders are invited (by March 31) for the construction of port works at **Paysandu** (Uruguay), including electric handling and lifting apparatus.

Manchester Corporation require tenders by April 4 for 33 000 and 6 600 V switchgear, induction regulators, &c. Specifications from F. E. Hughes, Town Hall, Manchester.

West Ham Guardians require tenders by March 24 for three months' supply of electrical fittings, ironmongery, &c. Forms of tender from the Clerk, Union-road, Leytonstone, E.11.

Tenders are required by March 18 for supply of electric lighting sundries, ironmongery, &c., to the **Cardiff** City Mental Hospital, Whitchurch, near Cardiff. Forms of tender from the Clerk and Steward.

Rathmines and Rathgar Council require tenders by March 21 for materials, &c., for their electricity department, including house service cable, house service and fuse boxes, metors, &c. Forms of tender from the Electrical Engineer.

The Council of the Metropolitan Borough of **Hammersmith** invite tenders for the erection of overhead coal-conveyor, and brick chimney shaft, and replating of steel sheeting of coal bunkers. Specifications, &c., from the borough electrical engineer, Mr. G. G. Bell. Tenders to the town clerk, Mr. Leslie Gordon, by 4 p.m. March 16.

Belfast Electricity Committee invite tenders for the supply of materials and stores, including cables, wires, lamps, electricity meters, cut-outs, electrical accessories, carbon brushes, troughing, joint-box compound, street-box frames and covers, conduits, pipes, &c. Forms of tender from the city electrical engineer (Mr. T. W. Bloxam), and tenders to the town clerk, Mr. R. Meyer, by April 4.

Lurgan Urban Council has received seven tenders for the supply and laying of underground cables, the lowest being by the Enfield Ediswan Cable Company, at £3 156, which has been accepted.

Nelson Council has accepted the tender of the Anglo-Belgian Corporation for the supply of 12 sets of tramway points and crossings at £840. Other firms tendered at £1 740, £1 719 and £1 680 respectively.

Stepney (London) Council has purchased from Agricultural and General Engineers, Ltd., a 1½-ton Garrett electric vehicle at £1,000, less 2½ per cent. for cash. The Council has also accepted the following tenders: British Insulated and Helsby Cables, Ltd. (lowest tender), for e.h.t. and T.C.L.C. cable; Sutton & Company for troughs and covers.

Sheffield Electric Supply Department recently invited tenders for plant and a German firm is said to have tendered at £40 000, but the lowest British tender was £100 000. This is a good indication of the sort of competition the electrical industry may expect in the future unless steps are taken to prevent dumping.

Catalogues, Price Lists, &c.

Revised price lists of ironclad switch and fuse gear and of "Glasgow" switches have been issued by the **Midland Electric Manufacturing Company, Ltd.**, Barford-street, Birmingham. In nearly alll cases there have been substantial reductions of price, which have been rendered possible by the company's recent factory extensions and standardised methods of production. In addition to price and technical details of the company's manufactures, there are some good illustrations of standard switches, cut outs and other apparatus for lifting and power purposes.

The pamphlets and trade literature issued by the **British Thomson-Houston Company, Ltd.**, are usually of a high order and contain much useful information for engineers and plant users. Their descriptive list No. 5 600, relating to automatic control gear for a.c. and d.c. circuits, is no exception to the rule. In a well-printed and fully illustrated pamphlet of over 50 pages, there is a full and clear description of the design and construction of the company's systems of contactor gear. For d.c. circuits two systems of current limit control have been perfected, viz., the series contactor and the mechanically interlocked current limit relay systems. Full details of these are given as well as of the company's current limit relay for a.c. circuits, together with excellent illustrations of standard lines of equipment for mines, steelworks and other industrial power services.

Liquidations and Bankruptcies.

A meeting of creditors of the **Harman Electric Company, Ltd.**, will be held on March 16 at the office of the liquidator, Mr. F. M. Jeboult, 9, Walbrook, London, E.C.4.

A second dividend of 4s. in the £ has been declared in the voluntary liquidation of **Commercial Electric & Accessories, Ltd.**, and is payable at Messrs' Carter, Sons & White's, 79, Wool Exchange, London, E.C.2.

Ernest Albert Goodings, trading as **Goodings & Son**, motor and electrical engineer, The Grove, Watlington-street, Reading, has been adjudicated bankrupt.

Mr. E. P. Dutton, Bowlalley-lane, Hull, has been appointed trustee in the bankruptcy of **John Vincent Bell**, electrical engineer, 21, North Bar, Within, Beverley.

Claims against James Skinner, trading as **Foster, Skinner & Company**, electric fittings dealer, 6, South Castle-street, Liverpool, are to be sent by March 23 to Mr. E. D. Symond, 11, Dale-street, Liverpool.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

17,036-14 **Lederer.** Electric gas-filled glow discharge lamps. (19/7/14.)

17,046-14. **Lederer.** Electric gas-filled glow discharge lamps. (28/7/14. Addition to 17,036-14).

133,700 **Schroder.** Electrical seam welding machines. (30/5/18.)

141,[illegible] **Metropolitan-Vickers Electrical Co.** [illegible] testing the magnetic qualities of magnetisable material. (4/4/19.)

141,352 **Assie.** Electric furnaces. (9/8/17.)

141,[illegible] **Aktieselskabet** [illegible]. Method [illegible] performance of chemical processes in electrical furnaces, together with apparatus intended therefor. (12/4/19.)

143,498 **Western Electric Co.** Telephone systems. (21/5/19.)

143,929 **Soc. Anon. des Etaplissements H. Pilon.** Rectification of high-tension alternating currents. (9/4/19.)

Comprises a system for obtaining high tension direct current by rectifying alternating current by means of hot cathode electric valves, in which the valve of the "kenotron," "tungar," or like kind is connected to a point (*i.e.*, the centre) of the winding of the high tension secondary of a transformer, which has no difference of potential with the earth, and with a source of current feeding the hot filament of the valve, which source of current need not be insulated from the earth.

144,698 **Western Electric Co.** Telephone transmitter. (22/6/14.)

147,804 **Siemens-Schuckertertwerke Ges.** Electric arc lamps for searchlights or projectors. (3/4/17.)

151,992 **Metropolitan-Vickers Electrical Co.** Electrical regulator systems. (2/10/19.)

155,230 **Farmer.** Electric contact devices. (10/12/19.)

156,813 **B.T.-H. Co.** (G.E. Co.). Speed regulation of electric induction motors. (20/11/16.)

156,836 **Steele, Martin & McCarthy.** Electric welding. (27/6/19.)

156,862 **Price.** Electric heating device applicable for use in connection with cooking utensils and the like. (16/9/19.)

156,868 **B.T.-H. Co. & Taylor.** Alternating current dynamo-electric machines. (2/10/19.)

156,876 **Bolitho.** Transmitting-apparatus for use in wireless telegraphy and telephony. (6/10/19.)

Relates to appliances for generation of modulated oscillations for use in wireless telephony and telegraphy, in which a control circuit containing a three-electrode value and a source of modulating high voltage supply is coupled with the main generating circuit, which control circuit is so arranged that the reaction produced thereby acts in a reverse direction to that which sustains the oscillations in the main generating circuit and tends to oppose these oscillations, the resulting reaction on the generating circuit being thus capable of being reversed or reduced with a frequency depending upon the modulating high voltage supply in the control circuit.

156,944 **Galloway.** Portable magnetometer. (29/10/19.)

156,945 **Cheetham & Metropolitan-Vickers Electrical Co.** Electric meters. (29/10/19.)

156,954 **Wrighton & Edison Swan Electric Co.** Electric bells. (4/11/19.)

156,995 **Marks (Oesterreichische Siemens-Schuckertwerke & Regal-Patente Ges.)** Process and apparatus for the electrical transference of designs in the textile arts. (24/1/20.)

157,000 **Dixon.** Electric lamp mountings. (16/2/20.)

157,011 **Watson & Callender's Cable and Construction Co.** Switch and fuse contacts. (13/3/20.)

157,039 **Jackson** (Sperry Gyroscope Co.). Arc lamps. (11/7/19. Divided application on 152,411.)

157,041 **B.T.-H. Co.** (G.E.Co.). Electric incandescent arc devices. (4/3/16. Divided application on 152,694.)

APPLICATIONS FOR PATENTS.

July 19, 1920.

21,595 **Hale, Pearn & Co.** Ceiling roses, &c.
21,609 **Automatic Telephone Mfg. Co.** Relays for telephone systems.
21,619 **Schattner.** Apparatus for distance control of electric switches.
21,628 **March & Newey.** Conduit fittings.
21,641 **Bridgland.** Adaptors for holding arc lamp carbons.
21,666 **Pillon.** Electric clocks.
21,676 **Sieurin.** Burning carbon electrodes in furnaces.
21,683 **Fessenden.** Signalling through water or air. (21/7/19, U.S.)
21,684 **Western Electric Co.** Telephone repeating circuit. (31/7/19, U.S.)

July 20, 1920.

21,712 **Wall.** Amplification of telephone currents, &c.
21,725 **Satterthwaite.** Automatic switch for electric hoists, &c.
21,726 **Cristofoletti & Manetti.** Incandescent lamps.
21,735 **Riley.** Telephones.
21,745 **Greenhalgh & Longbottom.** Electric welding.
21,755 **Nadaud & Young.** Switches.
21,756 **Cherry.** Apparatus for electro-chemical treatment of vapours.
21,766 **Reyrolle & Harriman.** Contacts for fuses, cut-outs, &c.

July 21, 1920.

21,831 **Rochford.** Electric illuminating devices for stages, &c.
21,855 **Soc. Anon. des Etablissements L. Bleriot.** Electro-magnets, &c. (31/7/19, Belgium.)
21,860 **Lawes.** Means for improving contact between collectors and conducting rails, &c.
21,863 **Sullivan & Joseph.** Variable inductance devices for timing, &c.
21,868 **Callaway.** Terminal receivers for electric wires.
21,873 **B. T.-H. Co.** (G. E. Co.) Electric welding apparatus.
21,875 **Phillips Akt.-Ges.** Magneto-electric lamps. (24/7/19, Germany.)
21,876 **Phillips Akt.-Ges.** Small magneto-electric machines. (21/7/19, Germany.)
21,893 **Siemens Schuckertwerke.** Synchronous machines. (21/7/19, Germany.)
21,899 **Igranic Electric Co.** (Cutler-Hammer Mfg. Co.) Switches.
21,912 **Allgemeine Elek. Ges.** Alternating current meter. (22/7/19, Germany.)
21,914 **Metropolitan-Vickers Electrical Co.** Wireless receiving apparatus. (5/8/19, U.S.)

July 22, 1920.

21,934 **St. Helens Cable & Rubber Co. & Evans.** Electric junction, &c., boxes.
21,958 **Alber.** Batteries. (26/7/19, Switzerland.)
21,967 **Higham.** Apparatus for heating water electrically.
21,976 **Haddan (Hall).** Control devices for telephone services.
22,007 **Marconi's Wireless Telegraph Co.** (Goldsmith). Wireless telegraphy and telephony.
22,018 **Middleton.** Electric signalling devices for road vehicles.

July 23, 1920.

22,039 **Morris.** Rotary dischargers for radio-telegraphy.
22,065 **Kohlmeyer.** Storage batteries.
22,077 **Scintilla.** Voltage regulators for generators. (8/8/19, Switzerland.)
22,084 **Glaser.** Current-regulating devices.

July 24, 1920.

22,106 **Stringer.** Switches.
22,120 **Huartson & Lamb.** Conveying current to movable truck, &c.
22,131 **Cleaver.** Electric machines.
22,154 **Walker.** Electric-junction boxes, &c.
22,160 **Siemens-Schuckertwerke.** Suspension insulators. (6/1/20, Germany.)
22,168 **Tillinghast.** Electrical accommodation indicator for theatres.

Companies' Reports, &c.

AN ATTACK ON ELECTRICAL LEGISLATION.

In reviewing the year's operations at the annual meeting of the Tramways, Light & Power Company, Ltd., last week, the chairman (Viscount Chilston) said that 1920 had been a difficult year owing to trade depression and labour troubles. The new power station which the Leicestershire and Warwickshire Power Company had erected on the River Avon to deal with the southern portion of their area had been completed, and their lighting undertaking at Warwick had for the last three months been entirely supplied from the new station, while the change-over at Leamington Spa was practically completed. An important industrial consumer had also been connected, and when all their motors were fully connected their bill should be £30 000 per annum. The central portion of the Leicestershire & Warwickshire Company's area was served by the generating station near Hinckley, and during the year considerable extensions had been made to the station. In the Derbyshire and Nottinghamshire area only the minimum extensions of plant had been made in the power station to tide over the period until they obtained a supply from the proposed new station on the Trent, but the high-tension cable system had been considerably extended.

Referring to the Electricity (Supply) Act, of 1919, he said that, in the opinion of the directors, electrical development in Great Britain to-day would have been much greater and the trade prosperity of the country would have been more quickly reinstated if the Act had not been passed, and if the industry had not been subjected to the doubts and uncertainties caused by that ill-advised legislation. The Electricity Commissioners had been given power to delimit so-called "electricity districts," following upon which some 13 districts had been mapped out, included in those being the areas covered by two of their companies' undertakings. The experience in the two districts in which inquiries had been held by the Commissioners was not calculated to inspire confidence as to the success of the working of the Act. In their opinion it was unfair to the public at large, it was unfair to the manufacturers of the country, and it was unfair to those interested financially and otherwise in electricity supply to delay developments and stagnate the industry generally until the Ministry of Transport tried to reconcile irreconcilable elements in their endeavour to set up reluctant joint electricity authorities. That policy could not, in their opinion, succeed. In one of their properties (the Derbyshire & Nottinghamshire Electric Power Company) they had had experience of the power of the Commissioners to veto the erection of new power stations. The demand for electricity shortly after the Armistice made it clear that they must go ahead with the power station on the Trent, and consequently they acquired a site where we would have ample water and railway facilities. After their application for the erection of the station had been made, the Corporation of Nottingham also lodged an application for the erection of a new station for the city supply, but after a local inquiry the Corporation were authorised to erect a new station on the Trent, although they had no statutory powers to supply outside their municipal boundary. The chairman of the Commissioners evidently was guided by what he called pending legislation, and not by the law as it stood at the date of the inquiry. In a joint electricity authority the power company would naturally have representation, the idea being that the power company should buy all its requirements in bulk from the large central station, but such a station, if and when built, would be under committee control, and that largely municipal. They all knew that committee control, with a municipal bias, and efficiency did not go hand in hand. The Corporation now intended to build a small temporary station, fitted with second-hand plant, in order to deal with the crying requirements of their own citizens for electricity long overdue. The action of the Commissioners had resulted in many years' delay in providing a supply of electricity to large areas containing power users aggregating over 200 000 H.P., and to the ordinary man who understood the problem their action was inexcusable. In the current year, the board were confident that, unless there was any setback, the net revenue would show a substantial increase, and judging from the increased business to date, they were of opinion that their forecast of £80 000 net earnings by their companies for the current year was a fair estimate.

A quarterly dividend of 2 per cent. on the common stock has been declared by the Canadian General Electric Company, Ltd.

An interim dividend at the rate of 7 per cent. per annum (less tax) on the preference shares of Ward & Goldstone, Ltd., will be paid on the 31st inst.

Messrs. Lazard Bros. & Company have purchased £500 000 4½ per cent. first mortgage debenture stock of the Newcastle-on-Tyne Electric Supply Company at 68·35 per cent., and they are offering their stock for sale at 69 per cent.

The net revenue of the Traction & Power Securities Company, Ltd., for 1920 was £33 819 plus £10 932 brought forward. The directors recommend a dividend at rate of 7s. 6d. per share, carrying forward £12 722, subject to corporation tax.

The report of the National Boiler & General Insurance Company for 1920 states that the balance available is £37 193, plus £4 347 brought in, making £41 540, less £15 000 transferred to current risk fund, leaving £26,540. The directors recommend a dividend at 18s. per share, placing to investment reserve £6,841, and carrying forward £3,949.

The report of the London Electric Wire Company and Smith's, Ltd., for 1920 states that the issued capital has been increased by final calls on new issue of preference shares, and the expenses of this issue have been written off. £50 000 has been placed to reserve, making £100 000. The directors recommend a final dividend on ordinary shares, making 7½ per cent. for the year, carrying forward £38 926.

The directors' report of the Notting Hill Electric Lighting Company, Ltd., states that the available profit for 1920 is £35 762. Depreciation, renewal and reserve fund absorb £3 000; special reserve £3 000, and debenture interest, &c., £12 062. A dividend on ordinary shares at rate of 8s. per share, less tax, is recommended, carrying forward £3 647.

The Globe Telegraph & Trust Company, Ltd., has declared a quarterly interim dividend of 5s. per share on the old and new ordinary shares (tax free). It is further proposed that the sum of 4s. 8d. per share, being interest at rate of 10 per cent. (tax free), in respect of the instalments paid on the new ordinary shares, be paid on the new ordinary shares.

The net profit of Davis & Timmins, Ltd., for 1920 (including £43 627 brought forward), after allowing for depreciation, etc, was £79 069. After placing to general reserve £2 000 and to income tax £8 183, the directors propose a balance dividend at rate of 10 per cent. per annum on the ordinary shares, making 8 per cent. per annum, and a bonus of 17 per cent., tax free, carrying forward, subject to special taxation, £55 535.

It is announced that the 122,440 £1 ordinary shares of the River Plate Electricity Company, Ltd., which were issued in May last, have been converted into ordinary stock. The greater part of the company's claim against the German Transoceanic Electric Company (of Berlin) for arrears of interest and amortisation on the 5 per cent. obligations has been received through the Clearing House for Enemy Debts.

The net revenue account of the Oxford Electric Company, Ltd., for 1920, inclusive of £188 brought forward, shows an amount to credit of £11 779. After providing for debenture and sundry interest and capital issue expenses, the balance available is £8 315. The directors recommend a dividend at rate of 5 per cent. per annum on the ordinary share capital. A sum of £457 has been placed to reserve and £1,120 has been written off in respect of obsolete plant, leaving a balance forward of £108.

The profit of the Chelsea Electricity Supply Company, Ltd., for the year 1920 was £41 874, and with £1 523 brought forward, plus interest (£2 159), the total is £45 556. It is proposed to place £17 312 to credit of renewals, depreciation and contingencies reserve, to write off the cost of extinction of founders' shares (£2 178), to write off investments (£2 925), and to pay a final dividend on the ordinary shares of 32 per cent., making 6 per cent. for the year, leaving to carry forward £2 250.

The net profit of Clarke, Chapman & Company, Ltd., for the past year, after providing for debenture interest and other charges, was £107 216, to which was added £26 550 brought forward, making £123 766. With the dividends paid in June last year, and the depreciation, &c., deducted, the balance is £82 069. The directors recommend final dividends on the preference shares at the rate of 7 per cent. and on the ordinary shares of 1s. 6d. per share, placing to reserve £20 000, and to reserve account for income tax £12 000, leaving to carry forward £14 819.

Sir John Cowan, who presided over the annual meeting of Bruce Peebles & Company, Ltd., last week, congratulated the shareholders on the success achieved during the past year. Allowing for advance in prices of all engineering commodities, the actual orders for 1920 were more than double the best pre-war year of the company, and orders were continuing to come in steadily. Referring to the proposal to issue the balance of the share capital at par, less a commission of 10 per cent., he said he thought it was a fair offer, and that the directors were prepared to take up their full shares.

The profit of the Lancashire United Tramways, Ltd., for 1920 was £50 852. Receipts increased £50 838 and expenditure £60 682. The Liverpool & Prescot Light Railway having been sold to Liverpool Corporation, the owning company has been liquidated and proceeds of liquidation paid over to trustees for prior lien debenture stockholders, who have applied them to purchase of prior lien debenture stock of United Company amounting to £47 329. Liquidation of New St. Helens & District Tramways Company has also been completed, and £71 522 in respect of shares standing in books at £16 642 was received from liquidators, surplus being placed to depreciation account. Interest and dividends received from operating companies, together with motor coach and sundry receipts, amounted to £64 469. After deducting interest on prior lien debenture stock and expenses, there remains a balance out of which full interest of 5 per cent. will be paid on the second mortgage debenture stock for 1920, the £2,416 remaining being carried to depreciation. There is also a balance on year's working of operating companies, after payment of interest and dividends, of £24 289.

The directors of the Kensington & Knightsbridge Electric Lighting Company, Ltd., states that during 1920 the number of houses and shops connected increased by 228 (from 5 409 to 5 637), and the energy consuming devices, calculated in lamps of 30 W consumption, by 38 519 from 603 219 to 641 738 (18 096 to 19 252 kW. The number of units sold was 5 810 662, and the net profit for the year available for dividends is £16 344. Adding £1 223 brought forward and deducting the interim dividends paid during the year (at rate of 8 per cent. per annum on the ordinary shares, 6 per cent. on the first preference shares to June 30, and 5 per cent. per annum on the second preference shares to Sept. 30, amounting to £7 575) the balance is £9 992. The second half-year's dividend on the first preference shares absorbed £1 500, and provision for the dividend on the second preference shares amounted to £625, leaving a balance of £7 867. Out of this the board recommend payment of a dividend at the rate of 10 per cent. per annum for the last half-year, which will absorb £5 250, making with the interim dividend already paid 9 per cent. for the year on the ordinary shares, leaving to be carried forward £2 617.

The Electricity (Supply) (No. 2) Bill, which is likely to be introduced again, is said to need amendment in certain particulars to meet the interests of existing undertakers. The company is acting with the majority of the London companies, and with the London County Council and the Conference of Local Authorities, in preparing a technical scheme for improving the electricity supply organisation in Greater London. The important administrative and financial conditions which should govern the creation and powers of a Joint Electricity Authority are having the careful consideration of the Associated Companies.

The directors' report of the COUNTY OF LONDON ELECTRIC SUPPLY COMPANY, LTD., states that the net capital expended during 1920 on account of the company's districts amounted to £293 821. The net total expenditure up to Dec. 31 last amounted to £2 734 002. After deducting generation and distribution costs, repairs, rents, rates, &c., the year's revenue was £244 254, and with £19 188 brought forward the amount available is £263 442. Deducting interest on the first and second debenture stock and on temporary loans (£53 751), amount written off preliminary expenses (£8 972), amount carried to reserve for depreciation (£50 000) and amount carried to general reserve (£62,500), the balance for distribution is £88 218. Interim dividends for the half-year ending June have been paid on the 6 per cent. fully-paid preference shares and on the ordinary shares at the rate of 5 per cent. per annum, absorbing £26 876 and leaving for further distribution £61 342. The directors now recommend that a further dividend on the 6 per cent. preference shares and a further dividend on the fully-paid ordinary shares for the half-year ended Dec. 31, 1920, at the rate of 11 per cent. per annum, be declared, making 8 per cent. for the year, the balance being £18 595 11s. 7d.

The board record with regret the death of Mr. Francis E. Savory, one of the original directors, and since the last report Sir Ernest Hiley and Sir Guy Granet resigned. Lord Gainford and Lieut.-Col. Sir Frederick Hall have been appointed to the board, and the deputy chairman (Sir Harry Renwick) has been appointed chairman and managing director of the company. In order to comply with the requirements of the Electricity (Supply) Act, 1919 application was made early last year to the Electricity Commissioners for their consent to the company proceeding with the erection of its proposed generating station at Barking, but the Commissioners have decided to defer the matter until after March 31, 1921, by which date schemes have been invited by them covering the constitution of a Joint Electricity Authority for the London and Home Counties Electricity District. An extraordinary general meeting has been convened at the conclusion of the ordinary general meeting for considering, and, if thought fit approving, a Bill introduced by the Company for facilitating the erection of the proposed generating station at Barking, in the event of the consent of the Electricity Commissioners being obtained. The applications received during the past year amounted to the equivalent of 5 678 kW, making the total at Dec. 31 last 87 902 kW. The total units sold were 49 553 223, against 42 487 672 in 1919, and the number of consumers has increased from 31 390 to 34 764.

As to the associated companies, the directors of the South London Electric Supply Corporation have declared a final dividend on the ordinary shares of that company at the rate of 9 per cent. per annum (making 7 per cent. for the year), and the directors of the Bournemouth & Poole Electricity Supply Company have declared a final dividend on the ordinary shares at the rate of 7 per cent. per annum, making 6 per cent. for the year. The Coatbridge & Airdrie Electric Supply Company continues to progress.

The directors' report of the CITY OF LONDON ELECTRIC LIGHTING COMPANY, LTD., states that the capital expenditure during 1920 was £176 451, and after deducting the amount written off the net expenditure is £2 112 658. The total of the reserve funds is £371 574. The total revenue for 1920 was £656 093. Deducting expenses of generation and distribution (£275 130), repairs and maintenance of buildings, machinery, &c. (£26 381), street lighting expenses (£10 274) and rent, rates, taxes, management expenses and special charges (£126 347), the balance is £217 961, and with £23 050 brought forward, the total available is £241 011. After paying interest on loans from bankers, and on the first and second debenture stock for the year (£213 636), transferring £85 378 to reserve and contributing £2 725 to the Employees' Provident and Benevolent Funds, &c., the amount available is £109,633.

The voluntary deposit scheme of employees continues to be highly successful, and at the end of the year the total amount deposited was £30 887. The directors do not consider it in the interest of the shareholders to put forward a scheme for the reorganisation of electricity supply in London, but they have expressed to the Commissioners their willingness to give their assistance to the Companies and authorities which are preparing a scheme, provided its general outlines are such as can be accepted by the Company.

The construction work in preparation for the erection of additional turbo-alternators and boilers has been actively proceeded with, but the plant itself, although promised last September and October, has not been delivered owing to labour and other troubles. The Bankside Finance and Industries, Ltd., has been formed with an authorised share capital of £250 000 (the whole of which will be held by the City Company), has taken or will take over the various properties and surplus assets not required by the City Company as undertakers under the provisional orders and Electric Lighting Acts, and will develop the same and carry on other supplementary business. An early issue of capital has become necessary. The borrowing powers, which are limited to £900 000, have been exercised to the extent of £800 000, but the balance of £100 000 4½ per cent debenture stock cannot be issued to advantage at present. It is imperative to enlarge the borrowing powers, and the directors propose that they be empowered to borrow up to the amount of the subscribed capital for the time being.

Presiding over the annual meeting of the MIDLAND ELECTRIC CORPORATION FOR POWER DISTRIBUTION, LTD., last week, the chairman (Mr. James Taylor, J.P.) stated that in spite of the difficulties and anxieties arising from the continued increases in the cost of fuel, wages and from labour troubles, the profit for 1920 was larger than that of any previous year, owing to the expansion of their business. The net revenue was £109 419, an increase of £19 981, and with £14 279 brought forward after settling the excess profits duty to the end of 1919, the amount available was £123 699, which it was proposed to allocate as set out in the directors' report, leaving £48 198 to be dealt with. It was proposed to pay a further dividend of 6 per cent. on the old ordinary shares (making 10 per cent. for the year) and also to pay a dividend equal to 10 per cent. per annum on the new shares issued in July last. That would leave a balance to carry forward of £36 486, subject to excess profits duty for 1920. A public utility company such as that must necessarily always be spending fresh capital to meet the demands upon it, and during the year they had expended £80 158 and had commitments of approximately £150 000. In order to meet that an issue of £130 000 in £1 ordinary shares had been made in July.

After analysing the accounts Mr. Taylor said that the delay in the delivery of new plant, ordered in March, 1919, had been most unfortunate, as the company had been unable to connect up many consumers who urgently desired a supply of power. Referring to the division of the country into electrical areas, he said it was proposed to divide the Midlands into north-west, south-west and eastern areas, and the company's territory had been provisionally fixed by the Electricity Commissioners as partly in the north-western and partly in the south-western districts. Objections to the separation of the company's supply area in that way had been lodged. Despite bad trade, the demand for electric energy still continued, and the question of ordering further plant was before the directors. For the first few years the company's progress had been slow, but the position improved considerably about 1911. In that year the capital expended was £474 461, the gross revenue £43 159, and the net profit £2,500; they sold 10 254 412 units, but there was no dividend. In 1920 the capital expended had been £846 828, the gross revenue was £331 518, the net profit £83 278, the units sold being 38 341 675, and the ordinary dividend 10 per cent.

In conclusion, he thanked Mr. Sales, the secretary, and Mr. Parkinson, the chief engineer, who for the last 20 years had rendered yeoman service to the company, who did not mind working when trade was bad, and had worked harder when things were more prosperous.

New Companies.

The following list has been compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, Chancery-lane, London, W.C. 2 :—

EDGAR PHILLIPS, LTD. (173 245).—Reg. Feb. 17. Capital £7 000 in £1 shares, to acquire and carry on business of sanitary and electrical engineer, &c. Directors: E. Phillips, A. E. Diment and Hanrietta Hayman. Reg. office: 62, Church-street, West Hartlepool.

HORSA ELECTRICAL CONTRACTING COMPANY. LTD. (173 346).—Reg. Feb. 24. Capital £1 000 in £1 shares, to carry on the business of mechanical and electrical engineers. Directors: H. T. C. F. Jalirk, E. J. B. Bevan and S. T. Weaver. Reg. office: 112, Horsa-road, Erith.

JONES BROTHERS (LLANGOLLEN) LTD. (£173 348).—Reg. Feb. 24, capital £14 000 in £1 shares, to acquire and carry on business of manufacturers and repairers of and dealers in motor conveyances, electrical and general engineers. Directors: E. Denby-Jones and J. O. Jones. Reg. office: Berwyn-street, Llangollen, Denbigh.

LEEDS BATTERY COMPANY, LTD. (173 325).—Reg. Feb. 23. Capital £1 500 in £1 shares, to carry on business of dealers in and manufacturers of electric batteries. Directors: J. H. Firth, S. Hawkins, E. B. Barrett, C. E. Sheard and G. Higginbottom. Reg. office: 44, Silver Royd Hill, Wortley, Leeds.

J. B. MIDGLEY, LTD. (173 285).—Reg. Feb. 22, Capital £500 in £1 shares, to carry on business of electricians, electrical and mechanical engineers. Directors: J. B. Midgley, J. J. Tanner, F. Johnson and P. E. Gallogher. Reg. office: 26, Caledonian-road, King's Cross, N. 1.

ROADRAILS, LTD. (173 291).—Reg. Feb. 22. Capital £600 000 in £1 shares, to acquire inventions for any light railway, road railway, tramway or other means of communication or conveyance by any locotractor or other system. Directors: R. S. Stronach and A. D. Borton. Reg. office: 1, Dover-street, W. 1.

THREE STAR ACCUMULATORS: LTD. (173 287).—Reg. Feb. 22. Capital £3 000 in 10s. shares, to carry on business of mechanical and electrical engineers. Reg. office: 54, Redcross-street, E.C. 2.

WOOD & LAMBERT, LTD. (173 335).—Reg. Feb. 23. Capital £7 500 in 6 000 preference and 1 500 deferred £1 shares, to acquire and carry on business of automobile, mechanical, electrical and general engineers. Directors: T. Wood and B. Harris. Reg. office: 13, Old Burlington-street, W. 1.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics": "Air Estimates"; and "Instruments for Measuring Engine Clearance Volumes."

"The Cabinet Maker"; "The Decoration of Furniture"; "National Furnishing Trades' Convention"; and "Measured Drawings of Furniture from the Victoria and Albert Museum."

"Chemical Age": "Rubber Chemistry and Technology," by Dr. Philip Schidrowitz; and Mr. Paul Kestner's visit to the Society of Chemical Industry.

"Farm and Home": "Government and Wheat Prices"; "The True Treasure of the Nation"; and "Scientific Agriculture."

"The Fruit-Grower": Sir Daniel Hall on "Research"; Dinner of the British Growers' Federation; and "Mushroom Pests."

"Gardening Illustrated": "Brooms for Present Planting"; Apple Yorkshire Leening (illustrated); and "Irises of the Reticulate Group" (illustrated).

"Hardware Trade Journal": "Hardware in the Making: The Manufacture of Hollow-ware"; "Special Leather Goods Articles"; and "Institute of Metals Meeting."

Forty Years Ago.

(The Electrician, March 12, 1881.)

The Crompton Light at Glasgow.—Two more of these lights are, we believe, about to be erected in George Square, Glasgow.

The Exhibition at Paris.—The Council of the Society of Telegraph Engineers has nominated a committee which will give every information relating to the forthcoming Electrical Exhibition at Paris.

Telephone at Ipswich.—Permission has just been granted to Messrs. E. R. and F. Turner to establish telephonic communication between their foundry and a branch office. The wires are overhead. Messrs. Ransome of the same town have the telephone in use at their works.

A New Electrical Contemporary.—The first issue is announced for the 15th of this month of "L'Electricien," under the direction of MM. Vignes and Cyon. It will be published by M. Masson, of Paris. Our contemporary, "L'Electricite," points out that the above title clashes with our own, which is unfortunate.

Better than Land League Meetings.—Mr. J. R. Holmes, of London, formerly engineer of the Orkney and Shetland telegraphs, recently lectured on electricity and its applications at Ballymena, near Belfast. We venture to think that this is better food for the multitude than they have been accustomed to of late.

Prices of Metals, Chemicals, &c.

			Tuesday, Mar 8.	
		Price.	Inc.	Dec.
Copper—				
Best selected.........	per ton	£70 0 0	—	£1 0 0
Electro Wirebars ...	"	£72 0 0	—	3 0 0
H.C. wire, basis ...	per lb.	0s. 11¼d.	—	⅜d.
Sheet	"	1s. 0½d.	—	⅜d.
Phosphor-bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	"	1s. 3¼d.	—	⅜d.
Brass 60/40—				
Rod, basis	"	0s. 8½d.	—	—
Sheet, basis	"	1s. 1[illegible]d.	—	—
Wire, basis	"	1s. 1¾d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£7 15 0	—	£3 5 0
Galvanised steel wire, basis 8 SWG	"	£29 0 0	—	—
Lead Pig—				
English	"	£20 0 0	£0 10 0	—
Foreign or Colonial	"	£18 2 6	£0 12 6	—
Tin—				
Ingot	"	£153 0 0	—	£7 0 0
Wire, basis	per lb.	2s. 1¾d.	—	1d.

Salammoniac.—Per cwt. 100s.-95s.

Sulphur (Flowers).—Ton £14 10s.

" (Roll-Brimstone).—Per ton £14 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £35.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 10d.

Sodium Chlorate.—Per lb. 4¾d.

Rubber.—Para fine, 0s. 11½d.; plantation 1st latex, 1s 0¾d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by Messrs. W. T. Henley's Telegarph Works Company, Ltd.

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Arrangements for the Week.

FRIDAY, March 11th (to-day.)

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Sixth Guthrie Lecture on "Some Recent Applications of Interference Methods," by Prof. A. A. Michelson.

University of London.

5.30 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Lecture III., "Industrial Hydraulic Engineering," by Prof. Luigi Luiggi, D.Sc.

Institution of Electrical Engineers.—Students' Section.

6.30 p.m. At King's College, Strand, London, W.C. Paper on "Some Recent Developments in Converting Machinery for Small Sub-stations," by Mr. J. A. Broughall.

Institution of Electrical Engineers.—Scottish Centre Students' Section.

7.30 p.m. At the Royal Technical College, Glasgow. Annual General Meeting and Paper on "Machinery Operations in Automobile Construction," by Mr. R. J. Hird.

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "Marine Diesel and Marine Oil Engines," by Mr. K. O. Keller.

Junior Institution of Engineers.

8 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Electrical Drive in the Cotton Trade," by Mr. A. T. McGuire.

Electro-Harmonic Society.

8 p.m. At Cannon-street Hotel, London, E.C. Last Smoking Concert of the Season.

SATURDAY, March 12th.

Royal Institution.

3 p.m. At Albemarle-street, London, S.W. Lecture on "Electricity and Matter," by Sir Ernest Rutherford, F.R.S. Lecture II.

Birmingham and District Electric Club.

7 p.m. At Grand Hotel, Colmore Row, Birmingham. Paper on "Common Sense Methods of Recording Costing and Progress in Shop Management," by Mr. H. C. Young.

MONDAY, March 14th.

Institution of Electrical Engineers.—North-Eastern Centre.

7.15 p.m. At Armstrong College, Newcastle-on-Tyne. Discussion on Various Regulations of the Electricity Commissioners for Electricity Supply, to be opened by Mr. C. Vernier.

Institution of Electrical Engineers.—Dundee Sub-Section.

7.30 p.m. At University College, Dundee. Lecture on "Shipyard Electrical Equipment, with Special Reference to Contactor Switchgear," by Mr. H. R. Griffiths.

Royal Society of Arts.

8 p.m. At John-street, London, W.C. Lecture on "X-Rays and their Industrial Applications," by Major G. W. C. Kaye. (Lecture II.)

TUESDAY, March 15th

University of London.

5.30 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Lecture IV., "Industrial Hydraulic Engineering" (continued), by Prof. Luigi Luiggi, D.Sc.

WEDNESDAY, March 16th.

University of London.

5.30 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Lecture V., "Transportation Engineering," by Prof. Luigi Luiggi, D.Sc.

Institution of Electrical Engineers, Wireless Section.

6 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Paper on "The Effect of Electron Emission on the Temperature of the Filament and Anode of a Thermionic Valve," by Mr. G. Stead, and "On Some Thermionic Tube Circuits for Relaying and Measuring," by Miss W. A. Leyshon and Dr. W. H. Eccles, F.R.S.

Institute of Cost and Works Accountants.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn Buildings, London, W.C. Lecture on "Some Observations on the Proposed Amendments of the Workmen's Compensation Act, 1906," by Mr. H. G. Simmons.

Industrial League and Council.

7.30 p.m. At Caxton Hall, London, S.W. Lecture on "Some Obligations of Industry to Labour," by Mr. T. W. Casey, M.P.

Institution of Electrical Engineers.—S. Midland Centre.

7 p.m. At the University, Edmund-street, Birmingham. Lecture on "Possibilities of Power Production," by Prof. F. W. Burstall.

THURSDAY, March 17th

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "The Long-Distance Telephone System of the United Kingdom," by Sir William Noble.

Illuminating Engineering Society.

8 p.m. At the Royal Society of Arts, John-street, London, W.C. Discussion on "Motor Car Headlights: Ideal Requirements and Practical Solutions," opened by Major A. Garrard.

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Notes.

The New Telephone Enquiry.

A CONTEMPORARY heads its announcement of the appointment of the latest committee to consider British telephone organisation, administration and charges, "A Representative Select Committee." And while this is literally true, a perusal of the names immediately suggests the question—representative of what? For one thing is obvious, the Committee is certainly not representative of anything that can be called engineering or electrical interests. With the exception of Mr. ALEXANDER RICHARDSON, whose connection with engineering is mainly on the mechanical and civil sides, and possibly Capt. A. MOREING, there is no one who can be described as knowing much about the technical side of telephony. Nor is there anyone who is acquainted with the difficulties of supplying telephone facilities as distinct from the difficulties of using them. The committee is, in fact, composed of the usual legal elements with a sprinkling of Labour, and includes one representative of the co-operative movement, of a chartered accountant and a distinguished general It is a little hard to see how such a body can satisfy the desires of those who wish the negligences and ignorances of the Post Office telephone department exposed with all the deftness of a surgeon, and the cause that are preventing its proper development as skilfully removed.

The Lines of Approach.

WE are not therefore surprised to find that both the Middle Classes Union and the National Union of Manufacturers are seeking representation on the Committee. But there are grave difficulties in the way of such a course. Only Members of Parliament can sit on a Select Committee, and though the Committee in this case has exceptional powers to appoint from outside such persons as it may think fit for the purpose of obtaining expert information or advice, these outsiders will have no vote and no authority to examine witnesses except through a member of the Committee, at best a cumbersome and unsatisfactory process. This precedent of enlisting outside help is therefore not so great a move forward as has been represented, and its value or otherwise will entirely depend on the attitude which the Committee generally take up towards expert assistance. There is still a great deal of "expertophobia" in official quarters. Nevertheless, it is certain that if the operations of the Post Office telephone department are to be examined in that unbiased and informed way which only can lead to useful results, the fullest use must be made of the expert advice available, and those chosen to assist the Committee must be given within the limits of the rules of the procedure the widest scope for obtaining the information they require and of putting their views forward. If this is not done this Committee will give no more satisfaction than its predecessors.

Electricity v. Gas.

THE discussion on the relative values of electricity and gas for domestic purposes which took place last week at a meeting of the National Association of Supervising Electricians revealed an interesting change in the outlook of Mr. F. W. GOODENOUGH. Ten or twelve years ago, hearing Mr. GOODENOUGH speak on this question, recalled JOHN WESLEY taking the whole world as his parish. He used to laugh to scorn the idea that electricity could ever be more than an agent of the super-rich or the super-foolish. In this attitude he followed a Mr. CHEW, who, as will be seen by a reference to THE ELECTRICIAN of March 19th, 1881, in his inaugural address to the Manchester District of the Institution of Gas Engineers, confided to his hearers that electricity would never supersede gas for interior illumination, though it was well adapted for large open spaces. Last week, on the other hand, we were much struck by the lack of that whilom note of confidence which used to make Mr. GOODENOUGH's outpourings so interesting. If he develops at this rate we shall confidently look forward to the time, ten or twelve years ahead, when he will appear as an advocate of electricity.

The Delimitation Fallacy.

MR. GOODENOUGH's principal argument was that a delimitation of the spheres of activity of both gas and electricity would be an advantage; that there was plenty of room for both industries in the service of civilisation; that there were wide fields for each in which there was practically no competition and that the ground where they clashed was relatively limited. Why not, therefore, face facts and let each industry concentrate on developing profitable business rather than waste time and energy fighting competitors for no good purpose? Electrical engineers, he considered as a candid friend, would find it more advantageous if they only made claims which could be well substantiated and did not try to capture business on a basis on which they could not hold it. We might reply in like vein, but we will resist the temptation. For, from Mr. GOODENOUGH'S point of view, the unfortunate fact remains that, as Mr. SELLEY pointed out in the course of the discussion, that though the use of gas is increasing the use of electricity for domestic purposes is increasing at a much greater rate, in spite of the lack of experience which every new industry has to contend with and the setbacks which were caused by the war. This plea for delimitation is, in fact, as Mr. BEAUCHAMP well said, an insidious attempt on the part of the gas interests to enter into an agreement which, if it could be worked, which we doubt, would neither be to the benefit of the electrical industry nor to that of the general public. While, therefore, rejecting the idea of such circumscription of our efforts on the two grounds that it would be both impossible and impolitic, we do not wish to see anything in the way of cut-throat competition on the part of the electrical industry. By careful management on both the manufacturing and the supply sides the present cost of domestic electricity can, we feel sure, be reduced, while the benefits that follow its use will of themselves assist development, especially if well-considered propaganda be undertaken.

The Need for Propaganda.

IT is on this one subject of propaganda that we have a lot to learn from the gas industry. For in our opinion there is no doubt that much of the success of the gas interests in recent years has been due to the persistent and wholehearted way in which arguments in favour of its use have been dinned into the ears of the general public. If this success can be attained with such relatively poor material as the British Commercial Gas Association has had at its disposal, how much greater will be the success when a useful agent like electricity is being similarly pushed? No opportunity should therefore be lost by the electrical industry of bringing before the general public the advantages of domestic electricity. In this connection we might call attention to the need for better presentation of arguments by electrical speakers. At the meeting the other night we could not help being struck by the extraordinary difference in the quality of the speeches delivered by those representing the two industries. One set was concise, definite and often witty—the other diffuse and often inaudible. In fact, it is a matter for serious consideration whether a school of elocution for electrical engineers should not be established. For to put forward a good argument poorly is to deprive it of most of its strength, and to speak so that people cannot hear what is being said is to deprive it of the rest.

The Reparations Bill.

ELECTRICAL engineers would do well to examine the clauses of the Reparations Bill, which was introduced into the House of Commons on Monday with a view to discovering the effect the arrangements proposed are likely to have on British electrical industry. For while it is comforting to know that when it becomes law, in theory half the value of German goods imported into this country will pass into the British Exchequer, we have seen the failure of too many of these attempts to interfere with economic laws and trade freedom, to believe that everything will be quite so simple or so without any harmful effect on our own industry, as seems to be supposed in certain quarters. It must not be forgotten that international trade, and this is essentially an international question, is like a gyroscope in which the imposing of an external force on one part has unexpected results on the movement of the whole. There is no doubt that the success or failure of the scheme from the commercial point of view will depend on whether it will work to our advantage or not, and to some extent on the complaisance of the German industry. We are not surprised to find that in the best informed circles there are already some doubts on these points.

The Alternatives.

To descend to details it would be interesting to know how Government proposes to protect itself against fictitiously low values being put on the goods imported, and so reducing the amount paid into the Exchequer. On the other hand, the German exporter may think it worth while to place 50 per cent. on the normal price of his goods, with the result that the sum paid into the British Exchequer will be larger than would otherwise be the case so making the British consumer pay a share of the German indemnity, which is hardly what is desired, though it may before long amount to that. Again, any goods we buy from Germany must ultimately be paid for in British goods exported to Germany. If half the value of German imports go to the British Government a fund will accumulate which will enable them to reduce the taxes, and to that extent benefit British trade. But if the German goods had been paid for in the ordinary way a fund would have been created in Germany for the purchase of more goods from this country, and so British trade would have been directly stimulated. The difference is then really one between indirect and direct stimulation, and upon the point as to which will ultimately be more advantageous for our trade there may well be difference of opinion. One thing is evident that the best way of keeping out German articles, or rather of preventing them being sold at a price which competes unfairly with our own industry, is to pay the greatest attention to more efficient productive methods, and the more scientific use of machinery.

Insulating Properties of Oil.

SOME four years ago we gave a short account of a research into the insulating properties of transformer oil which had been undertaken by three Japanese engineers with the object of standardising commercial methods of testing. These researches showed that the breakdown voltage of an oil depended to a very large extent not only on the presence of water, but on the presence of cotton fibre which might easily absorb moisture. On that occasion we expressed the opinion that the conclusions reached should be verified at an early date and from an article on the same subject by Prof. T. A. MCLAUGHLIN, which we publish on another page of this issue, it will be seen that the investigations, if not carried much further, have now been confirmed in an interesting way. Prof. MCLAUGHLIN gives the results of a number of tests which he made with several different kinds of oil which show generally that the effects of the prolonged passage of current is to diminish the conductivity of the oil, though at some point or another an increase in conductivity suddenly takes place with consequent breakdown. There is, however, considerable variation between different samples of the same oil. Microscopic examination of the oils tested showed the effect to be due to small dust particles which the passage of current collected together until they formed a series of complete bridges across the oil. When this link was complete the conductivity suddenly rose. It will be agreed that these results show the great care that is necessary in ensuring absence of dust particles and fibre from the oils used in electrical work, while equally the absence of free water is desirable. Now that Messrs. HIROBE, OSWAGA and Kubo's conclusions have been verified in so satisfactory a way, the next step is obviously to see how these drawbacks can most easily be avoided in practice.

An Unusual Electrical Accident.

A report on two unusual accidents on the London Underground railways, which, curiously enough occurred on the same day, but which were fortunately attended by no injury to either the passengers or the staff has recently been issued by the Ministry of Transport. The first of these accidents occurred on the Baker Street and Waterloo Railway. Serious arcing broke out on the front motor-car of a train travelling between Piccadilly Circus and Oxford Circus Stations. As a result considerable damage was done to the cabling and connection boxes, as well as to the woodwork of the motor-car. The smoke and fumes which arose were, indeed, so serious as to impress the train staff with the advisability of removing the passengers to the nearest station. But attempts to do this were frustrated by inability to reach the short-circuiting device or to communicate with the sub-stations by telephone. The guard had, therefore, to go back to the Piccadilly Circus station, where further delay occurred owing to certain members of the staff being unwilling to depart from the strict letter of the rule, which states that passengers must only leave by the front end of the train. In the second accident there was a similar delay in cutting off the current, and therefore similar inconvenience to the passengers.

War Design and Material.

In both cases the fire was due to the fracture of the positive shoe cable at a point where a metal sleeve connector was fitted. The breakage caused an arc which travelled up the pipe to a point where the negative main cable crossed it where a "short" occurred. We are told that the metal connector employed was unsuitable for the purpose and was only fitted owing to shortage of staff and material. There is, therefore, no mystery about the business and such an accident is unlikely to occur again.

A Chance for Safety First.

There is, however, an important lesson to be drawn from what occurred. For it seems a pity that better arrangements were not available for the speedy cutting off of the current. It is true that in both cases it was impossible to use either the telephone or the short-circuiting bars. But even had the latter been available, Major Pringle points out that the men were not used to handling them, and, that being so, we should think for their own sakes it was just as well they did not make the attempt. This state of things is the more open to criticism by comparison with the Lancashire & Yorkshire Railway, where provision for emergency short circuiting has been provided. And it will be agreed that if a device of this kind is necessary on an open-air line it is much more necessary on a tube railway, where the material and psychological effects of a fire are likely to be exceedingly dangerous to human existence. It is therefore to be hoped that some of the efforts of the Safety First campaign, of which we hear so much, will be turned in this most necessary direction.

London Supply Companies and Reorganisation.

We are not surprised to find that the proposals for the reorganisation of the industry in the Greater London area and for the formation of a Joint Electricity Authority, which were outlined in our last issue, formed the principal subject matter of the chairmen's addresses to their shareholders at several of the meetings of the London electricity supply companies. We give elsewhere abstracts of the speeches of the chairmen of the Charing Cross and Metropolitan Companies, from which it will be seen that in tone and character they leave little to be desired, and they form a striking contrast to the jealousy and parochialism which seem to prevail in other parts of the country. While naturally anxious to safeguard their own interests they appear to have open minds and to be sincerely desirous of co-operating in any useful scheme for improving and reorganising electricity supply in the largest and probably the most complex of the electricity districts. The subject appears to have been approached with good will and sympathy by the majority of the companies and local authorities concerned, and if the interval before the public inquiry in June be utilised in further discussions of debatable points there may be a good chance of an agreed scheme being put before the Electricity Commissioners. Of course, the administrative and financial provisions will be the most difficult portions of the scheme to adjust, but until the projected Electricity Bill is passed nothing definite can be done, for the local authorities cannot provide any of the money that will be required. It is to be hoped, therefore, that the Ministry of Transport will make up its mind without further delay as to what it proposes to do, for the present feeling of uncertainty is doing serious injury to the electrical industry.

Manufacturers' Difficulties in 1920.

It is evident from the annual reports that have so far been published that the past year has been one of exceptional difficulty for all manufacturing and trading companies. This is not unexpected, but the difficulties which have led to these results are somewhat extraordinary, as will be readily gathered from a perusal of the speech of the Chairman of the Telegraph Construction and Maintenance Company, which we give on another page of this issue. Lord Selborne pointed out that the prices of most raw materials fell heavily during the year, and that in a falling and unstable market a large company undertaking extensive contracts runs great risks. For instance, iron wire fell about £20 a ton, steel nearly £30, copper wire about £50 and jute yarn £60 a ton. It shows, therefore, much for the skill of those responsible for the management of the company that the net profit, after providing for taxation, &c., was over £110 000 or only £14 000 less than the previous year.

Labour and the Situation.

We are not surprised to find that Lord Selborne had much to say about the excessive demands of Labour and the depressed conditions in the shipping industry. Incidentally, he gave the figures of the cost of working the company's cable ships, which showed that at present two of them involve an annual loss of about £1 330, and that the three did not even earn what must be put by for their depreciation. It is obvious that this condition of affairs cannot continue, and that either operating expenses will have to come down or the ships will have to be laid up. The directors, however, hope to be able to get back to economic working this year. Dealing with the great burden upon industry caused by the heavy taxation and rising rates, his Lordship pointed out that the company was paying £130 000 for these charges, or very much more than the shareholders receive in dividends. In 1900 the rates and property tax on both their works were only £2 619, but in 1921 they would have to pay £19 000. He had no cut and dried scheme for effecting an improvement, but insisted that we could only emerge from our present economic position by rigid economy, by reducing taxation and by developing international trade. These could only come through assured peaceful conditions, a lesson which might well be driven home in many quarters.

Capitalisation of Electricity Undertakings.

For some time past there has been a controversy on the Islington Borough Council regarding the financial position of the municipal electric supply undertaking. Allegations of over-capitalisation have been made, and there has been a demand for a special committee of inquiry to investigate the points at issue. From a report of the Borough Treasurer we learn that the gross capital outlay on the undertaking is £602 918, while the capacity of the plant is 9 250 kW, or an average of about £65 per kW. As the average for ten other London stations is £66 per kW, it is inferred that the charge of over-capitalisation is not sustained. The matter cannot, however, be settled in this easy way, for the age and character of the generating sets must also be taken into consideration in dealing with such systems. The plant installed at Islington consists of two 1 500 kW and one 3 000 kW turbo generator sets, which are fairly modern, but for the rest is made up of eight small and somewhat antiquated steam alternator sets of an average capacity of about 400 kW each, while the steam-raising plant consists of 13 water tube boilers of uncertain age. So that there is a fairly high capital charge outstanding on plant which will soon be obsolete if that stage has not already been reached. But if we also take into account the fact that over £180 000 of the money borrowed has been repaid it will be seen that the position is not as black as it is painted. Since 1912 the capital charge per kW installed has fallen from £82 to its present figure, and when the foreshadowed extensions are completed this will be further reduced to £45 per kW for a capacity of 18 750 kW.

Profit Earning Capacity.

Another test applied to discover the stability of the undertaking was its profit earning capacity. For fairly obvious reasons this is not an infallible guide in the case of a municipal undertaking where a good and cheap service should be the aim and profit a secondary consideration. In any event the profits of any undertaking depend largely on the price charged for the commodity supplied, so that so long as a municipal undertaking pays its way, as the Treasurer rightly points out, the making of a large profit is not its proper function. On the other hand, if a deficit is made it may be charged to the rates, though watchfulness can generally prevent such a state of things coming about. In Islington, as a matter of fact, there have been six years during which a deficit resulted, but all surpluses and deficiencies have been carried to a reserve fund against which are also charged items of a capital nature which have been made the subject of a loan The total of such charges amounted to £20 752, up to 1920, and the balance still standing to the credit of the reserve fund to £30 997. During the past year the profit was £16 039 and the loan interest £13 476, a total of £29 515. This is the amount which would be available for distribution by way of dividend in the case of a company, and would work out at 4¾ per cent. So that though Islington's undertaking is perhaps not in some ways so progressive as it might be it is not yet within measurable distance of the Bankruptcy Court.

The Endowment of Engineering.

We are glad to see that the patronage of wealthy men is being extended to the endowment of chairs of engineering, and to the provision of laboratories for the instruction of engineering students. Among the latest instances of this commendable kind of charity is the £30 000 presented by Lord Weir on behalf of the Institution of Engineers and Shipbuilders in Scotland to the University of Glasgow. This fund was raised in connection with the James Watt centenary, and it is hoped to use it to convert the two existing heat engineering and electrical engineering lectureships into Chairs bearing that distinguished name. The late Mr. Robert Wylie has also left the residue of his estate to the University of Glasgow for the further endowment and equipment of the Regius Chair of Engineering, and of the James Watt Engineering Laboratory. This legacy is said to amount to a very considerable sum. These are examples which might very well be more often followed by men of wealth in this country. For though it may be argued that the provision of proper education for all classes is a State responsibility, the possession of a capital fund of this sort allows certain much needed extra facilities to be provided, and is a matter which should still remain among the privileges of those possessed of an ample share of this world's goods.

An Enquiry and Some Morals.

If anyone doubts the necessity of Mr. Llewelyn Atkinson's warning regarding the slow progress that has been made in the reorganisation of electricity supply in this country, and the harm that will result to the electrical industry if this progress is not accelerated, he need only turn to the proceedings at the enquiry into the rival schemes for providing electricity supply in the West Lancashire and Mersey district. There he will obtain ample confirmation that matters are quite as bad as, if not worse than, the President stated. For in the sorry dramas that are now being staged not only in West Lancashire, but in other parts of the country, the bureaucratic and legal elements, which at their best are forces of reaction, are playing their full part, and electricity supply and electrical engineers are correspondingly suffering. It is indeed certain that the more obstructionists are allowed to block the way, the less chance there is of a cheap and abundant electricity supply being available for the manufacturers and inhabitants of the country, not only within a few months, but within the life time of those now existing.

A Barrage to Progress.

Now it is not least among the disadvantages of the legal and bureaucratic minds that they begin by erecting a series of purely hypothetical obstacles to any scheme of progress that is put forward. On these obstacles as a foundation arguments, more or less plausible, are built up until by a process of growth a mass of dielectic and entanglement is formed which presents a very real barrage across the stream of progress. This state of mind is the result of ignorance, as much as anything else, for to modify the well-known lines from "Measure for Measure," the bureaucrat and the lawyer too are generally "most ignorant of what they are most assured," and the fantastic tricks they play before high heaven are calculated in very truth to make the angels weep. But while on the part of lawyers and bureaucrats such procedure is only to be expected, that is no reason why engineers should join in this unfruitful discussion or assist in the work of placing artificial obstacles in the way of obtaining electricity supply as economically as possible. If in fact there is an electrical department in heaven its denizens must also be weeping at the methods which are now being pursued by some of those whose duty and interest it should be to assist the electrical industry.

The Spirit of "Parish-Pumpism."

How true these statements are may be gathered from a consideration of the speeches of counsel and the evidence given at the West Lancashire enquiry last week. During this enquiry the spirit of "parish-pumpism" was in the ascendant. Mr. **Tyldesley Jones**, who was representing the Mersey Power Company, for instance, suggested that the district supplied by this undertaking should be excluded from the proposed joint area. In the course of his argument on this text he urged on the Commissioners the necessity of giving fair treatment to existing undertakings and pointed out that no compulsion would be tolerated. This, of course, is all very well, and does Mr. **Jones** great credit, but it is equally obvious that no real reorganisation of the supply industry can take place without some modification of existing conditions and, the sensitiveness of human nature being what it is, without, we are afraid, hurting somebody's feelings. So far are we convinced of this that we disagree with Mr. **Tyldesley Jones** to the extent of believing that to settle this matter a benevolent autocracy, such as we hope the Commissioners will soon be empowered to become, would be the best way out of the present *impasse*, and would have very great advantages, repulsive as such methods would no doubt be to present democratic ideas. But while democracy in many ways has much to recommend it, it certainly labours under the disadvantage of causing an enormous waste of time and an altogether unnecessary expenditure of money, besides throwing into higher relief than is justified those warring elements whose principal essential is the noise they evoke on each and every occasion.

Some Curious Arguments.

In this connection we are interested to learn that the principal reason why Mersey Power Company should be excluded from the proposed area is that it is doing very well and that to include it in the district would enable a cheaper supply to be given to the collieries of St. Helens or to the mills in Liverpool, at the expense of the chemical industries which it now serves. It is only to be expected, we suppose, that the shadow of the parish pump should influence the attitude which smaller municipalities take up towards reorganisation, but we should have expected a private undertaking to have adopted a wider outlook. Apparently the smaller the undertaking the more circumscribed its viewpoint, and we need only say that the Company has no more than 63 power consumers to indicate how very small its claims are to separate recognition.

In fact so small are they that we are surprised to find Mr. **McLellan** enunciating the dictum that no electricity authority would supply the Company's area as cheaply as the Company will be able to do it from their new generating station. This is the more interesting, as another witness pointed out that the waste heat from the salt evaporators was being utilised in the production of electricity. We feel, therefore, that Mr. **McLellan's** argument must be of purely local application, for in the Newcastle area we seem to remember that small waste-heat stations have been established with some success, not for supplying individual works only, but for feeding into the large distributing system which in itself is of such extent as to form an electricity district in being. We are the more puzzled by this, as later in his evidence Mr. **McLellan's** agreed that present difficulties, such as high prices and the inherent cost of money, did not affect the truth of the principle that large schemes for the generation and transmission of electricity were preferable to the old parochial system, and pointed out that the great obstacle to this arrangement was the jealousy of local authorities. The two arguments certainly do not square, and we should like to know which we are to accept.

"Compartment" Development.

On the concluding day of the inquiry, which occupied no less than eight days, some interesting evidence was given by Mr. C. P. **Sparks**, consulting engineer for the Wirral scheme in advocating what he termed "compartment" development—*i.e.*, the creation of smaller electricity districts which could be grouped later on into larger districts. Though he was opposed to the smaller schemes on principle, because they would ultimately involve a larger capital expenditure, he thought the existing financial stringency left us no choice at present. Engineers are usually men of large ideas and wide vision, but we think that Mr. **Sparks** is laying too much stress on the financial situation. We do not believe that the position, though difficult, is quite as bad as it is painted in some quarters, and we hope that if there is no stronger argument than this against the larger scheme the Commissioners will not give countenance to any change in their present policy.

Rowing a la Mode.

The whole condition of the affairs disclosed at the enquiry cannot in fact be better illustrated than by the simile advanced by Mr. W. H. **Andrew**, the Town Clerk of St. Helens, who said that all the authorities concerned were in the same boat, with Liverpool acting as stroke and all the others pulling in different ways, while the Commissioners on the bank were hurling all sorts of maledictions at their heads with, we might add, the crowd looking on in sheer amaze. If indeed we push this simile farther it is evident that a boat propelled on this "Ouidaesque" principle would fail to progress up stream, and would gradually drift down stream until sooner or later it found its way to the bottom of the river, leaving these unskilled exponents of the nautical art struggling in the water. We should view this immersion with indifference if the only result were that it would bring those concerned to their senses, but we are afraid that in the process it might submerge the engineers concerned, as well as do the electrical industry, and therefore the public generally, irrevocable damage.

Support of the Commissioners.

In our opinion it is essential that in the necessary reorganisation of electricity supply the claims of districts should have precedence over those of localities, and the policy of the Commissioners in this matter must be to exercise their powers for the good of the public generally, and especially to defeat all that Bumbledom of which we are now seeing such pitiable exhibitions. We doubt very much if the ratepayers would object to this course, though the officials naturally would be hurt in that part of their anatomy where their self-glorification resides. True reorganisation can in our opinion only be reached in two ways, by pressing through Parliament the Electricity Bill which was introduced last session, and by giving to the Commissioners the wholehearted support of the electrical industry. While there is some natural impatience at the delay which has occurred, it must be realised that for that delay the Commissioners must not be blamed, it being entirely due to the warring elements to which we have called attention. It is, therefore, the duty of electrical engineers and of the electrical industry generally to give the Commissioners, who, it is no secret, are working under great disadvantages, their ungrudging help and to defer criticism of their actions to a more convenient season. We have said before that if the reorganisation of electricity supply had been left in the hands of engineers the schemes by this time would be well on their way to fruition. As, however, this is not possible, it is essential at least that electrical interests should combine to nullify to the greatest possible extent those forces of reaction which are delaying, and will continue to delay, if not speedily checked, the coming of the new electrical era.

On the Design of Split Phase Motors.

By E. A. BINNEY.

The term "split-phase" motor is here applied to the single phase induction motor having a main or running winding and an auxiliary or starting winding on the stator, and a squirrel cage rotor. This type of motor is generally built as a fractional horse-power motor and is extensively used for driving labour-saving devices such as washing machines, coffee grinders, meat choppers, &c. The motor is usually started up on full line voltage, without the use of a starting box. Consequently, in calculating the starting performance of this type of motor this fact must be kept in mind.

It is well known that a single phase squirrel cage induction motor, having two similar windings on the stator, displaced 90 electrical degrees, can be started on a single phase circuit by inserting a resistance in series with one winding and connecting the two circuits in parallel. On connecting the motor to an alternating current supply, currents will flow in both windings, but these currents will not be in phase with each other, due to the different impedance of the parallel circuits. This results in the production of a very unsymmetrical rotating field, sufficiently pronounced, however, to produce a torque and cause the rotor to revolve and attain a speed corresponding to the frequency and the number of poles. In the following article it is intended to give a method of calculating the starting performances of such a motor and to show the limitations inherent to this method of starting.

THEORY OF THE MOTOR.

Fig. 1 is a diagram of the motor under discussion. It is assumed that the rotor is locked and that the windings are connected to a source of alternating current. Current will flow in the separate circuits, the value being limited by the impedance of each circuit.

Thus, in the main circuit, the current I_1 is expressed by

$$I_1 = \frac{E}{Z_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where Z_1 is the total impedance of the main circuit, including the rotor, and E is the impressed voltage.

Similarly,

$$I_3 = \frac{E}{Z_3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The number of turns in the main winding, which is permanently connected to the supply, are practically determined by the desired running performance, the frequency and voltage of the supply.

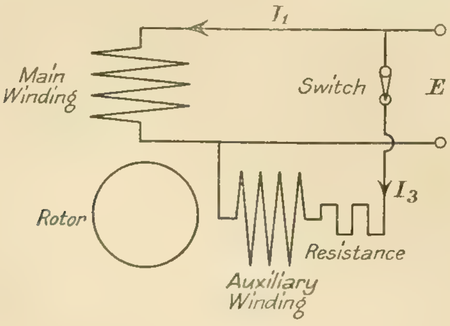

FIG. 1.

On the other hand, the auxiliary winding, which is used only in the starting period, that is for but a few seconds, can be varied in the number of turns and resistance according to the wish of the designer, since the running performance is independent of this winding. It follows that the current I_1 is practically predetermined, whereas I_3 may be varied at will.

The starting torque can be conveniently expressed in "synchronous watts" and for this type of motor is

$$W_s = 2fI_1I_3r_2U \sin \alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Where I_1 and I_3 are the currents in main and auxiliary windings, r_2 is the rotor resistance reduced to terms of main stator winding, U is the ratio of turns of auxiliary to main winding and α is the phase displacement of the currents I_1 and I_3. f is a factor less than unity, which corrects for leakage between stator and rotor and can be taken as 0·9.

The torque in ft.-lbs. is

$$T = \frac{7{\cdot}04 W_s}{N} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Where N is the synchronous speed of the motor.

If we now consider the equation 3, we see that there are three factors: I_3, U and $\sin \alpha$, which may be varied without effecting the running performance of the motor, but which greatly effect the starting characteristics. The rotor resistance r_2 cannot be varied at will, since the slip and overload capacity of the motor would be effected. But since the starting torque is directly proportional to the value r_2 it is evident that some variation of this factor must be considered.

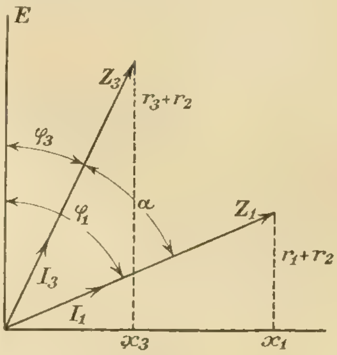

FIG. 2.

The current I_3 is inversely proportional to the impedance Z_3 of the auxiliary circuit:—

$$Z_3 = \sqrt{X_3^2 + (r_3 + r'_2)^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where

r'_2 = Rotor resistance reduced to terms of auxiliary winding turns.

r_3 = Resistance of auxiliary winding.

X_3 = Reactance of auxiliary circuits.

The angular displacement (in time) can be varied over a limited range, usually from 0-45 deg. This angle depends upon the ratio

$$\frac{(r_1+r_2)}{Z_1} = \cos \varphi_1 \quad \text{and} \quad \frac{r_3+r'_2}{Z_3} = \cos \varphi_3.$$

The vector diagram (Fig. 2) shows these relations clearly. Assuming a value of rotor resistance r_2 and knowing the main winding resistance and reactance, $\cos \varphi_1$ is known. Therefore, I_1 is determined in value and phase. Since $\alpha = \varphi_1 - \varphi_3$ any change in α must be obtained by changing φ_3. This is done by varying the resistance r_3 or the reactance X_3 or both. At the same time I_3 will vary, and since an increase in r_3 will cause a reduction of I_3 it is evident that a maximum value of $I_3 \sin \alpha$ can be found for a certain value of r_3.

$$\text{The ratio } U = \frac{\text{effective auxiliary turns}}{\text{effective main turns}} = \frac{fw_1t_1}{fw_3t_3}$$

where t_1 and t_3 are series turns in the main and auxiliary windings and fw_1 and fw_3 are the respective winding factors, also enters into the torque equation. Since the torque is proportional to U, other factors being equal a large value of U would appear to be desirable. However, the factors I_3 and $\sin \alpha$ are both reduced by an increase in U, therefore there must be a certain value of U which gives best results. By choosing various values of U, say, 0·3, 0·5, 0·75 and 1·0, we can calculate the starting torque and current in each case. A comparison of the torque obtained for a given total current with different values of U will show which ratio gives the best results.

Influence of Motor Rating.

In order to carry out these calculations, it has been shown that the main winding of the stator and the resistance of rotor must be known. As previously mentioned, these values are more or less fixed by the rating of the motor. Thus, if we intend to design a 1/8 H.P., four-pole, 50 cycle motor having an overload capacity of 100 per cent. and a full load slip of 5 per cent., the main stator winding and the rotor winding are designed accordingly. This, then, determines the values I_1, r_1, r_2, X_1 and $\cos\varphi_1$ (r_2 is expressed in terms of the main winding).

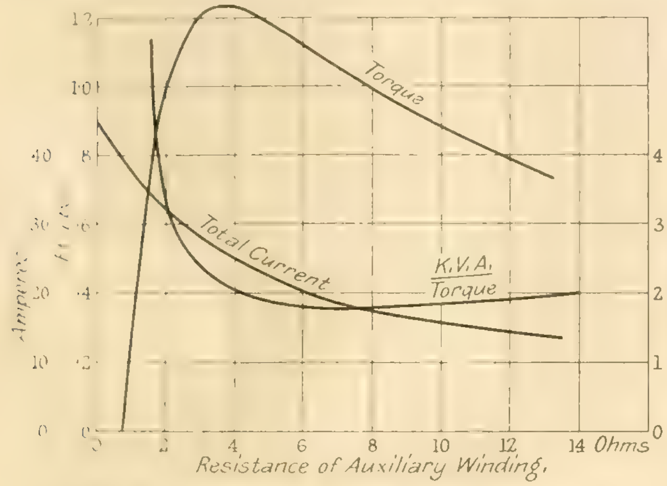

Fig. 3.—Starting Torque for $U=0{\cdot}50$, $r_2=5{\cdot}0$ ohms.

We are now at liberty to proceed with the design of the auxiliary winding. The reactance X_3 may be taken as U^2X_1, the rotor resistance in terms of auxiliary winding as U^2r_2. It is convenient, in carrying out the necessary calculations, to vary the value of r_3 and find the corresponding values of Z_3, I_3 and $\cos\varphi_3$. As an example, the starting performance of a 1/8 H.P., four pole, 50 cycle 100 volt motor will be calculated. We will assume that the main winding has been calculated and the resistances and reactance determined to be the following:—

$$X_1=10 \text{ ohms.} \qquad r_1=3 \text{ ohms.}$$
$$U=0{\cdot}5 \qquad r_2=5 \text{ ohms.}$$

Then $$Z_1=\sqrt{10^2+(3+5)^2}=12{\cdot}8 \text{ ohms.}$$
$$I_1=\frac{100}{12{\cdot}8}=7{\cdot}8 \text{ amperes.}$$

Further $$X_3=0{\cdot}5^2\times 10=2{\cdot}5 \text{ ohms.}$$
$$r'_2=0{\cdot}5^2\times 5=1{\cdot}25 \text{ ohms.}$$
$$\cos\varphi_1=\frac{3+5}{12{\cdot}8}=0{\cdot}625\,;\quad \varphi_1=51{\cdot}3^\circ.$$

The total current I_T is the geometrical sum of I_1 and I_3' and is expressed by

$$I_T=\sqrt{I_1^2+I_3^2+2I_1I_3\cos\alpha}.$$

Further

$$W_x=1{\cdot}8\times I_1\times r_2\times U\times I_3\times\sin\alpha=35I_3\sin\alpha,$$

and $$\text{torque}=\frac{7{\cdot}04\ W_x}{1{,}500}=0{\cdot}0047\times W_x \text{ ft.-lbs.}$$

r_3	$r_2'+r_3$	X_3	Z_3	I_3	Cos φ_3	φ_3	φ_1	α	Sin α	Cos α
0·75	2·0	2·5	3·2	31·3	0·625	51·3	51·3	0·0	0·000	1·000
1·75	3·0	2·5	3·9	25·7	0·77	39·5	51·3	11·8	0·205	0·978
2·75	4·0	2·5	4·7	21·2	0·85	31·7	51·3	19·6	0·336	0·942
4·75	6·0	2·5	6·5	15·4	0·92	23·0	51·3	28·3	0·474	0·880
6·75	8·0	2·5	8·4	11·9	0·95	18·1	51·3	33·2	0·548	0·836
10·75	12·0	2·5	12·25	8·15	0·978	12·0	51·3	39·3	0·633	0·774

I_1	I_1^2	I_3^2	$I_1\ I_3$	I_T	W_x	Torque ft.-lb.	KVA Torque
7·8	61	978·0	244·0	39·1	—	0·000	0·00
7·8	61	658·0	200·0	33·5	184	0·865	3·87
7·8	61	448·0	165·0	28·8	249	1·17	2·47
7·8	61	236·0	120·0	22·6	255	1·20	1·88
7·8	61	141·0	93·0	18·9	228	1·07	1·77
7·8	61	66·5	63·5	15·1	180	0·845	1·79

The last column of the table contains the values KVA per foot-lb. torque. This is a useful factor in comparing the starting performance of various designs. Fig. 3 shows curves of torque, total current and kilovoltampere per ft.-lb. for $U=0{\cdot}50$.

Starting Current and Starting Torque.

The calculations in Table I. have been repeated for $U=0{\cdot}75$ and $U=1$. The corresponding curves are plotted in Figs. 4 and 5. Fig. 6 gives curves showing starting current plotted against starting torque. There are, of course, two points on the curve at which the same torque is obtained, to the right and to the left of the maximum value. The current values in Fig. 6 correspond to the torque points to the left of the maximum value.

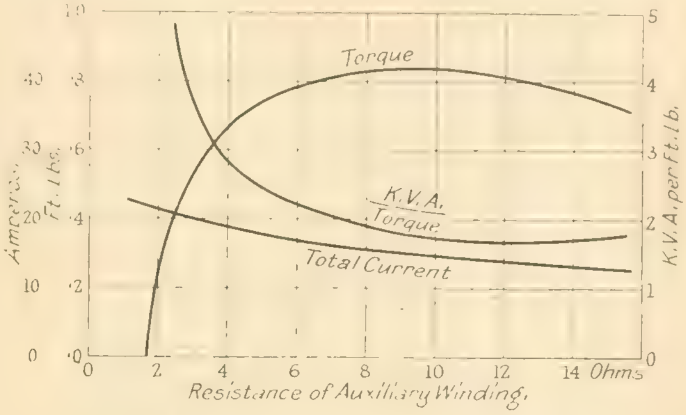

Fig. 4.—Starting Torque for $U=0{\cdot}75$, $r_1=5$ ohms.

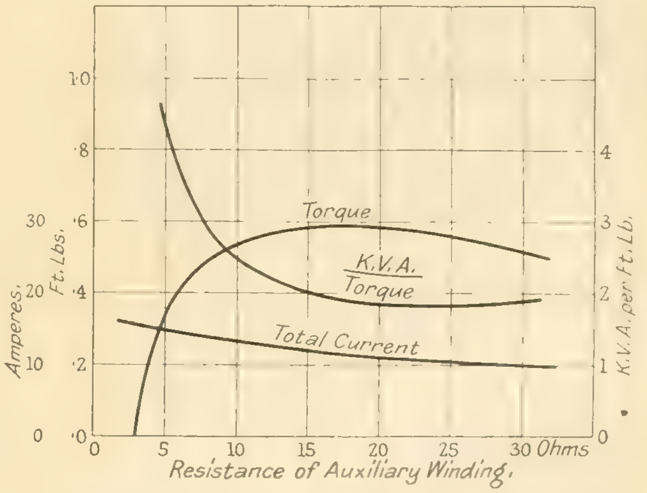

Fig. 5.—Starting Torque for $U=1{\cdot}0$, $r_2=5$ ohms.

Fig. 6 shows that for a starting torque up to 0·5 ft.-lb. (in this case) the ratio $U=1{\cdot}0$ gives lowest starting current values. For torques between 0·5 and 0·8 ft.-lb. a ratio $U=0{\cdot}75$ is better than a ratio $U=0{\cdot}5$. The choice of U therefore depends upon the starting torque required. Since it is generally the aim of the designer to obtain the desired starting torque with the lowest possible starting current, the largest ratio U giving the desired torque should be chosen. It is also worthy of observation that a variation of the resistance has less effect upon the starting torque in the case of a large ratio U. The resistance of the auxiliary winding compared with that of the main winding is high. In order to obtain this it is necessary to use a relatively fine wire. The current density in this wire may reach very high values. It is generally possible to keep the current density within permissible limits by choosing a large ratio U, since for a given resistance the number of turns are greater, therefore a larger section of wire can be employed.

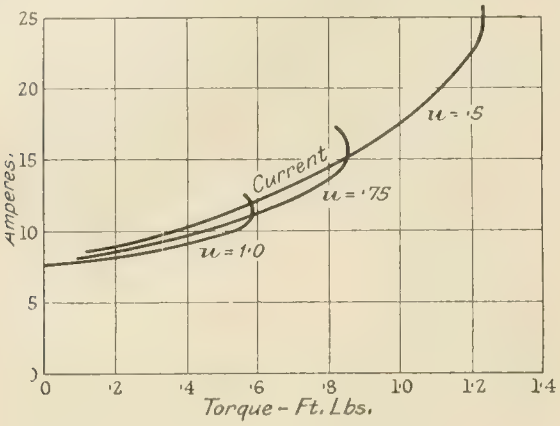

Fig. 6.—Starting Current and Starting Torque.

Effect of Frequency.

The effect of frequency on the design is important. It becomes more difficult to obtain a satisfactory starting performance as the frequency is reduced. Referring again to the vector diagram, Fig. 2, it is readily recognised that a reduction in frequency reduces the angle a, since the reactances X_1 and X_3 are reduced in proportion to the frequency, while r_1 and r_3 are constant.

Fig. 7 gives the running performance of the 1/8-h.p. motor for which the starting torque curves are calculated. The full lines correspond to a rotor resistance of 5 ohms, whereas the dotted lines are for the same motor with the rotor resistance decreased to 3 ohms. These curves clearly illustrate the sacrifice in efficiency and overload capacity incurred by the choice of a high rotor resistance for the purpose of obtaining a satisfactory starting torque. The high resistance rotor has the very desirable feature of providing a smooth, gradually increasing speed torque curve. The speed torque curve of a motor with low resistance rotor possesses a decided dip at a speed close to one-third synchronous speed. If the load demands a torque in excess of the minimum value occurring at the dip, the motor will be unable to pull up to full speed and will "hang" at this low speed with the inevitable result of burning out.

In the foregoing discussion it has been shown how to design a split-phase motor capable of starting against a load without the agency of a friction clutch or other similar means.

The advantage of a reliable friction clutch applied to the split-phase motor, however, is incontestable. If the clutch is of such a design that the rotor can attain a speed of approximately 80 per cent. synchronous speed and then the auxiliary circuit opened before any appreciable drag on the shaft

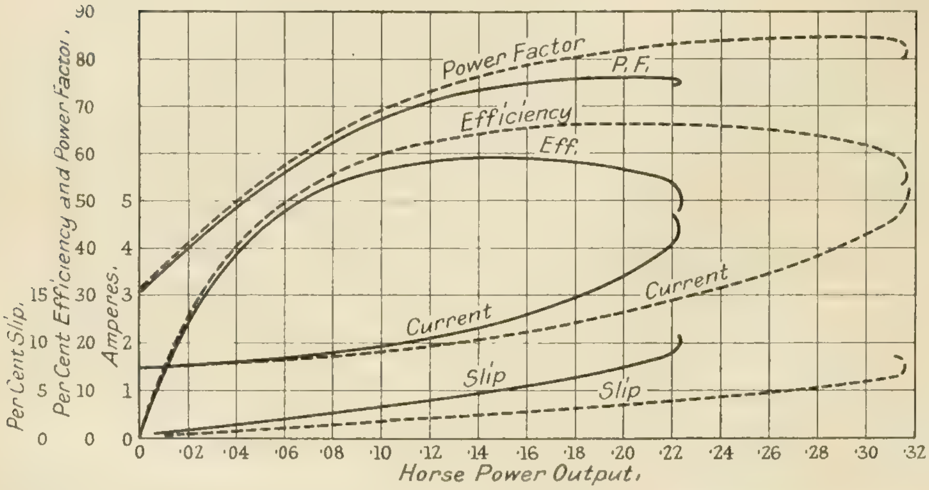

Fig. 7.—Running Performance of $\frac{1}{8}$ h.p. 50-cycle Motor, 100 Volts, 1,500 revs. per min.
Full line curves for rotor resistance of 5 ohms (reduced to primary terms).
Dotted line curves for rotor resistance of 3 ohms.

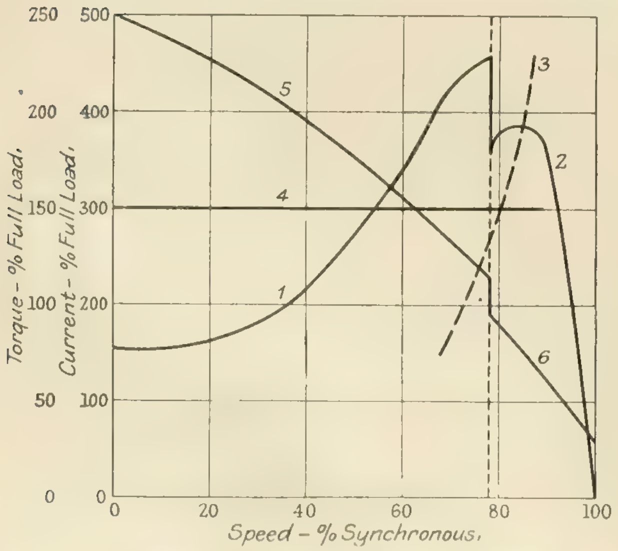

Fig. 8.—Speed Torque Curves Clutch-Type Motor.

Curve 1.—Inherent torque developed by main and auxiliary winding.

Curve 2.—Inherent torque developed by main winding alone.

Curve 3.—Friction torque of clutch.

Curve 4.—Torque required to start assumed load.

Curve 5.—Current before opening auxiliary winding.

Curve 6.—Current after opening auxiliary winding.

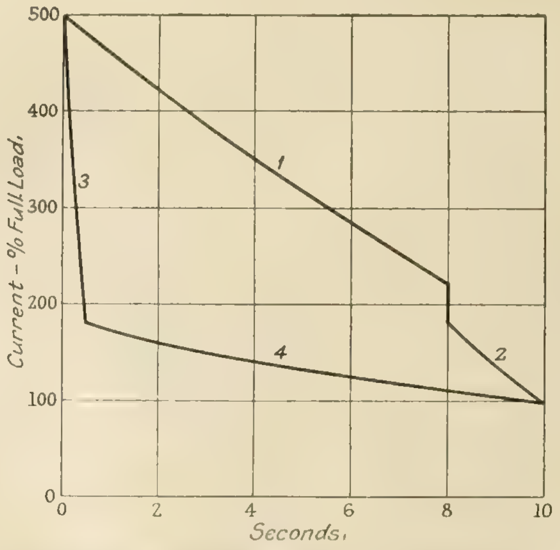

Fig. 9.—Time-Current Curves with and Without Clutch.

Curve 1.—Current with clutchless motor.

Curve 2.—Same after opening auxiliary winding.

Curves 8 and 4.—Current with clutch-type motor before and after opening auxiliary winding circuit.

is exerted by the clutch, the motor can safely attain full speed with a load demanding a starting torque considerably in excess of full-load torque. This is due to the fact that the torque available is equal to that developed by the motor at the speed at which the clutch operates. Since in the running condition the motor develops its maximum torque with a slip of 15 to 20 per cent., it is advantageous to adjust the clutch so as to carry a load somewhat in excess of this torque at the same speed.

Curves for a Clutch-Type Motor.

Fig. 8 shows the speed torque curves of a clutch-type motor. The greater part of the torque developed by the motor at speeds between 0 and 80 per cent. is used to accelerate the rotor, which runs free on the shaft. The acceleration is therefore extremely rapid. As the speed increases a gradual increase in the torque exerted by the clutch takes place until sufficient torque is exerted on the shaft to start the load. In Fig. 8 this occurs at 80 per cent. synchronous speed. The auxiliary winding is cut out at a slightly lower speed, so that the motor is now working on the inherent torque curve due to main winding only. The load is accelerated after the motor has attained a high speed and therefore is drawing a relatively low current. The advantage of this type of motor over a clutchless motor is better illustrated by the time-current curves, Fig. 9. It is assumed that both motors are able to accelerate the load to full speed in 5 seconds, while the armature of the clutch-type motor attains 80 per cent. of full speed in 1/2 seconds. It is apparent that the clutch-type motor works under far the most favourable conditions as regards current draw during the interval from 1/2 to 5 seconds. Since the addition of a clutch introduces a further possible source of trouble and expense in manufacture, the application of the clutch-type motor is generally limited to the class of load requiring a higher starting torque than can be readily obtained from a clutchless motor.

The Deleterious Effect of Fibres on the Electric Insulating Power of Oils.

By THOMAS A. McLAUGHLIN, M.Sc.
(University College, Galway).

In The Electrician of March 2, 1917, a short account was published of an experimental research on the electric insulating properties of transformer oil, carried out in the Electro-Technical Laboratory at Tokyo by Messrs. T. Hirobe, W. Ogawa and S. Kubo. The main feature of the research as therein reported was to bring to light the very deleterious effect on the insulating power of transformer oil of the presence of fibres from cotton rags used in cleaning containing vessels or otherwise introduced into the machinery contained in the oil. It was stated that a single fibre of poor insulating value would be sufficient to break down the insulation of a transformer. In an editorial note the importance of this result was pointed out and a desire was expressed that the conclusions should be verified at an early date.

Similar conclusions as to the importance of fibres in insulating oils, arrived at independently and from a different viewpoint, may therefore be worthy of note. In this case the research was carried out from an academic view-point, having its origin in a casual observation of the electrical conductivity of paraffin oil measured between two cylinders. The conductivity was found to vary enormously, the explanation being not immediately obvious. An investigation into the phenomena was started in 1916, prior to the publication of the report referred to, and concluded without any knowledge of this report. The results arrived at showed the phenomena to be due to the presence of fibres, and in the investigation which led to this conclusion much information was gathered as to the effect on the specific resistance of oils of the presence of fibres. In the paper above mentioned the matter is approached from the valuable technical viewpoint of the effect of fibres in lowering the break-down voltage in transformer oil, but their importance from this viewpoint was only realised on reading the report when this research was completed. In so far, however, as any considerable lowering of specific resistance means an increased chance of a breakdown by providing an easy passage for a spark, these results are a verification of those already referred to.

The possibility that the enormous variations in the conductivity of paraffin oil might be due to varying impurities in the oil led to the testing of a purer and more standard type of oil, liquid paraffin as sold for medicinal purposes and guaranteed to be in accordance with the British Pharmacopœia, 1914, being chosen.

Tests on Electrical Conductivity of Liquid Paraffin.

(*a*) *Variation of Current with Electric Field.*—Efforts were first made to obtain a simple graph showing the variation of current with electric field. A battery of small storage cells was used as a source of potential. The apparatus consisted of a circular glass vessel, about 4 cm. high, to hold the liquid. A brass plate rested on glass supports in the bottom of the vessel and a wire from it served to connect it when required to the battery of cells. Another brass plate, protected by a guard ring, was fixed in position about 1 cm. from the lower plate. The vessel was provided with a glass cover, a small hole in which permitted connection being made from the top plate to an electrometer. The liquid was thus kept sensibly free from contamination of any kind. In contact with the oil ebonite assumed a conductivity commensurable with it; it consequently was found impossible to use it in the construction of the apparatus. The lower plate was charged to potentials shown in table and the current at the upper plate measured by the electrometer.

The results were as follows:—

Volts per centimetre.	Current proportional to
20	1·0
30	1·4
40	1·9
53	2·5
63	3·0
73	800

An abnormal increase of current took place as shown by figures for the last increase of 10 volts. Reducing the field to 40 volts per centimetre, the current was now of the same order as at 73 volts. Removing the field and leaving the oil idle for some hours 73 volts a centimetre now gave current proportional to 4·2.

A fresh supply of liquid on being similarly treated gave the following figures:—

Volts per centimetre.	Current proportional to
20	1
74	4
142	13
250	34
440	63

Here there is no abnormal increase in current even at a much higher voltage than in the first case. A third sample showed an abnormal increase at 75 volts a centimetre and a fourth at 100 volts a centimetre. A fifth showed no abnormal increase at 2,032 volts a centimetre.

(*b*) *Effect of Prolonged Passage of Current on Conductivity.*—With a constant voltage of 84 volts a centimetre the results were as follows:—

Taking the original current as 100: After an interval of 30 minutes the current was 103. After a further interval of

30 minutes the current was 89. After a further interval of 45 minutes the current was 76. After a further interval of 5 minutes the current was 28,300.

With another sample of oil a potential of 252 volts a centimetre gave this result:—Taking the original current as 100: After 20 minutes the current was 110. Twenty-five minutes later the current was 97. Twenty minutes later the current was 92. Forty-five minutes later the current was 80. Sixteen hours later the current was 18,800.

With a third sample and a potential of 410 volts per centimetre the result was:—Taking original current as 100: After 25 minutes the current was 120. 140 minutes later the current was 76. 120 minutes later the current was 57. Sixteen hours later the current was 37. Thus for more than 20 hours the current gradually decreased, showing no great increase.

A fourth sample showed an even more abnormal increase. Taking the original current as 100, the current after 5 minutes was 105, after 15 minutes was 95, after 30 minutes was 325,000.

The effect of the prolonged passage of current is, in general, to diminish the conductivity of the oil, but at any time a sudden increase in conductivity may take place. This increase is irregular as to time and field required to bring it about, large fields being no more effective than small. It is also noticeable that for a short time after the field is first put on the current is liable to increase slightly, but this tendency passes away and the current decreases with time, provided the state of great conductivity does not come about. What might be called the normal effect, the decrease of the current with time, is a well-known characteristic of liquid dielectrics. The importance of the state of high conductivity will be immediately obvious; it means that the oil is at any time liable to assume an apparent specific resistance sometimes as low as 1/3,000 of its normal value and always so small a fraction of its normal value as to impair gravely the value of the oil as an insulator. An investigation into the cause of the phenomenon was then proceeded with.

Is the Abnormal Conducting State Dependent on Water or Air in Solution in the Oil?

To remove moisture a sample of the oil was forced through a thickness of six filter papers, the latter having been thoroughly dried beforehand. To remove air in solution from the same sample it was placed in a closed vessel which was kept exhausted by a vacuum pump for six hours. When the pump was started for some little time a plentiful supply of air bubbles was produced from the oil, but this gradually died out, and when no more appeared the oil was assumed to be free from air. The sample being now tested gave the abnormal conductivity under a field of 2,000 volts per cm.

Other Oils Tested for a Highly Conducting State.

It has been remarked that paraffin oil was found to be subject to irregularities in its conducting power. Other oils were now examined in the light of the results obtained for liquid paraffin. As was sometimes the case in testing liquid paraffin the conductivity was tested between two vertical brass plates immersed in the oil. A similar phenomenon was found to occur even more readily than in the case of liquid paraffin. Thus the conductivity of paraffin oil under a field of 40 volts per cm. suddenly increased 150 times. Benzole, petroleum ether and xylene on being tested all yielded similar results.

Failure to Produce Highly Conducting State in Toluene.

Several samples of pure toluene on being tested showed no abnormalities in their conducting power. A few drops of water were added to the oil, but had no great effect on the conductivity except in one case in which a large drop was placed in the oil between the plates and touching each plate. Under the action of an electric field this drop decomposed with violent chemical action, leaving some small particles of carbon in the oil. A state of great conductivity was also found to have been thus brought about. On illuminating the area between the plates the carbon particles were seen to have formed a chain between the plates. On breaking this chain the high conductivity disappeared and reappeared when the chain was reformed.

Microscopic Examination of Oils in an Electric Field.

Samples of the oils were placed in the apparatus, the area between the plates illuminated, and examined by a microscope. The oils were seen to contain small dust particles, usually of a short but fibre-like nature. Under the action of an electric field these particles moved to and fro between the plates hitting one and rebounding to the other, at the same time changing their position in the liquid. Small fibres of a very fine type either originally present in the oil as supplied or introduced in the preparation of the apparatus were also lying on the plates and stood out under the action of the field. These fibres were probably most usually introduced into the oil by the fine cloth used in cleaning the apparatus. If they were long enough they were seen under the microscope to form a complete link between the plates, if not they usually gathered together sufficient dust particles or similar foreign matter to enable them to complete the bridge. This latter process might naturally take hours, being dependent on the number and position of dust particles in the oil. In all cases immediately the link was complete the conductivity of the oil increased in the abnormal fashion previously referred to. On removing the field the link usually broke, and if left long enough the particles forming it got redispersed through the liquid. The extent of the increase in conductivity depended on the material and number of the fibres. If water was introduced into the oil it took the form of small bubbles and tended to collect on the fibres and foreign matter increasing their conductivity. No great tendency of small bubbles to collect and form a chain in the same fashion as the fibres was noticed. In the less viscous oils particles and fibres had more freedom of movement, and thus were more easily brought into position and the high conducting state produced. In no case was this state present when no bridge was visible. It is to be noted, however, that the fibres were not visible in the oil to the eye under ordinary illumination, they had to be sought for with a low power microscope under good illumination. The trouble was caused by fibres of this nature.

Dust Particles, Fibres and High Conductivity.

Samples of liquid paraffin were centrifuged and all dust particles thus removed. The brass plates were cleaned by dipping them in nitric acid, then in distilled water, and washing finally with xylene, which readily evaporated and left the plates dry and free from all fibres and dust. The plates were placed about 2 mms. apart in the oil and a field of 400 volts used. Although the field was left on for 16 hours no abnormal conductivity occurred. Various other samples were tested with the same result, and it was thus definitely established that the abnormality in the conductivity of previous samples must have been due to foreign matter in the oil or on the plates in the nature of dust particles and fine cloth fibres which formed bridges between the plates under the action of the current. The other oils used, tested similarly, gave the same result.

Conclusion.

In dealing with insulating oils great care is necessary to insure absence of dust particles and fibres, which if present would be liable under the action of an electric field to form up in chains and seriously decrease the insulating power of the oil. As pointed out in the Paper referred to on transformer oils these fibres might easily be introduced by using cotton rags in cleaning apparatus. Oily cotton rags are sure to leave fibres behind them. These fibres even though of a very fine and practically invisible nature will have a high conductivity and may easily form a chain for a breakdown by a rush of current and the passage of a spark. The presence of free water particles is also undesirable, for if dust particles or fibres are present they will join them and render them more conducting, while they may, if very favourably placed, themselves link up and form a chain. If this chain is formed under high voltage it will act as a medium for a spark, the passage of which will release carbon particles which in turn can form a conducting chain.

These results may thus be taken as verifying from a different view point those in the paper first referred to, in particular they seem to point to the truth of the statement that "it may then be positively stated that only a single fibre of poor insulating value will be sufficient to break down the insulation of a transformer, however high the quality of the oil may be as a whole, for the puncture will occur at the weakest point." In so far as a fibre may reduce the specific resistance of an oil hundreds or even thousands of times, it can well be regarded as forming a weak point.

In the course of the research much information as to the electrical properties of "liquid paraffin" was noted. It seems to be much superior to any other oil as an insulator viewed from the point of view of specific resistance. At about 1 000 volts per cm. its specific resistance was of the order 10^{14} or 10^{15} ohms. Between the parallel plates used a spark in the oil could be obtained at about 2 200 volts per mm.

This research was conducted at University College, Dublin, under the advice and direction of the late Professor J. A. McClelland, F.R.S.

Steels for Permanent Magnets.

The investigation of the magnetic quality of steels suitable for use as permanent magnets has engaged the attention of the Hadfield research laboratory for a considerable number of years, and as a result Messrs. HADFIELDS, LTD., are now able to supply customers' requirements with special brands, including some new steels which show remarkable magnetic properties. Each of these steels it is important to note can be readily forged or rolled, when the usual precautions necessary with tungsten magnet steels are taken, and the hardening treatment is in each case of the simplest possible description.

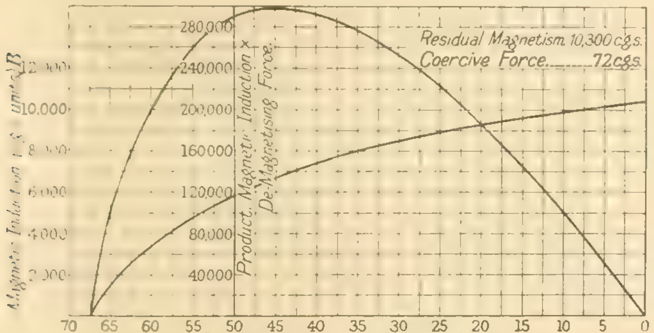

FIG. 1.—CURVES SHOWING MAGNETIC QUALITIES OF HECLA M.T. 64 STEEL.

Among these steels we may mention Hecla M.T. 64, which is a tungsten magnetic steel of the best quality. It is recommended for use where a high-grade tungsten steel is particularly specified. Its magnetic qualities are shown in Fig. 1. The hardening treatment recommended is to heat carefully to 850°C., soak—*i.e.*, maintain this temperature in the furnace—sufficiently to ensure uniformity of temperature throughout the section, and then quench in water.

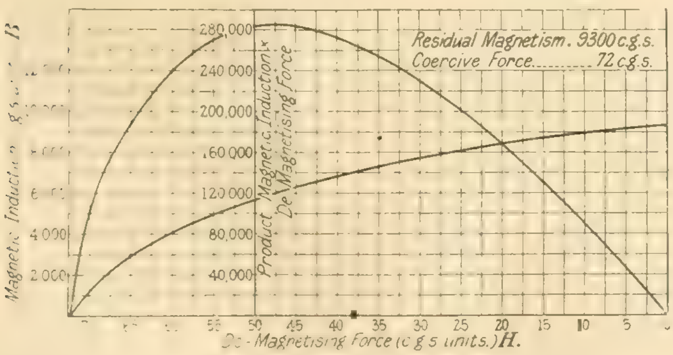

FIG. 2.—CURVES SHOWING MAGNETIC QUALITIES OF HECLA M.T. 63 STEEL.

The second steel is known as Hecla M.T. 63, and was developed in the Hadfield research laboratory with the special object of meeting the requirements of some users for a steel less costly than tungsten steels, while but little inferior as regards magnetic properties. For service under conditions where the best and most expensive steels are not essential, this steel will, it is claimed, be found specially suitable. The qualities of this material will be seen from Fig. 2. The remanence is 9 300 C.G.S., and the coercive force 72 C.G.S. The hardening treatment recommended is to heat carefully to 800°C., soak sufficiently to ensure uniformity, and then quench in water.

The most interesting of the steels is, however, "Permanite," which represents an entirely new departure in steels for permanent magnets, since the magnetic properties are far in advance of those of previously known steels, with the exception, perhaps, of the K.S. magnet steel described in our issue of December 17th, 1920. Fig. 3 shows the full demagnetisation curve of this steel, and it will be seen that the coercive force has the unusually high value of 119 C.G.S., while the remanence is over 11 000 C.G.S., being equal to or better than that of the best tungsten steels. The high coercive force of this material enables it to withstand rough usage in a remarkable manner, as the falling off in strength is almost negligble. Owing to this quality and the high value of its $B \times H$ product, it is therefore recommended for use in magnetos and in apparatus where excessive demagnetising influences are encountered.

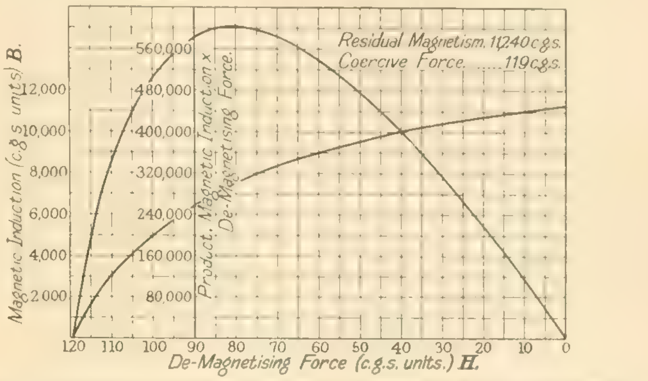

FIG. 3. CURVES SHOWING MAGNETIC QUALITIES OF "PERMANITE" STEEL.

It is necessary to point out that as "Permanite" is extremely difficult to demagnetise, it follows naturally that a strong field is necessary to magnetise it. It is found, however, that a magnetising force of about 900 to 1 000 C.G.S. gives satisfactory results. The hardening treatment recommended is to heat carefully to 900°C., soak sufficiently to ensure uniformity, and quench in water.

Celluloid in Electric Safety Lamps.

The MINERS' LAMP COMMITTEE has recently issued a memorandum embodying the report of a research conducted into the use of celluloid in the construction of electric safety lamps. In a covering letter to the Secretary of Mines the committee explain that the celluloid cases of the accumulators of these lamps have on several occasions been burnt owing to a short-circuit while the lamp has been in use underground. Though the number of these occurrences has been small and no serious injury has resulted, it is necessary to know whether they are a real source of danger. Three possibilities suggest themselves: (1) The ignited celluloid might cause an ignition of firedamp external to the lamp; (2) the fumes evolved might be dangerous to health; (3) the pressure produced by the fumes might burst the lamp case. These three possible sources of danger have been investigated experimentally under the direction of the Research Sub-committee, and their report shows that no danger need be apprehended from any approved type of miners' electric safety lamp from either of the first two causes, but that the third is a possible source of danger in the types of lamps which are assembled by means of a screw joint. This danger can, however, be completely guarded against by the provision of vent holes in the metal cases of such lamps, and such vent holes if suitably arranged and of suitable dimensions introduce no danger of a passage of flame from within the lamp case.

The committee point out that it should not be inferred from the report that they consider the screw joint inferior to the bayonet joint for the electric safety lamp; there are other equally important matters to be considered in making a comparison of the merits of the two types with which the committee propose to deal in a subsequent report. The committee make the following recommendations:—

(1) That, as regards electric safety lamps which are or may be nearly gas-tight (*i.e.*, lamps assembled by means of a screw joint) and in which accumulators with inflammable cases are used, the case for the lamp should be provided above the level of the accumulator with not less than five vent holes of not more than 1/16th in. diameter. It would be reasonable for the Home Office to require this provision of vent holes to be made immediately as regards new lamp cases, and within six months from the date of publication of the report as regards lamp cases in use.

(2) That all electric safety lamps submitted for approval should be required to withstand tests in the most explosive mixture of firedamp and air.

The Design and Construction of Scientific Instruments.*

By **ROBERT S. WHIPPLE, M.I.E.E., F.Inst.P.**

The manner in which the optical and scientific instrument industry met the demand thrown upon it during the war is now a matter of history. The present period, however, has serious aspects such as the severe competition from abroad, and the restrictive duty threatened in the case of supplies to American colleges, formerly large purchasers of duty-free scientific apparatus, However, the importance of the scientific instruments to the community is now becoming better realised, and ultimately the industry should be able to hold its own.

Scientific instruments may be divided into two classes—(1) a piece of apparatus designed for the purpose of an experiment, or (2) a tool. Almost all tools, as Maxwell pointed out, have been developed from purely scientific instruments. When an instrument is to be made the following mutually related questions arise:—(1) What accuracy is required? (2) What sensitivity is wanted? (3) What amount of money may be spent on the instrument? Accuracy requirements are broadly as follows:—(*a*) An instrument must have the required accuracy; (*b*) it must have a constant accuracy; (*c*) every important source of inaccuracy should be known; (*d*) any error should, as far as possible, be capable of elimination by adjustment; (*e*) this adjustment should be possible without the addition of other special apparatus; (*f*) when an error cannot be eliminated it should be as constant as possible; (*g*) when an error cannot be eliminated it should be capable of measurement by the instrument itself without external apparatus, so that the results may be corrected.

THE FUNDAMENTALS OF MEASUREMENT.

Measurements are ultimately made by a human brain and that has itself no accurate quantitative power. The only power that we possess that is accurate is that of judging coincidence, or rather non-coincidence. The judgment of the eye in this respect attains brisk precision, the power of other senses is less developed. Hence the instrument maker should arrange that, whatever may be the quantity to be measured, the final measurement depends on the coincidence of two phenomena. Coincidence is nearly always obtained by balancing two forces, *i.e.*, a null method, as for example in weighing. Many devices have been introduced to save time, such as the spring balance, the vernier, the divided scale, the micrometer head, &c. These are finally all null methods, as the scales, &c., have been calibrated against other weights or scales which have involved null methods.

The accuracy of any instrument depends upon the accuracy of each individual step in its performance. Some errors are inherent to the instrument, others may be eliminated by suitable precautions. The probable degree of error requires careful predetermination, and neglect of this precaution may involve much loss of money. The accuracy of elaborate levels used in surveying has been sacrificed by the comparative inaccuracy of the surveying staves. Similar considerations apply to electrical measurements, where the effect of temperature and of certain resistance, thermal effects, stray magnetic fields, &c., must all be considered.

Frequently increasing sensitivity involves reduced accuracy, and the usefulness of the instruments is thereby diminished The sensitivity of an instrument may be defined as the power of detecting and measuring small changes in the property under investigation, accuracy as the power of measuring the changes correctly. An instrument is usually a magnifying device and magnification may introduce uncertainty. Good design may partially annul bad workmanship, but the converse is not true

SOME PRACTICAL POINTS.

In instrument work, and especially in electrical instruments, the spiral spring is of great service. The problem of the control spring is frequently difficult. The ratio of the length of the spring to its width and thickness and also the quality of the material of which it is made, all offer room for further research.

By geometric design it is generally easy to avoid backlash between the different parts of an instrument. If a cylindrical rod is turning in a cylindrical hole and the rod is too small for the hole, there will be shake between the rod and hole. If, however, the rod is held down into the *Y* supports by suitable springs there can never be shake in the movement. Maxwell states that "when an instrument is intended to stand in a definite position on a fixed base it must have six bearings, so arranged that if one of the bearings was removed the direction in which the corresponding point of the instrument would be left free to move by other bearings must be as nearly as possible normal to the tangent plane at the bearing." If this principle is observed the pressure and therefore the friction at each bearing will be kept at a minimum, and the springs requred to avoid shake and backlash reduced to the minimum strength consistent with the work required of them.

Most mechanics know from a study of satisfactory and unsatisfactory lathe beds which designs are geometrically sound. A lathe and an instrument are closely akin, except that the forces and wear on a lathe-bed are much more severe, and surfaces have to be employed instead of point or line contacts. The design of parts that have to rotate relatively to each other must follow the same general principles. The one serious drawback to strictly geometric design is the fact that there may be a certain amount of "floppiness," and this cannot be tolerated in many instruments—for example, in surveying instruments.

In the case of small rotational movements geometric design is of great value. In the well-known rocking microtome the parts on which the section is carried and which are moved forward in steps as small as 0·001 mm. are blunt knife edges of cast iron.

Much of the success of a measuring instrument may depend on the method of mounting the screw. No indeterminate strains should be given to the screw or nut. Many devices have been designed for this purpose. Sometimes the nut is carried in a rocking mounting, so as to allow it to take up its position on the screw, but to permit any rotation. An excellent example of this is shown in the feed screw of the rocking microtome, in which the screw works in a nut formed in a rocking piece, which rests in two V-grooves in a ring-shaped casting.

The making of a satisfactory screw and nuts is a difficult problem, but progress in the manufacture of accurate screw-cutting lathes and a knowledge of screw threads has quite revolutionised the subject.

THE IMPORTANCE OF SCALE DESIGN.

Enough consideration has not always been given to the scales used in instruments. The position of the scale or the reader by means of which the scale is read is of importance. If reading is being taken with a microscope, it is often more convenient to have a low power with a comparatively large field of view, rather than a higher power with a restricted field. The former may enable figures on the circle to be seen, and at the same time give sufficient accuracy for the purpose of the experiment. The relative length of the short and long lines on a scale is a point of some consequence. In general, if the long or ten lines have a length of 1, then the fives should be 0·75, and the units 0·5. In many cases it has been the practice to make the shortest stroke of the same length as the space between it and the adjoining one. An open scale is easier to read than a crowded one. The eye becomes remarkably proficient in subdividing small spaces. Mr. Trotter* has given a good deal of consideration to the size of figures on instrument scales, and suggests a simple block letter, the total width of which is seven-tenths of the height, and the thickness of the strokes forming the figure one-tenth of the height, as the most satisfactory. Some experiments made at the National Physical Laboratory have shown that when the figures have to be made luminous by means of a radium compound the proportion of width of line to the height of the figure for maximum legibility should be about 1 to 8 for letter and figures in which the height exceeds 5 mm. Below this limit experience suggests that the breadth of line may be usefully increased to one-sixth of the height of the figure.

In designing an instrument the conditions under which it is to be employed (*i.e.*, the skill of the user, the effect of weather if used outdoors) must be considered. The research instrument of to-day is the tool of to-morrow. Instrument makers have failed in this, that they have not realised sufficiently quickly the new applications of research to industry.

THE EFFECT OF CRITICISM ON DESIGN.

What then does the new application of an old instrument or the use of a new one entail? First of all, imagination to see a prospective demand; second, efficient and economical methods of manufacture. Several leading American instrument firms have organised development departments. A dozen instruments are made to put out into service with a view to attract outside criticism. After the criticisms are received the final model is prepared, and the development department hands to the works a finished instrument for manufacture on a large scale.

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* Abstract of the Presidential Address to the Optical Society.

* "A Set of Proposed Standard Numerals for the Scales of Measuring Instruments," A. P. Trotter, Journal Inst. Elect. Eng., Vol. LIV p. 273, 1916.

Having decided that there is the possibility of a fairly large sale it is advisable to consider what parts may be pressed or die-cast, and to incorporate as many standard parts as possible. A reduction in cost may frequently be made by replacing brass or bronze by cast-iron or die-cast aluminium parts. Well-made metal patterns are essential on account of the time saved in preparing jigs and fixtures. Various finishing processes, the lacquer and paint spray, the sand blast and the electroplating plant, all form part of the equipment of a modern instrument factory, and by enabling the employment of unskilled labour help to reduce the cost of manufacture. The moulding of ebonite and bakelite is a valuable process, and should be used largely in future instrument work.

The catholicity of knowledge required by the instrument maker has been emphasised both by leaders of the industry and employees. The authorities at two or three of our universities are widening their courses in optics to try and train the future designer of optical systems. The British Scientific Instrument Research Association, under the able direction of Sir Herbert Jackson, promises to be a great help to the industry.

I believe there is a future for the manufacture of scientific instruments in this country. The community is beginning to appreciate the help that instruments can give it in its industrial life. The growth of science and the spread of scientific education will open out many new opportunities for the use of instruments. The instrument maker must rise to these opportunities.

Railway Telegraph Construction.

By M. G. TWEEDIE, A.M.I.E.E.

Telegraph line construction for signalling and communication purposes on railways has features not possessed by Post Office work. Railway circuits, for instance, until recently were comparatively short, long distance telephone trunks being rare. The lines are nearly always open. The number of wires on a railway route, of course, varies. In the neighbourhood of a big railway centre 200 or 300 wires may be required. Air space paper cables are usually employed instead of open work at such places. On branch lines worked by electric train staff apparatus three wires only are required, one wire for the electric train staff instrument and a pair for the telephones.

Railways being permitted to erect their own lines on their own property, are not troubled by the necessity for easements when planting stays or struts as long as they remain on railway ground. In consequence a large number of stays and struts are used.

Development Small.

The development of the lines is slight, as the route is restricted to the side of the railway in most cases. As an increased demand for telephones and other appliances arises additional wires are added to existing routes. When renewing poles and wires allowance has to be made for this sort of thing. A relief can be obtained in some places by having pole lines on both sides of the railway, but this is not always possible. P.O. wires are sometimes carried on a separate route to the railway wires in this manner. Close estimating and design of open lines and cable routes is not resorted to in all cases, the district inspector being allowed a free hand. The latest G.P.O. practice is, however, used as a guide nowadays.

Renewals of routes are necessary after 40 years or so. When these routes pass through large centres the question of cabling is considered, and usually adopted. The difficulty of not being able to add short lengths to a cable route, such as from a track current to a signal box, is overcome by running insulated wire in the casing carrying the cable. Should the cable be armoured and suspended on hooks, a special route of wood casing or steel conduit is required for occasional wires.

G.P.O. Practice Followed.

The arrangement of the wires on the poles is gradually becoming the same as G.P.O. practice. Generally the telephone and telegraph trunks are kept at the top of the poles, below them local telegraph or telephone circuits, with block and repeater circuits, &c., in the bottom positions. Spare arms are left below each group of wires. By this method the addition of extra wires or alteration to existing local circuits is not likely to affect the through wires. Revolving has been adopted for telephone circuits on new routes. On the old routes, with short and long arms alternately, crossing is used. Owing to the great difficulty experienced in picking up the right wires after a breakdown, when they are revolved, it is quite possible crossing will be reverted to. It is not, perhaps, generally known that the short and long-arm design was used to prevent contacts when the wires got out of regulation. It would appear from this practice that not very much importance was attached to the regulation of wires in early railway telegraph days.

If any surveys for new routes have to be made the method employed is left to the local inspector. New routes are required for new or reconstructed railways, or diversions of existing routes for widenings and alterations to the railway boundaries.

Method of Layout Employed.

For laying out poles and other heavy stores a special train can be employed, and this usually necessitates Sunday work. With the present scale of pay received by railwaymen this is an expensive business. It is quite a question whether motor lorrying out stores by road on week-days to convenient points where roads cross or meet the railway would not save this expense. A special train with train crew has to be paid for by the telegraph department; it is not supplied free, as might be supposed.

The actual digging of pole-holes, fitting and erecting poles can be done on week-days as well as wiring or transferring wires. The construction gangs when less than two hours' train journey from their work reside at home. If working further away they are required to lodge out. As men object to this and they have also to be paid lodging allowance, the employment of a 30 cwt. motor lorry to convey them to and from their work would be of mutual advantage to the railway and the men. The gangs would be conveyed direct to their work, and no waits for trains and walks from the nearest station to their work would be necessary. The men would also be fresher. This method of getting the gangs to their work and back was employed by the Railway Telegraph Branch of the British Army Signal Service in France with entire success. The G.P.O. have also moved their gangs about in this way since the war.

Working Conditions.

The conditions under which cable work is carried out are very similar to open construction, except that a cable inspector does the entire work with his own men, and when finished it is handed over to the district inspector for use. As cable work in most cases is only necessary at big railway centres to which a fast frequent train service exists, railway travelling would not take up an undue amount of time. Also when men do lodge away they can usually live close to their work. When tunnels or bridges are being cabled similar conditions to those of the construction gangs arise, and motor transport might be used with advantage.

As far as the engineering and designing of routes is concerned, some railways have an engineer who specialises in this work, while other lines leave it entirely to the district inspectors. On the latter lines practice and quality of work differs according to the experience of the inspector. Headquarters may occasionally issue general instructions, but no close study of construction is made or considered necessary.

During the war a considerable mileage of branch lines was taken up and sent overseas. At the same time the telegraph route was dismantled. Now some of these lines are being replaced, and in consequence a telegraph route will be required. It would be interesting to know whether the advantages of the 20 ft. Mannesmann steel pole have been considered for this work. It is easy to handle, quick to erect, and no arm slotting is required, and they should be practically indestructible. They are used extensively in the colonies, where only native labour is available, and insects and climate make the use of wooden poles impossible.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Offices on receipt of published price, plus postage.]

"Germination in Its Electrical Aspect." By A. E. Baines. (London: G. Routledge & Sons). Pp. xxi+185. 12s. 6d. net.

"Practical Electrician's Pocket Book and Diary, 1921." (London: S. Rentell & Co.). Pp. lxxv+522. 3s. net.

"Wireless Telegraphy, with Special Reference to the Quenched-Spark System." By B. Leggett, A.M.I.E.E. (London: Chapman & Hall). Pp. xv+485. 30s. net.

"Die Transformatoren." By Dr. Milan Vidmar. (Berlin: Julius Springer). Pp. xvi+702. 120m.

"Domestic Fuel Consumption." By A. H. Barker, B.A., B.Sc. (London: Constable & Co.). Pp. x+159. 14s.

Laxton's Builders' Price Book for 1921. (London: Kelly's Directories, Ltd.). 104th edition. Pp. clx+537. 7s. 6d. net. Supplement, pp. 219.

Correspondence.

AMPLIFYING THE OPTOPHONE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Campbell Swinton's letter in your issue of March 11th reports the first success obtained in making optophone sounds *audible in a room.* The sound produced by the French military amplifier was sufficiently loud, but the loudness was not the same for all the five notes. There was a certain amount of selective action. Acting on Mr. Swinton's advice, I tried other amplifiers, and the final success was obtained on March 2nd with a three-valve amplifier, kindly lent by the Marconi Wireless Company. The experiments took place at the National Institute for the Blind in Great Portland-street, in the presence of Sir William Collins, D.L., K.C.V.O., the well-known ophthalmic surgeon, Mr. F. Swann, of the Marconi Company, and Mr. C. P. MacCarthy, for many years concerned in teaching blinded soldiers to read. The sound was emitted by a wooden trumpet, and easily filled a moderate-sized room. Two blind pupils trained at the Institute, Mr. Emblen and Miss M. Green, were immediately able to decipher the sound and "read" the book mounted in the optophone. It was Sir A. Pearson's "Victory over Blindness," printed in ordinary clear type. The system used was that known as "white-sounding," in which the letters are characterised by the notes they extinguish rather than those they sound. The optophone as constructed by Messrs. Barr & Stroud, Ltd., can be worked on either system, but I prefer "white-sounding" for its simplicity and reliability.

The importance of this new development lies not in its use to the individual, who will probably prefer the earpieces, but in the facility with which a large class of blind persons can now be taught at once.—I am, &c.,

London, March 14th. E. E. Fournier d'Albe.

A QUESTION OF NOMENCLATURE—WIRE RADIO.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The question of the choice of an appropriate name to designate a new discovery in science or an important invention in engineering is frequently a difficult one. A suitable name must meet at least the conditions of briefness, euphony, and at the same time conveying a fairly adequate idea of the subject. The suggestions that have been made of designating the system as "High Frequency" or "Mega Frequency" do not seem to me quite apt inasmuch as frequencies down to 3 000 cycles per second are being used for multiplex telegraphy. In fact, it is the present practice of the American Telephone and Telegraph Company to reserve the band of frequencies between 3 000 and 10 000 cycles for telegraphy.

It is my opinion that the original suggestion of General Squier in your December 17th issue proposing the term "Wire Radio" is good. This term conveys the idea of transmitting telephonic or telegraphic messages over wires employing radio means and equipments in the matter of frequency, source of power, apparatus, &c. The only objection to this designation is that the word "Wire" assumes different forms when translated into different languages. To meet this objection I would suggest the term "Line Radio Telegraphy and Telephony" which is a slight modification of the term proposed by General Squier. The word "Line" being practically the same in German and French as in English.

It is to be regretted that we did not adapt the practice of so designating every new art as to associate it permanently with the name of the inventor; we could have then in this case called this system "Squier Telegraphy" as suggested by Dr. Eccles in his letter of January 14.—I am, &c.,

Washington, D.C., February 20. Louis Cohen.

THE ELECTRIC WASHER—IS IT A TOY OR A TRIUMPH?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I was pleased to see the letter from "American Housewife" on the above subject, and can fully endorse her remarks about hot water, filling, and hanging out to dry. I have had an electric washer in use at home for over 12 months, and can testify that it is not only a triumph but a boon! Not only is my wife delighted, but our charwoman is enchanted with it, and has on several occasions operated it single-handed, thus testifying to its simplicity in use.

The average number of articles washed per week is over 100—the operation occupying 1 hour—and the total current consumption less than a third of a unit. One great advantage which has not been mentioned by your correspondent is that having filled the machine and switched on, other work can be proceeded with.

I would state that from my experience the best type of machine is the "Canadian Dolly Type" with a wooden tub, as you not only get the rubbing effect of the old washing board but the water keeps hot for a much longer period than is the case with a machine having a metal body.

I consider that the electric washer is the greatest time, labour and money saver of all the labour-saving devices on the market, and, considering its small current consumption with consequently no necessity for special wiring, it ought to have a great future in this country.—I am, &c.,

Pinner, March 15. H. Wynne Roberts.

ELECTRIC WASHING AND THE BIRTH RATE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In last week's Electrician "An American Housewife" (who, I suspect, is not quite so feminine as her pseudonym might lead one to suppose) takes me to task somewhat belatedly for an almost forgotten article of mine on the subject of electric washers. Her letter is courteously critical, but I think is written without conviction, and purely as a piece of commercial propaganda. Whoever your correspondent may be, she is certainly acquainted with the art of special pleading, and knows how to avoid any controversial rocks which might wreck the frail vessel of her argument. It would not surprise me at all to learn that the writer's interests are concerned more with the selling than with the use of electric washers.

An Incredible Figure.

I am flattered by the statement that my article has aroused "considerable comment among American housewives," and feel that such an end would justify almost any means. However, I had no intention of suggesting that American housewives are any more foolish or extravagant than their English sisters. In some respects I believe they are a great deal wiser, but I certainly believe that American husbands are far less shrewd than the average Englishman in their choice, or in guiding their wives' choice, of household equipment.

The figure of $100 000 000 given as the total value of American washing machine sales for 1919 was taken, I think, from "Electrical Merchandising." I may have over-estimated (or rather over-guessed) the number of washers represented by this amount of money, and I am quite prepared to accept your correspondent's deduction—if she can convince me of the accuracy of her financial premise, of which, for the moment, I prefer to remain politely incredulous. Nothing short of properly certified statistics would induce me to believe that 550 000 electric washers were manufactured in the United States in any year since their regretted defection from the British Empire.

Colour the Determining Factor.

As for "An American Housewife's" specific arguments, they are really unanswerable; not because they are true, but because they are mostly irrelevant. The electric washer might economise hot water if it were not for the fact that the water generally gets unusably dirty before it gets unusably cold. In other words colour and not temperature is the factor which decides the necessity or otherwise of changing the water. In any case there are such things as tubs fitted with lids and hand-operated dollies. Temperature preservation is not an exclusive feature of the electric washer.

In the matter of filling, emptying and carrying tubs, your correspondent is delightfully naïve. Of course, one may fill an electric washer or a tub or a cup—or any old receptacle—

by the syphon method, if one cares to do so. The point I tried to make in my article was simply that the electric washer, *per se*, did not relieve the housewife from the work of filling and carrying tubs. "An American Housewife" might just as well argue that the electric washer is of great domestic value since it enables her to see better, owing to the fact that her husband had a larger electric lamp installed in the wash-house when he bought the washer.

I think I did suggest that some of the American *electric* washers were probably *gas* heated, and I regret to find my suspicions confirmed by your correspondent. If that is supposed to be an advantage of electric washing, then give me the honest filthiness of a gas copper.

A Little Bet.

"An American Housewife" is apparently not aware that it is a common practice in this country to wring out the clothes before hanging them up to dry; or does she mean to imply that an electrically-driven wringer is capable of extracting a greater proportion of the moisture than an ordinary wringer operated by the strong right arm of an English charwoman? Even I, a weakly scribe, could, almost without effort, pass through a hand-operated wringer heavy and much-folded articles which would be entirely beyond the power of a quarter-horse motor.

I wouldn't mind laying heavy odds—say a case of Scotch whiskey against an American "Ersatz" liqueur (I am sure your correspondent would prefer whiskey to gloves or other feminine fal-lals) that clothes can be more quickly and thoroughly relieved of their water content by means of a hand wringer than by means of the absurdly inadequate device attached to the average electric washer.

Justifying Circumstances.

"An American Housewife" is probably quite right in what she says about American charwomen and laundries, in which case we may perhaps admit that the electric washer has a certain economic value in the dry and servantless land of her nativity. Obviously, if manual help cannot possibly be obtained one *might* be justified in spending as much as a thousand pounds on a device which would save ten minutes' work a week. It all depends upon the valuation one puts upon one's time.

My economic criticism of the electric washer was based on English conditions, and in England one can still hire charwomen at a fair wage and of a fair degree of competence.

No Char—No Children.

I am interested and amused by the somewhat illogical relation which your correspondent seeks to establish between the problems of racial suicide and domestic help. "On the farms," we are told, "where for a generation household help has been almost extinct, the families average but two children apiece . . ." A closer study of her country's vital statistics would no doubt also reveal the disconcerting fact that in the large city mansions, where servants in sybaritic profusion jostle one another on every stair and landing, the families also average but two children apiece. She would also find that in the poorest families, where there is neither room nor money for any kind of domestic help, the birth-rate is extraordinarily high.

Hard work has never stopped any woman, whether American or English, from having babies; indeed, it seems rather to encourage procreation than otherwise, and I am afraid "An American Housewife" must look elsewhere for an explanation of the low birth-rate in rural districts. Anyway, if she *is* right, the obvious and simple corrective (from her point of view) would be to install an electric washer in every farm-house.

Our Racial Needs.

If her last paragraph is intended to be taken seriously, your correspondent has at the end found herself compelled to surrender to the calm logic of my original argument, since, following her birth-rate line of thought, she admits that the survival of the genus charwoman is essential to the racial needs of England. In other words, she confesses that the charwoman can do more to increase our depleted population than the most ingeniously contrived electric washer; which is, of course, only reasonable and in accordance with modern biological theory.

In conclusion, may I assure "An American Housewife" that my wife's charwoman is by no means a household drudge. She is an independent, intelligent and industrious woman, well, but not extravagantly, paid, and she does not consider herself "unfortunate" in her employment. She *completely* relieves my wife of the labour of clothes washing, which is more than any electric washer could do, even if it lived up to all the claims which have been made in its behalf. I am, &c.,

"Electrocynic."

A Ministry of Origins.

By ERNEST J. P. BENN.

The Bill introduced into the House of Commons on Friday last by the Prime Minister to provide for the recovery of the German indemnity should be carefully studied in all its many details by every trader. As has so often happened in connection with recent legislation, a good political purpose is made the occasion for an extension of the practice of bureaucratic interference with trade upon a scale which rivals in magnitude any of the arrangements for control put into force during the war.

I am not in this connection one little bit concerned with the rival schools of thought on the question of the German indemnity; I do not desire in any way to argue either as to the wisdom of the 50 per cent. arrangement, as to its practicability or as to its effect upon the import and export of goods from or to Germany. It is obvious that the proposed collection of the 50 per cent. tax will render trade with Germany wellnigh impossible, but if that were the only probable result of the measure now before the House of Commons, I should not be concerned to discuss the matter in these pages. The Bill as drafted, however, will not only affect goods that are known to be of German origin, but will give to the bureaucrats the widest powers of inquisition into every sort and description of trade and exchange. It is in effect another sample of the old dodge by which the boards of officials attached to the 80 Government offices which still fatten upon us manage to keep themselves in existence, and to grow and multiply indefinitely.

A Staggering Blow to Freedom.

The German Reparation Recovery Bill, if it goes further in its present form, will be the first step towards the establishment of a new Ministry of Origins, which will rival in its size and its ramifications the Ministry of Health itself. In order to trap the miserable German the English trader is to be subjected to the minutest examination as to the origin of every article which he handles. One clause provides that the Commissioners shall be empowered to require "particulars in the prescribed manner as to the country of manufacture or production of *any* goods, and that if the particulars are not furnished to the satisfaction of the Commissioners, the goods shall for the purpose of this Act be deemed to be goods wholly manufactured or produced in Germany." If the Bill contained no other clause than this, it would be condemned as a staggering blow to the last remaining shreds of freedom in commercial and industrial matters. There is not a shadow of a doubt that under this clause the Board of Trade, or the Commissioners of Inland Revenue, or both, will proceed to appoint gangs of officials in every part of the country, who will be armed with powers to hold up business at every point until particulars, which in most cases the possessors of the goods will be quite unable to give, are furnished to the satisfaction of the said officials. How in the name of reason is it possible for the importer of an American consignment to satisfy the Commissioners of Inland Revenue as to the country of origin of every portion of the goods which he has purchased? The clause, it will be noted, covers all transactions in the goods of any country, and stands in the way of the expeditious completion of business with Italy or France just as effectually as it bars business with Germany.

As might be imagined, the bureaucratic experts are not so innocent as to allow a chance like this to slip through their fingers, and they have built upon this need for a certificate of origins a whole host of complications modelled on the exact lines familiar to those who tried to do business in the days when the Ministry of Munitions appointed a Professor of Literature to arrange a system known as Priority. No less than four Government departments, the Treasury, the Commissioners of Customs and Excise, the Board of Trade and the Lord Chancellor, are all empowered under this Bill to make such regulations, to frame such schedules, to appoint such officials and to require such particulars as they in their sole discretion think fit. A special clause is introduced containing the mandatory word "shall," in which the Board of Trade is to appoint committees for the various purposes of the Act, which means that the machinery of the Military Service Tribunals is to be re-instituted in order to subject every parcel of goods upon every tradesman's shelves to appropriate processes of examination. The big new printing works which the Stationery Office has just acquired almost as if to accentuate the already difficult problem of unemployment in the printing trade, will now be busily occupied producing large sheets of rules and regulations under this Reparations Recovery Act, and traders will have to reorganise their clerical staffs in order to comply with all the demands that will be made upon them in connection with it.

A Typical Example of Control.

Here, for instance, is a typical provision which on the face of it has an appearance of reason :—

> The Board of Trade may by order —
>
> (*a*) Reduce as respects articles of any class, make or description, the proportion of the value of the goods payable to the Commissioners under this Act, or exempt articles of any class, make, or description, from the provisions of this Act.
>
> (*b*) Vary as respects articles of any class, make or description, the precentage referred to in section two of this Act.
>
> (*c*) Extend the classes of contract to which section four of the Act relates.

The House of Commons will no doubt be cheerfully assured by Ministers that in the above respect the Bill contains every safeguard against any hardship which it might inflict upon any particular class of trader. That benevolent and far-seeing friend of industry, the Board of Trade, may be trusted to give immediate attention to any request from responsible firms to "reduce," "vary," or "extend" the provisions of the Act as it may seem desirable. But what does this mean in actual practice ? The Federation of British Industries, the British Commercial Association and a thousand Chambers of Commerce will at once appoint Committees to study the damage which may be done to interests which they represent, and a stream of deputations will rush to the Board of Trade. A big new building will be commandeered, a thousand clerks with appropriate superiors appointed, and they will in due time issue long lists of reductions, variations and extensions which will puzzle and bewilder every tradesman in the land just as surely as did the daily emissions of the Ministry of Food.

A New Inauguration.

It follows, of course, that in order to secure relief from the injustices which will be wrought by this measure, the unfortunate traders who are brought up against it will be required to disclose all sorts of particulars, to be subsequently passed on to Revenue officials or profiteering officials or other departments which may exist. All these departments will promptly increase their staffs in order to deal with the new grist thus brought to their mill, and the business of earning an honest living will be made still more difficult.

The most determined advocate of heavy indemnities has no wish to add to the difficulties of English trade and commerce. These difficulties are already great enough ; the absorption of unemployed, the recovery of the exchanges, the improvement in the standard of living, and the reduction of its cost all depend upon a simplification and facilitation of trade and commerce, and the business world is earnestly praying for the rapid removal of still more of the restrictive bureaucratic arrangements which now make things so difficult. The present criticism will be misunderstood if it is interpreted as an argument for an easement of the terms as regards our late enemy ; assuming that the 50 per cent. arrangement is a proper and workable one, it will be quite easy to bring it into force without imposing upon us another army of officials. If the House of Commons would take the view that the community was composed of honest persons, and would pass a short Bill requiring 50 per cent. of any specified moneys to be paid to the Commissioners of Inland Revenue, and at the same time attach heavy penalties to a wilful invasion of these provisions, the whole thing could be done with the simple assistance of half-a-dozen extra officials in the Department of the Public Prosecutor. This Bill, like most other recent legislative enactments, is simply a Bill to provide work for officials. It starts like the others upon the assumption that every trader is a thief, and that he must be made in connection with every transaction to give guarantees and undertakings as to his honesty. The life of bureaucracy depends upon the maintenance of this pernicious idea. If we could get back to the old theory that an Englishman is innocent until he is proved guilty, if we could give one another credit for honest intentions and rely upon penal clauses for the punishment of offenders when found, we should save a lot of money in officials, add immeasurably to the comfort and efficiency of our business men, and all of us would be a great deal better off.

W. Lancs & Mersey Electricity District

The inquiry by the Electricity Commissioners into the schemes for the reorganisation of electricity supply in the West Lancashire and Mersey District was resumed on the 8th inst. and concluded on the 10th inst.

At the outset it was announced that Warrington and St. Helens Corporations had withdrawn their support to the scheme for the formation of a joint electricity authority. Warrington Corporation felt the time was inopportune for the inauguration of schemes involving large capital expenditure and they requested the Commissioners not to proceed with the constitution of a joint authority. Later in the inquiry it was announced that Warrington had altered its views and that it would support the scheme for a Joint Authority.

St. Helens Corporation, acting on the advice of their Electricity Committee, decided that having regard to the evidence given and the attitude adopted by Birkenhead, Wallasey, Bootle, Warrington and Southport, they could not give any further support to the scheme, though they considered advisable the preparation of a scheme for another area.

Mersey Company's Case.

Mr. **Tyldesley Jones**, K.C. (for the Mersey Power Company), contended that the district served by the Company, including the urban and rural districts of Runcorn and Widnes, should be excluded from the joint area. Big questions were involved which could not be settled by an electrical engineer looking at a map which showed him the distribution of population and industry. He urged that the Commissioners must put in the forefront of their deliberations the necessity of giving fair treatment to existing undertakings which had done a great deal to develop the electrical industry. In every scheme put forward compulsion must be absent. An idea had got about that if people did not come in they would be forced in by the Commissioners. That unfounded idea had had considerable effect in the country generally and had begotten a distrust in the minds of those who had been previously prepared to invest large sums in the industry. The Act did not contemplate the splitting up of the United Kingdom into a certain number of electricity districts.

The Chairman : That is about as likely and untrue as the proposal that all the existing generating stations should be wiped out and replaced by 16 super-stations.

Mr. **Tyldesley Jones** proceeded to describe the growth of the Mersey Power Company's undertaking. From $1\frac{1}{2}$ million units in 1912 the supply had grown to 25 millions last year. Ten large new works had been established in the district in the same period. The average price charged worked out at less than 1d. per unit, and the Company was satisfied that it would be able to maintain its supply at the same average price from its new steam power plant. The district served was one which was peculiarly favourable for cheap supply. The Company was in a peculiar position because of the advantages it derived from the chemical industries which it served. Was it suggested that the chemical industry was to bear a bigger burden in order that there should be a cheaper supply for the collieries of St. Helens or the mills of Liverpool ? It would be fatal to many industries, which were only able to carry on against foreign competitors by means of utilising to the utmost the peculiar benefits of their processes, if that policy was to be adopted.

Mr. G. W. **Malcolm**, joint managing director of the Salt Union (owners of the Mersey Power Company) explained how the waste heat from salt evaporators was utilised in the production of electricity. The possibilities of the district could be better developed under private enterprise than by public control. If the Company had failed to develop its area and to put into its undertaking all the capital required, there might have been a case for public control, but, in view of its record, such interference would be absolutely unjustified. In three months time they would be supplying part of Ellesmere Port, and they were prepared to supply the industrial district along the Weaver valley.

In cross-examination by Mr. Lloyd, witness denied that the salt trade was very unstable ; it had been particularly steady for a long time past, and whatever happened to the trade, nothing would interfere with the 25 000 000 units supplied by the Salt Union to the Mersey Company. When the new steam power plant was completed the waste heat factor would be very much diminished in importance.

Mr. Jas. **Nelson**, electrical engineer to the Mersey Power Company, said that last year the Company had 1 013 consumers, of whom 63 were for power. Towards the close of the war the Ministry of Munitions encouraged the Company to erect a main generating station.

Mr. Wm. **McLellan** (Merz & McLellan, consulting electrical engineers to the Company) thought that the joint electricity authority could not possibly supply the Company's area as cheaply as the Company would be able to do from its new generating station. Other possibilities of the utilisation of salt-making processes in the generation of electricity were being examined. He did not regard the Mersey as an electrical barrier, as there was the tunnel. A joint authority, with all the warring elements of which it would be composed, would not be likely to develop the area efficiently.

In reply to Sir **Harry Haward**, he said he meant it was never easy to get local authorities to work harmoniously together. If they were prepared to sink their personal differences and only be interested in cheap electricity, it might be possible for them to combine, "but they won't do that ; there is jealousy between local authorities."

The Chairman : Do you think the present difficulties—the high prices and enhanced cost of money—have rendered less desirable the general principle which was laid down in 1918, and generally accepted by the electrical industry, that large schemes for the generation and transmission of electricity were to be preferred to the old parochial system ?

Witness : I think the principle is still an end to be aimed at.

Mr. J. E. Singleton, for Runcorn Urban and Rural Councils, said that their case was bound up with that of the Mersey Company, by whom they were at present supplied. In the unhappy event of their being included in the joint district, they considered they were entitled to better representation than the fraction of a number which was suggested.

At this point the town clerk of St. Helens (Mr. W. H. Andrew) made a statement as to the reasons which had induced his Corporation to withdraw its support from the scheme. The Corporation had all along been of opinion that it could produce electricity more cheaply for itself than it could get it from the joint authority, but it recognised the general advantages of co-operation and had been willing to associate itself with the scheme even at a cost of some sacrifice. For the success of such a scheme, however, it was essential that they should all pull together, and it was quite evident from what had taken place that that happy state of affairs would not come to pass. The picture which kept recurring to his mind was one in which they were all in the same boat, Liverpool acting as stroke, and all the others pulling in different ways, and Bootle as cox steering them into all sorts of trouble, with the Commissioners on the bank hurling all sorts of maledictions at their heads.

The Chairman : I am afraid that we should need a megaphone to make some of you hear.

Mr. Andrew said there was a strong suspicion abroad that the backbone of the scheme was a desire to boost up Liverpool at the expense of its neighbours.

The Chairman : I am sorry that the attitude of St. Helens is not more helpful to the Commissioners.

The Wirral Scheme.

Mr. Jeeves, K.C. (on behalf of Wallasey Corporation) called further evidence in support of the Wallasey and Birkenhead proposal for the formation of a separate area for Wirral.

Mr. A. Collins, of Birmingham, spoke in favour of the Wirral scheme from a financial aspect, and said that the success of any scheme depended upon the joint electricity authority having control of the existing stations, to do with them as it pleased. The three essential points upon which every local authority should have information before committing itself to the promotion of any scheme were : The method of dealing with the existing stations, the method of payment for such existing stations and the security for capital issues, and the price which one would expect to be charged to the local authorities concerned. He thought it wiser " to refrain from spending capital now and go on, even at a slightly greater cost producing current from the existing agencies."

The Chairman : Is the logical deduction from that an abstention from electrical enterprise at the moment ? Yes, except such as is absolutely necessary to meet immediate future demands, and if they can be carried out without the building of new capital stations, it is wiser to refrain from capital outlay. He found "electrical engineers to be always very optimistic. If a capital station is put down and the price of current is not so low as they estimate for the potential demand in 1925, the results will in reality bear a very different construction."

The Chairman : In certain districts in which estimates were supplied to the Commissioners in 1918, the actual output during the two years has been in excess of the estimates.

Witness : It would be well if everyone did the best they could with extensions of the existing stations to meet a reasonable estimate for demand than to commit themselves to the erection of a super-station to meet an optimistic estimate. Birkenhead and Wallasey Corporations would be able out of their own resources to raise without delay the money for a Wirral authority. It was an experiment on lines agreed between the parties well worth the consideration of the Commissioners.

On the 10th inst. Sir John Snell asked the clerk of Ellesmere Port Urban Council why his Council had not put into force its electric lighting order of 1913.

In reply Mr. Francis said the Council had acquired the gas undertaking since the order was obtained. Negotiations had taken place with the Mersey Power Company for a bulk supply, but the Company was not prepared to give it. The Company preferred to secure a transfer of the order, and if that were not permitted, to supply the large power-users only. In other words, the Company wanted all the plums. The policy of the Council was not to make a profit out of electricity, but to secure the cheapest and best supply for the development of local industries, and for that reason it was supporting the proposal for a joint electricity authority.

Mr. C. P. Sparks, consulting engineer to the Wallasey and Birkenhead Corporations, was recalled on one or two technical points.

The Chairman : Is it your view that, having regard to the present prices, and the high cost of money, the increasing demands for electricity will be better met by compartment development than by comprehensive development ?

Witness : I am afraid we shall have to accept compartment development. I am very much opposed to it, but I cannot see any other way of doing it. He agreed, however, that compartment development would represent a greater capital expenditure than the larger schemes. He also admitted that in America even the large undertakings, compared with which ours were insignificant, had voluntarily committed themselves, though governed by private enterprise, to association in bigger groupings ; but the American electrical engineer was held up by economic conditions. Mr. Sparks thought we might proceed with groupings on a smaller scale, and finally merge those groupings in large schemes.

Mr. Harold Dickinson was also recalled in order to give evidence against the Wirral scheme. He expressed the view that in order to secure the best results it was desirable that in any joint district formed, the existing generating stations should pass into the absolute control of the joint authority. Otherwise endless chaos and intense dissatisfaction was bound to arise. So far as he was aware, all the promoting authorities of the Mersey and West Lancashire scheme intended to hand over their generating stations to the joint authority, subject to terms.

Mr. Jeeves, K.C., then addressed the Commissioners for Wallasey, and Mr. Miller, K.C., followed on behalf of Birkenhead Corporation. Both opposed the scheme, as did Dr. Eastham for the Manchester Ship Canal Company, but only in its present form. The Canal Company thought the promoters had not treated the financial side of the question in a convincing manner. Under the scheme the prospect of a supply to the growing industrial district on the south bank of the Mersey seemed to be remote, but from the Mersey Power Company a supply could be secured at an early date. If the scheme were approved the Ship Canal contended that it should include an obligation to supply the extensive and important industrial area in the development of which the Ship Canal Company was interested.

At this point Mr. Wooll intimated that Warrington Corporation was not antagonistic to the principle of a joint authority. The Mersey and West Lancashire scheme had not impressed them, but they would reconsider it on the modified lines which the Commissioners had suggested. They would certainly do their best to co-operate in any approved scheme.

Mr. Tyler, who represented all the railway companies concerned (except the Lancashire and Yorkshire, the Mersey, and the Liverpool Overhead Companies), referred to the contention of St. Helens Corporation that they should be left out of any scheme devised. The railway companies' experience of St. Helens Corporation in regard to electric supply had been somewhat unfortunate. Ten years ago application for current for railway works at Earlestown was rejected on the ground that it was outside the St. Helens area—a difficulty that could easily have been surmounted if St. Helens had been so minded. Eighteen months ago the application was repeated, and the reply was that the Corporation had not got the plant to give the supply. In those circumstances the railway companies asked that St. Helens should be included in the joint electricity district.

Mr. T. D. Clothier (for Bootle) said his clients wished to see the possibilities of a joint district explored to the full, but the scheme produced did not commend itself to them. They felt that they could obtain a better and cheaper supply from their own modern and well-equipped generating station.

Mr. Stewart-Brown, for the Mersey Docks and Harbour Board, expressed the view that the area provisionally determined was as small as should be prescribed for any scheme approved. The board deprecated the withdrawal of St. Helens, Warrington and the Mersey Power Company, as any diminution of the area would be a weakening of the advantages of combination. They were opposed to the Wirral scheme on the same ground, and also on the ground that it would have the effect of putting the board's estate under two different electrical authorities.

Representatives of the Lower Bebington and the Formby District Councils, of the United Alkali Company and Messrs. Lever Bros., also addressed the Commissioners, and the proceedings concluded with an effective reply by Mr. Wooll for the promoters of the larger scheme.

The Chairman intimated that whatever the outcome of the inquiry might be, it was proper that public acknowledgment should be made of the gratitude due to Mr. F. C. Wilson, the chairman of the conference of local authorities ; to Mr. E. W. Pierce, the Liverpool deputy town-clerk ; and to Mr. H. Dickinson, electrical engineer, and all their colleagues on the conference, for the initiative and self-sacrifice they must have devoted to the production of a scheme. With so many public authorities possessing individual aspirations and conflicting points of view, it must have been a great labour to produce any scheme at all.

The Nation's Financial Outlook.

Mr. Thornton, in a little book on " The Nation's Financial Outlook " published by Messrs. P. S. King & Sons, has given to the business man exactly what he requires to enable him to follow with understanding the Budget problems which will now loom large in public discussion. We remember no book on this thorny question which contains less of political bias, although Mr. Thornton expressly disclaims any desire " for the benefit or prejudice of any particular class." The taxpayer is given in an hour's reading a bird's-eye view of the financial situation and led gently but firmly to a serious view of his responsibilities. By avoiding detail and giving admirable summaries of main figures, the general problem and the bearing of its various parts one upon the other are made evident, while by way of a finishing touch, a chapter is added on the position of other countries which helps to get the whole picture into correct perspective.

I.E.E. Summer Meeting.

Further particulars have now been received regarding the summer meeting of the Institution of Electrical Engineers in Scotland. On Tuesday, June 7, in addition to the visit to Dalmarnock generating station, visits will also be paid to Messrs. John Brown & Company's shipyard at Clyde Bank, the Clyde Mills power station of the Clyde Valley Electrical Power Company and to other works, while an excursion will be made to some of the Glasgow Corporation's reservoirs. In the evening there will be a public function in Glasgow. On Wednesday, June 8, a Paper will be read at the Glasgow University by Prof. Magnus Maclean on the "Hydro-Electric Resources of the Scottish Highlands." In the afternoon a visit will be paid to Messrs. Babcock & Wilcox's works at Renfrew, followed by a river excursion on the Firth of Clyde at the invitation of that firm. On Thursday, June 9, the party will proceed to Fort William, where they will spend the night. On Friday they will visit the works of the British Aluminium Company at Kinlochleven and then go on to Oban, where the visit will terminate. Work and pleasure are therefore to be aptly mingled.

Members of the Institution have been circularised as to their intention of attending the meeting and it is requested that the necessary notification be sent to the Secretary not later than March 28.

Scottish Electricians' Strike.

The members of the Electrical Trades Union employed by firms in the Electrical Contractors' Association of Scotland went on strike on the 5th inst. and are still out owing to a wages dispute. The wages in the trade had been fixed by agreement up to Feb. 28, and it was also provided that wages should not be altered except on two months' previous notice given on or before Jan. 1. On Dec. 28 last the Union gave notice for a new increase of 6d. per hour, or a total of 2s. 9d. per hour. The employers replied by giving notice of a reduction of 3d. per hour, which would have made the wages 2s. per hour for a 47-hour week. On the 17th there was a conference in Glasgow and the employers intimated that work could not be obtained at existing rates to afford employment to the large majority of the man, and on Feb. 19 the Union were advised that the employers had stated their final position. The Union requested a further conference and this was held on the 4th inst., when no agreement was come to. The Union declared an immediate strike, but a section of the men, both Union and non-Union, have continued at work, and it is stated that Union men are beginning to make inquiries for work at the new rate of 2s. The employers point out that the strike has caused a certain amount of inconvenience in the case of jobs which were nearing completion, or in a few instances where there was special reason for completion on account of urgent demand for the use of the premises; but satisfactory arrangements have now been made to deal with most of these cases. The contractors in the last two months have noted a decided diminution in business, and they felt that the only way to stimulate trade was to reduce the cost of installation all round. In August, 1914, the local rate of pay of electricians was only 9d. per hour.

Tribute to Sir John Benn.

In celebration of Sir JOHN BENN having completed thirty-two years of consecutive service, and so becoming the father of the London County Council, and of his work in Parliament, a number of his friends and admirers have arranged a luncheon in his honour, which will be held at the Connaught Rooms, Great Queen-street, on Thursday, April 7, at 1 p.m. This celebration was at first intended to have been held on Sir John's seventieth birthday in November last, but the state of his health rendered it impossible to proceed with the idea. A representative committee, including Lord Crewe, Lord Pentland, the Right Hon. John Burns, Rev. John Clifford, and Mr. T. H. McKinnon Wood, has been formed to make the arrangements, and the Marquis of Lincolnshire, President of the National Liberal Club, has intimated his willingness to preside on the occasion. Those intending to be present are requested to communicate with the honorary secretary, Mr. Frank H. Elliott, 14, Berners-street, London, W. 1.

The Government Trans-Atlantic Cable.

In the House of Commons on Monday, Mr. Pike Pease (the Assistant Postmaster-General), speaking on a vote of £2 672 500 for salaries and expenses of the Post Office, including telegraphs and telephones, explained that the Government had purchased from the Direct United States Cable Company, at a cost of £570 000, a trans-Atlantic cable for the purpose of coping with additional Imperial traffic, and to provide an alternative line in case of interruption to the Imperial cable owned by the Government. The purchase price included a stock of cable, and the cable stations at Ballinskelligs, Harbour Grace (Newfoundland), and Rye Beach (United States). To lay a new cable would have cost about £1 000 000. The cable, which was transferred to the Post Office on Nov. 4 last, was laid originally in 1874-5, but one-half of it had since been replaced by new cable. The total length was 3 197 nautical miles.

Electricity Supply.

BRISTOL Corporation has applied for sanction to a loan of £125 000 required for extensions of mains and services during the next three years.

TAUNTON Corporation has applied for a loan of £1 000 for meters, principally for 200 new houses being built.

WHITEHAVEN Council has applied for a loan of £1 420 for laying supply mains to Kells, where there are 180 prospective consumers.

Sanction to a loan of £6 165 for extensions of the electric supply mains has been received by DOVER Corporation.

A sum of £4 518 will be spent by COVENTRY Corporation on the extension of electric supply mains to the new municipal houses.

The ST. PANCRAS (London) Borough Council is recommended to expend £23 550 on remodelling the mains in certain streets in the Borough.

ILFORD Urban Council proposes to erect a sub-station in the Broadway district and equip it with a 500-kW rotary converter, a step-down transformer, switchgear, &c.

STAFFORD Corporation has received sanction to the borrowing of £33 800 on account in respect of the Council's recent application for £78 000, for extensions at the electricity station.

The BRAINTREE Urban Council has made an arrangement with the East Anglian Electricity Company for the supply of electricity in the district.

FALMOUTH Council has refused to transfer its electric supply powers, and negotiations are to be opened with the Cornwall Electric Power Company for a bulk supply.

ABERYSTWYTH Corporation has agreed, subject to the consent of the Electricity Commissioners, to permit the local undertaking of the Cheswick Electricity Supply Corporation to be transferred to the British Properties, Ltd.

TORQUAY Corporation has postponed the proposal to erect a new power station at Newton Abbot, and in the meantime a consulting engineer is to report on the possibility of providing further boiler accommodation at the existing station.

BIDEFORD Corporation has entered into an agreement with S. L. Knill, who is associated with Messrs. Crompton & Company, for the erection of electric works, and it is anticipated that a supply of electric current will be available before next winter.

DUNDALK Urban Council has applied for sanction to a further loan of £2 000 for the electric supply undertaking. A difference has arisen with the G.N. Railway Company as to the supply to the locomotive works at Dundalk, and the matter will probably lead to legal proceedings.

The MERSEY POWER COMPANY, LTD., has given notice to the Acting Conservator of the Mersey of its intention to lay three power cables and two telephones cables in the bed of the river from its Percival Lane (Runcorn) power station to Ellesmere Port.

The STEYNING ELECTRIC LIGHT COMPANY, LTD., is applying to the Electricity Commissioners for a Special Order to generate and supply electricity in the parishes of Steyning, Bramber and Beeding, in Steyning Rural District.

A settlement has been reached in the dispute between the technical staff of DARWEN Corporation electricity department and the Corporation, over the non-acceptance by the latter of the Joint Board's recommendations regarding salaries and conditions. The Council have now decided to pay the schedule of salaries, and the grading of the staff has been referred to the district board.

After protracted negotiations between Messrs. J. & P. Coats and PAISLEY Corporation as to a supply of electricity, the firm have decided to extend their own generating station, and to abandon the proposal to take energy from the Corporation. The Electricity Commissioners refused to sanction an extension of the municipal electricity station and satisfactory arrangements for a bulk supply from the Clyde Valley Company could not be made. The result is not very creditable to the parties concerned.

An interesting report by Prof. Gibson and Mr. H. Richardson on the possibility of utilising water power in the generation of electrical energy has been presented to the DUNDEE Electricity Committee. It is pointed out that with the increasing demand for power the existing plant and the extensions in progress will very soon be fully loaded again. By suitably proportioning the capacity of steam and water power plant greater economy is usually possible than with either a simple steam or water-power plant. When the present and proposed extensions are added to the existing steam plant, the capital outlay will reach £660 180, and this will provide 63 000 000 units at an average cost per unit of 0·71d. Hydro-electric energy could either be obtained by developing the Ericht-Tummel scheme, or some modification of it, or by purchase in bulk from the Grampian Electricity Supply Company. If purchase were decided upon, Dundee would be relieved of financial obligations, but care would need to be taken to secure an adequate supply, and a definite contract made to secure current at a lower price than it could be supplied by the city itself. Failing satisfactory terms from the company, it is recommended that the Corporation should consider the development of the Ericht scheme alone at an approximate capital expenditure of £1 100 000. On this expenditure, for an output of 50 000 000 units per annum, the cost would be 0·51d. per unit. If this were operated in conjunction with the present steam station, the capacity of the two stations would be 110 000 000 units per annum, or fully four times the present output, and this would be ample for years to come. The average cost of production is put at 0·61d. per unit.

Electric Traction.

The directors of the Paisley District Tramways Company offer to sell their undertaking to Glasgow Corporation and a sub-committee of the Glasgow Tramways Committee is considering the matter.

It is announced that the Lancashire and Yorkshire Railway Company propose to reconstruct and electrify the railway between Ormskirk and Southport. This will complete the circuit of the electric railway from Liverpool along the coast to Southport, returning via Ormskirk and Aintree.

As the promoters of the Durham County Transport Bill failed to obtain the necessary consents of local authorities it has been decided not to proceed with the tramway in the parish of Boldon Colliery, and to withdraw all powers to construct the proposed tramways in the parishes of Boldon and Whitburn. The promoters will also not proceed with the proposed lines in the Jarrow and in the Sunderland districts. The Bill as amended has been allowed to proceed.

At the meeting of Belfast Corporation last week the Tramways Committee recommended the re-laying of eleven miles of tramway track at a cost of about £224 000, with a programme of relaying the remaining 58 miles in the next five years. It was stated that the arrears of maintenance had accumulated during the war and the heavier traffic had considerably reduced the workable life of lengths of track and greatly increased the maintenance of the permanent way and rolling stock. Repairs had been confined to make the track safe until such times as reconstruction could be entered upon. The total outlay on the track in 1917 was only £9 900, whereas in 1920 it was £30 900, but in the present year it would exceed £40,000. The relaying of the 58 miles of track in the next five years would cost £1 215 000. After discussion the matter was referred back to the Committee for a further report.

The general manager's report on the working of the Liverpool Corporation tramways and motor 'buses for the year 1920, states that revenue was £1 457 549, and operating costs were £1 386 522, leaving gross profit £71 027. Interest required £57 453 and sinking fund and repayment of loans £46 650, leaving a net surplus of £8 148. Of the above revenue, £46 534 was earned on the motor 'buses and the expenditure on the 'buses, including interest and depreciation, was £87 759, the result being a net deficit of £41 224. On the combined undertaking the net deficit was £41 224. Total revenue increased by £250 320, but the amount paid in wages was £704 617 compared with £546 187 in 1919, an increase of £158 430, while increases in cost of current, repairs, rates and taxes and general expenses amounted to £198 648. Total operating costs per mile were 22.232d. compared with 7.977d. in 1913. Passengers carried were 220 219 091, compared with 208 251 496 in 1919, and receipts per car mile were 22.82d. against 21.46d.

The Wolverhampton Corporation has now decided to increase the tramway fares to 1½d. per mile, with a minimum fare of 2d. The average receipts for the six months ended September last were 25d. per car-mile, but for the four weeks ended Feb. 23 they were less than 22d. per car-mile. The fares were increased in November, 1919, when a general increase of ½d. on all stages was made, and the additional revenue in twelve months was £26 500. The total costs were then 22·94d. per car-mile, but the costs for the year April, 1921, to March, 1922, are estimated at 28·3d., extra wages and electricity charges accounting for 3·5d. of this. The revenue at present is only 22d. per car-mile, the difference representing a deficiency of approximately £35 000. On next year's working, with increased fares it is estimated that there would be a loss of 2·3d. per car-mile, equal to £12 458, but the conversion to the overhead system will effect a reduction of £10 000 per annum in costs.

Imperial and Foreign Notes.

It is reported that between 6,000 and 7,000 men are now working on the Chippawa Falls Hydro-electric Development Scheme at Niagara Falls, Canada.

The Press rates of the Marconi's Wireless Telegraph Company to and from Quebec, Ontario and the Maritime Provinces have been increased to 3½d. per word.

The Australian Government is sending a party of experts to the Willis Islands in order to report on the possibility of establishing a Wireless Telegraph Station there. This remote group of islands is 250 miles off the Coast of Queensland, and it is thought that such a station would be of great assistance to the Government meteorologist in preparing his forecasts.

The Radio Corporation of America has obtained a contract from the Polish Government for the erection at Warsaw of a Large Wireless Station, capable of handling 300 words a minute.

According to the "Iron Age," there are now 256 electric furnaces operating in the United States or 10 per cent. more than in 1920. The number of electric furnaces used in the steel industry of the world has reached 961.

We earn from "The Engineer" that the electric cable industry of Germany has had a bad year during 1920. The goods sold during the first six months did not total as much as 30 per cent. of the pre-war figures, and during the last half of the year they fell below 25 per cent. Sales in Germany ceased altogether.

The Control of Bank fur Elektrische Unternehmungen, Zurich, has now passed from the A. E. G. to the Swiss bondholders. The change is due to the depreciation of foreign currency. The bondholders now become preferential shareholders and a new board of directors, consisting of 20 Swiss and four Germans, has been elected.

Institution Notes.

The Borough Polytechnic Institute will hold their annual exhibition of students' work on Saturday, March 19, from 6 to 9.30 p.m.

The Annual General Meeting of the Batti-Wallah's Society will be held on Monday next at the Holborn Restaurant, immediately after the usual Monday luncheon, which will begin at 1 p.m.

At a meeting of the Birmingham & District Electric Club last Saturday a Paper on "Common Sense Methods of Recording Costing and Progress in Shop Management" was read by Mr. H. C. Young. Mr. Young gave much valuable information from his own experiences in the management of large works, and especially insisted upon the importance of rapidly understood graphic records of day by day, and in some cases hour by hour progress. These records should be simple and easy to understand, kept regularly posted and displayed where everyone interested would see them; so that at a glance, all could see the immediate tendencies, and as soon as the actual line fell below a datum line, showing a ratio between input and outgoings, steps could be at once taken to investigate causes.

In the course of a Paper read before the North Eastern Centre Students' Section, Mr. W. N. Kilner suggested a system of generator protection by thermo-couples, *i.e.* placing a thermo-couple or thermo-couples in the hot spot of the machine. By this means when the temperature of the machine reached a pre-determined value a relay would be brought into operation to open the main generator oil switch. Keen interest was aroused by this suggestion and it was contended that the discrimination of such a protective system would hardly meet the demands of the present day practice, and, further, that although the couple would act quite well on a sustained overload, a dangerous momentary current might rise and damage the machine before the increase in temperature caused sufficient current to flow in the thermo-couple circuit to trip the relay.

The Home Office Departmental Committee on Lighting of Factories and Workshops has resumed its investigations. The Committee's work was temporarily abandoned after the publication of its First Report in 1915 owing to the war. The Committee is constituted as follows:—Mr. C. Dampier Whetham, F.R.S. (chairman), Mr. Leon Gaster, Sir Richard Glazebrook, K.C.B., F.R.S.; Dr. C. S. Myers, C.B.E, F.R.S.; Mr. J. Herbert Parsons, C.B.E., D.Sc., F.R.C.S.; Prof. C. S. Sherrington, P.R.S., Sc.D.; Miss R. E. Squire, O.B.E.; Sir Arthur Whitlegge, K.C.B., and Mr. D. R. Wilson, M.A. The Committee is restricting its inquiries at present to the following points:—(1) The conditions necessary to secure suitable lighting in factories and workshops; and (2) the effects of mixed natural and artificial lighting, with special reference to the lighting of underground workrooms. The secretaries to the Committee are:—Mr. J. W. T. Walsh, M.A., M.Sc., National Physical Laboratory, Teddington, and Mr. H. C. Weston, M.J.Inst.E., Investigator to the Industrial Fatigue Research Board, to whom communications should be addressed at 6, John-street, Adelphi, London, W.C.2.

The first meeting this year of the Diesel Engine Users Association since the election of its new president (Mr. C. O. Milton) was held on Feb. 24. A Paper on "Oil Engine Progress," by Mr. J. L. Chaloner, aroused a considerable amount of interest and was followed by an instructive discussion. The author referred in favourable terms to the position of the British internal combustion engine industry and the lines on which it was likely to develop in relation to continental and American competition. Of the high pressure engines in this country 25 per cent. worked on the mechanical injection principle and 50 per cent. were two-stroke engines. In the case of medium pressure engines 96 per cent. worked on the mechanical injection principle, while 58 per cent. were two-stroke engines. He urged the imperative necessityof further flexibility on the part of the engines in order that heavy grade oils might be used to a greater extent. The efforts made to simplify oil-engine construction had met with greater success than either on the continent or in the United States. The main feature of the high compression oil engine was that it did not use as high compression as a Diesel engine, and at the same time it dispensed with the air compressor and the necessary air service system. Various methods of fuel atomisation and of air, mechanical and gas pressure injection were described and compared. Mr. Chaloner considered that the gas pressure system might be discarded as a practical solution of the fuel injection method for internal combustion engines. The principle involved was only suitable for light fuels and the mechanical difficulties were many. The general tendency of introducing long-stroke designs for marine and other slow-running engines produced conditions favourable to the application of mechanical injection. He did not suggest that the problem of mechanical injection had been solved, but the results obtained showed that satisfactory progress was being made. The prospects were great and the possibility of a two-stroke engine without mechanically controlled valves justified the closest attention by engineers.

Personal and Appointments.

Mr. F. C. Thompson, B.Sc., D.Met., Sorby Research Fellow of the Royal Society, has been appointed to the Chair of Metallurgy at Manchester University.

Among the New Fellows of the Royal Society of Edinburgh are the following:—Archibald Barr, Ex-Professor of Engineering, University of Glasgow, and Dr. Charles V. Drysdale, M.I.E.E.

Mr. Walter Rutherford has resigned from the board and management of the English Electric Company, Ltd., and Mr. P. J. Pybus, joint managing director, has been appointed managing director of the Company.

Business Items, &c.

The registered address of the Twiss Electric Transmission, Ltd., will be 39, Victoria-street, Westminster, London, S.W. 1, after the 21st inst.

Messrs. Wm. C. Yuille & Company, Ltd., electrical suppliers, &c., 48, York-street, Glasgow, have appointed Mr. Alex. Munro, of the Edison Swan Electric Company, as manager.

The London offices and showrooms of Vickers-Petters, Ltd., at 75b, Queen Victoria-street, E.C.4, will be opened on 29th inst. The firm have also branch offices at Bristol, Glasgow and Dublin.

Mr. A. G. Perring has been appointed to represent Messrs. H. W. Smith & Company (1920), Ltd., in the Birmingham district, and his address is, Unity Buildings, 14, Temple-street, Birmingham. Telephone, Central 2159.

The Electrical Utilities, Ltd., has vacated its Victoria-street offices, and all future communications should be addressed to the Works, 1-3, Shelgate-road, Battersea Rise, London, S.W.11. Telephone: Latchmere 4216.

Messrs. C. A. Vandervell & Co., Ltd., Acton, notify that they are in a position to supply Jigs, Tools and Special Fixtures of the highest accuracy and quality, their factory at Brighton being well equipped for this class of work.

The Esperanto Lamp Company, whose managing director is Mr. F. L. Strawson, has been formed to carry on the lamp business of the London Factors and Agents, Ltd. The address will be 38 and 39, Parliament-street, London, S.W.1, and the general business of the London Factors and Agents remains unaffected.

The Cambridge & Paul Instrument Company, Ltd., of 45, Grosvenor-place, London, S.W.1, have now opened two repair depots. For the convenience of customers in Scotland and the North, a depot has been established at 12, Westgate-road, Newcastle-on-Tyne, and for customers from the Midlands a depot at Empire House, Great Charles-street, Birmingham.

Messrs. H. Pratt, Ltd., High-street, Aston, Birmingham, an old-established firm of heating and ventilating engineers, have opened an electrical department for the installation of electric lighting and power plants and the sale of electrical plant and accessories. The department will be under capable supervision and will be controlled by a technical director, who has had thirty years' experience of all classes of electrical work. The firm will be pleased to receive catalogues and prices from manufacturers.

Catalogues, Price Lists, &c.

Messrs. The W. T. Lambourne Company, 5, Henrietta-street, Covent Garden, W.C.2, have issued a price list of their leather, balata and textile beltings.

The name of the meters supplied by the Edison Swan Electric Company, Ltd., is the "Sangamo-Ediswan" a.c. and d.c. watthour meter, a leaflet relating to which has been issued by the company.

In a catalogue of 12 pages the Overseas Engineering Company, Ltd., 163-5, Gt. Portland-street, London, W., give particulars and prices of the "National" d.c. motors and dynamos, motor starters, electric lighting sets, a.c. ceiling fans, &c.

From Messrs. R. B. Hand & Company, Ltd., we have received a well-illustrated catalogue of the Portable Electric Machine Tools and Accessories manufactured by the R. G. Haskins Company, of Chicago, for whom they are sole agents for the United Kingdom. An accompanying pamphlet gives testimonials of numerous users of the tools.

A well-illustrated pamphlet of eight pages (X2 389) on "Witton-M.L." circuit breakers has been issued by the General Electric Company, Ltd., 67, Queen Victoria-street, E.C.4. Commencing with a specification, particulars and prices, diagrams and dimensions are given of the various types supplied for different industrial power purposes.

We have received from Messrs. Babcock & Wilcox a copy of their catalogue dealing with liquid fuel burning, which describes the systems used by that firm and shows the application of oil burning to different types of boilers to meet varying conditions of firing. We understand that more than 100 merchant ships have been fitted with burners of this system which has also been applied to any important land stations owing to the high efficiency which it gives. The net result is that over 700 B. & W. boilers fitted with this system of firing are now in use, while oil burners using the system as the atomising agent have also been fitted to 300 B. & W. boilers for land service in addition to those fitted to boilers of other makes. We shall hope to refer further to this interesting subject at a later date.

A new catalogue of 50 pages relating to the Vickers-Petter semi-Diesel oil engines has been issued by Messrs. Vickers-Petters, Ltd., of Ipswich. Full illustrated details are given of the stationary and marine types of these engines, which are designed for working on crude and residual oils or refined petroleum, and are manufactured in sizes varying from 10 to 450 h.p. The company is a combination of Vickers, Ltd., and of Petters, Ltd., and in every way it is well equipped for the manufacture of internal-combustion engines. The engine can be started from cold in one minute with the rapid starting lamp or instantaneously with the firm's patent electric starting device, and a full description of the latter is given. The other features and advantages of both land and marine engines are also clearly set out, and some good illustrations of typical electric lighting sets and marine engines are included.

Miscellaneous.

A new telephone exchange at Redhill was opened on Saturday last.

The late Dr. Alex. Muirhead, F.R.S., left estate of the gross value of £105 806, with net personality £94 542. Subject to his wife's life interest he left £3 000 to the Royal Society of London.

The death is announced of Mr. John Cameron, manager and secretary of the Blackpool and Fleetwood Tramroad Company until the undertaking was acquired by Blackpool Corporation about twelve months ago. Mr. Cameron was 72 years of age.

The Fourth Social Evening of the Ediswan Bristol Staff and their friends was held at the Company's showrooms on the 2nd inst., when an attractive musical programme was much appreciated by the audience.

At the Hereford and Worcestershire Agricultural Show, to be held from June 7 to 9 inclusive at Hereford, the electric supply undertaking at Hereford contemplates arranging a suitable display of electrical apparatus, with an electrical café, &c.

At the annual staff dinner of Messrs. J. H. Holmes & Company, Newcastle-on-Tyne, which was held recently, a large and representative gathering of the staff and branch office managers and agents from various offices in the United Kingdom were present. Mr. G. McGlusky presided and the four partners attended. A most successful evening was spent.

As a result of the recent dispute between some Belfast employers and the E.T.U. the National Joint Industrial Council has agreed to Belfast being brought in under Grade C (without arrears) as from the week ending the 12th inst., and shall be transferred to B Grade six calendar months later. The Belfast members will therefore receive 2s. 1d. per hour, and at the end of six months they will be paid the B grade rate, which is that of the whole of the United Kingdom.

Preparatory to the formation of Benn Brothers' Social Circle a successful whist drive was held at the Eustace Miles Restaurant, Chandos-street, London, on March 4, the company numbering upwards of 80, including several members of the Board of Directors. Mrs. Ernest J. P. Benn distributed the prizes. The second event is arranged to take place to-day and will be in the form of a social evening with music and dancing.

The Industrial Court has issued its decision on questions submitted for determination arising out of a previous award relating to the wages of electrical workers in generating and sub-stations, on railways outside London. As the last advance of 6s. a week was not a war bonus, but an augmentation of the card or base rates, the men concerned are held to be entitled to the respective London rates, including the 6s. advance, less 5 per cent. in Glasgow, Liverpool and Manchester, and less 10 per cent. in all other districts.

In a list of revised tariff valuations for goods imported into India on and after Jan. 1 last it is stated that telegraph instruments and apparatus and parts imported by or for a railway company are subject to 2½ per cent. *ad val.* (instead of being duty free as hitherto), and that railway material, on which the duty is 2½ per cent. *ad val.*, may include such tramways as the Governor-General may specifically include by notification in the "Gazette of India." Various valuations varying from 300 to 675 rupees per ton, are given for different classes of iron and steel, on which the duty is 2½ per cent.

The articles mentioned below have been classified by the French Customs Department under the headings mentioned in parentheses :—Anodes of molybdenum, with or without parts of other metals (under armatures and detached parts for electrical apparatus, from 59 to 150 fr. per 100 kilogs, according to weight, for British goods, or under chemical products, whichever rate is the higher); apparatus for annealing metals by electricity (under electrotechnical apparatus, from 20 to 110 fr. per 100 kilogs); electrodes with bases of tungsten or molybdenum for X-ray or other apparatus (under chemical products); electrical apparatus for electro-plating (under electrotechnical apparatus, from 20 to 110 fr. per 100 kilogs.).

Last week the Inventions Committee considered the claim of Mr. C. H. Wordingham for compensation for a device for automatically disconnecting electrical gear in a flooded compartment of a ship through an electrical main passing through such compartment. It was admitted that the invention was useful, ingenious and important, and was to be introduced into large ships of the Navy, but owing to reasons of economy it was now being introduced only in ships of recent construction. The system was likely to be a standard practice in the future. About 3 000 main guards were ordered and 647 supplied, over £20 000 altogether having been expended. The features of the invention were described and the Commission deferred its decision.

The first meeting of the Select Committee on Telephones took place on Tuesday, when it was decided to invite evidence from the Associated Chambers of Commerce and from the Press. Mr. Stanley Holmes, a member of the Committee, was deputed to see the Accountant-General of the Post Office with a view to securing official accounts at the inquiry. The Committee will sit on Mondays and Wednesdays, and the next meeting will be held after Easter.

The members of the Committee are: Mr. Evelyn Cecil (chairman), Major Evan Hayward, Mr. John Hodge, Mr. G. Hohler, K.C., Mr. J. Stanley Holmes, General Sir Archibald Hunter, Sir Evan Jones, Mr. Robt. Lynn, Mr. W. Lane Mitchell, Capt. A. C. Moreing, Mr. W. G. Perring, Mr. Alex. Richardson, Mr. A. K. Rodger, Mr. W. S. Royce and Mr. A. Waterson.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

8[illegible]14 Aldendorff. Telephone system in which the lines are interconnected by the aid of electro-mechanically controlled switches. (1/4/14.) (Addition to 2350/2/13.)

140,171. Vallino. Current-collecting devices for electric traction. (20/3/19.)

140,459 Guardiola. Interrupters for use with high-tension magnetos. (16/1/19.)

141,383 Punga. Alternating current motors. (26/3/19.)

141,703. Western Electric Co. Automatic and semi-automatic telephone systems. (11/4/19.)

142,465 Siemens-Schuckertwerke Ges. Conversion of electric currents. (17/2/17.)

Relates to a method of producing high continuous pressure from alternating pressure by employing condensers and current interrupters connected in series, whereby the voltage that is produced in a condenser during the passage of current through the corresponding current interrupter during the interruption ,of the current in the saidcurrent interrupter and the passage of current through the subsequent current interrupter charges the condenser corresponding to the latter.

142,474. Western Electric Co. Use of thermionic devices for producing frequency harmonics of electric oscillations. (28/4/19.)

Comprises means for impressing a current of substantially sinusoidal wave form upon a thermionic device, and means comprising an impedance element included in the plate circuit of said device for causing the output wave of said thermionic device to be distorted.

144,254 Landers, Frary & Clark. Controlling-device for electrically-heated utensils (29/5/19.)

144,609 Fabriques des Montres Zenith. Distributing-terminals for ignition magnetos (11/6/19.)

145,600 Goldberg. Process of electrolytically separating copper from nickel. (9/7/18).

146,268. Beissbarth. Electric switch. (31/1/19.)

146,843 Schember & Joksch. Electric steelyard weighing-machine. (8 7 19.)

147,047. Compagnie pour la Fabrication des Compteurs et Material d'Usines a Gaz. Electric transformers for use with measuring-instruments. (26/6/14.)

150,300 Western Electric Co., Ltd. Telephone exchange systems. (23/8/19.)

150,746 Akt.-ges, Brown, Boveri, et Cie. Process and apparatus for starting polyphase asynchronous electric motors. (8/9/19.)

151,260 Haglund. Electrolytic tanks with diaphragm cells. (17/9/19.)

151,600 Western Electric Co., Ltd. Repeaters for multiplex signalling systems. (25/9/19.)

154,575. Gurlt Ges. Relay for signalling purposes. (24/11/19.)

155,602. B. T.-H. Co. (G. E. Co.). Wireless signalling systems. (11/9/1918).

The system comprises an electron discharge relay with an incandescent cathode, an anode, and a grid connected to a tuned loop in such a way as to set up high frequency oscillations in the loop, and a second electron discharge relay having its cathode connected to the cathode of the first relay and its anode connected directly to an adjustable point within the inductance included in the tuned loop so that the amount of energy supplied to the loop is varied in accordance with the potential of the grid of the second relay.

155,614. Hirst & Brooks. Switchgear for controlling electric motors. (10/7/19.)

155,622. Turner and Abbott, Turner & Co. Electrical resistance units. (21/8/19.)

155,634. Crompton & Co., and Jones. Boxes for electrical apparatus. (19/9/19.)

155,637. Calvert. Electric heating of water. (20/9/19.)

155,642. Gill. Wireless telegraph receivers. (22/9/19.)

155,645. Uren. Protective fuses for electric circuits. (23/9/19.)

155,648. Hooper and Hobley. Electrical indicators and like apparatus. (23/9/19.)

155,662. B. T.-H. Co. (G. E. Co.). Electric motor control systems. (29/9/19.)

155,689. Satchwell. Manufacture of grid resistances. (21/10/19.)

155,698. Western Electric Co. (Western Electric Co.). Telephone and like circuits. (27/11/19.)

155,717. Caine and Edison Swan Electric Co. Electrical connections. (13/1/20.)

155,719. Petters, Ltd., and Petter. Apparatus for electric heating of engines of the hot-bulb type before starting. (24/1/20.)

APPLICATIONS FOR PATENTS.

July 26, 1920.

22,180 Thompson. Electric bell.
22,189 Crabtree. Tumbler, &c., switches.
22,215 Shrivell. Electro-magnetic telephone receivers.
22,231 Hall Research Corpn. Receiving signals by wireless telegraphy. (13/8/19, U.S.)
22,237 and 22,238 Metropolitan-Vickers Electrical Co. Discharge gap apparatus. (15/8/19, U.S.)
22,244 Adam. Electrolysis.
22,245 Adam, Fieldhouse & Stevenson. Electrolysis.
22,258 Siemens & Halske, A.G. Telephone receivers. (24/7/19, Germany.)
22,275 Waddington. Apparatus for electric welding.

July 27, 1920.

22,295 De Renzi. Switchgear for control of supply of electricity to machinery, &c.
22,296 Wilson. Balanced electric relays.
22,296 Garrard & Railing. Balanced electric relays.
22,313 Melotte. Electric driving of bowls of centrifugal separators. (26/12/19, U.S.)
22,358 Higgs. Electric machines.
22,359 Meyer (Dr. P.) Akt.-Ges. Alternating-current meters. (27/1/20, Germany.)
22,383 Hamlyn. Electric light sconce fittings.
22,390 Carey-Gavey Synd. & Higginson. Alternating-current motors.

July 28, 1920.

22,439 Player. Trollies of overhead cables.
22,440 Runkel. Electric lamp supports.
22,448 Sykes. Terminals for electric conductors.
22,458 B.T.-H. Co. & Hall. Electric controlling devices.
22,472 Von Wursteinburger. Protecting apparatus against electrolytic destruction. (2/8 19, Switzerland.)

July 29, 1920.

22,508 Chambers. Electro-magnetic reception arrangements.
22,527 Mullard. Multi-electrode valves, &c.
22,533 Siemens & Petithory. Racks for cables.
22,547 Langdon-Davies & Soames. Regulation of electric currents.
22,563 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Electro-magnetic controlling devices.
22,607 Carey. Alternating-current induction motors.

July 30, 1920.

22,669 Roberts. Electric stop motions.
23,673 De Renzi. Electric current plugs, &c.
22,685 Armagnat. Method of measuring lengths of electric waves.
22,703 Round. Reception of wireless signals.
22,732 Garde. Switches and switch holders.
22,761 Maschinenfabrik Oerlikon. Synchronous motor for polyphase current. (26/8/19, Switzerland.)

July 31, 1920.

22,797 Gatti. Electrical device for withdrawing metal splinters from the eye.
22,805 Alexander, Kerr & Hunter. Electric machinery.
22,817 Derry. Electrically-operated safety device for stopping machinery.
22,819 Nobuhara. Rotary electric machines.
22,828 Wyndham. Transmitting photographs, &c., by telephone or wireless telephony.

Tenders Invited and Accepted.

Kilrush Urban Council invite proposals for an electric lighting scheme. Particulars from Mr. E. Counihan, Solicitor to the Council.

Manchester Corporation require tenders by April 4 for 33 000 and 6 600 V switchgear, induction regulators, &c. Specifications from F. E. Hughes, Town Hall, Manchester.

Rathmines and Rathgar Council require tenders by March 21 for house service cable, house service and fuse boxes, metors, &c. Forms of tender from the Electrical Engineer.

Tenders will shortly be invited for the electrification of the Antwerp-Brussels railway (about 27 miles). The trains will seat 550, and consist of six coaches—one motor coach at each end, and four trailers.

The Commissioners of H.M. Works, &c., invite tenders by April 12 for the supply of electrical engineering labour in day-work in the Leeds district. Forms of tender and particulars from the Director of Contracts, Storey's Gate, Westminster, London, S.W.1.

The Lancashire & Yorkshire Railway Company require tenders by March 21 for six months supply of stores, including telegraph and electric fittings, telegraph and electric light wires, metals, oils, &c. Forms of tender from the Stores Superintendent, Osborne-street, Manchester.

The Deputy Postmaster-General, Melbourne, will receive tenders until April 19, for the supply of telephone switchboards (schedule 1,670) for the Australian Commonwealth Postmaster-General's department. Specifications may be seen at the Department of Overseas Trade.

Bedford Corporation Electricity Department invite tenders from British manufacturers for the supply of electricity meters and h.t. and l.t. cables for the ensuing year. Specifications from the borough electrical engineer, Mr. R. W. L. Phillips, and tenders by noon, March 31, to the Chairman of the Electricity Committee.

The municipality of Pretoria invite tenders for the supply and erection of switchgear. Tenders to Deputy Town Clerk, Municipal Offices, Pretoria, by 4.30 p.m., May 10. Copies of specification from the Town Clerk (deposit 5 guineas) and further particulars may be obtained from the General Manager of the Electric Light and Power Department.

The Council of the County Borough of East Ham invite tenders for the supply and delivery of low-pressure concentric cable, with joint-boxes, &c., and two c.i. lighting feeder pillars. Specifications from the borough electrical engineer and tramway manager, Mr. W. C. Ullmann, and tenders are to be sent to the Mayor, Town Hall, East Ham, E.6, by April 2.

Manchester Electricity Committee require tenders by March 31 for high-pressure steam and water valves, weighbridges and automatic coal-weighing machines, and by April 7 for high pressure steam and water pipes, &c., and electric and hand-operated cranes for Barton power station. Specifications from Mr. F. E. Hughes, Town Hall.

Belfast Corporation invite tenders for the manufacture and erection at the new Harbour power station of extra-high pressure and low pressure switchgear. Specifications from the consulting engineers, Messrs. Preece, Cardew & Rider, 8, Queen Anne's Gate, Westminster, S.W.1., or the city electrical engineer, Mr. T. W. Bloxam. Tenders to the Town Clerk's Office, City Hall, Belfast, by April 25.

Belfast Electricity Committee invite tenders for the supply of materials and stores, including cables, wires, lamps, electricity meters, cut-outs, electrical accessories, carbon brushes, &c. Forms of tender from the city electrical engineer (Mr. T. W. Bloxam), and tenders to the town clerk, Mr. R. Meyer, by April 4.

Hammersmith (London) Electricity Committee has accepted the offer of C. A. Parsons & Company (at £1 175) for the supply and fixing of an air cooler for the first of the 10 000 kW turbo-alternators which the firm is supplying to the Council. The Committee also recommend the acceptance of the following tenders: Hackbridge Cable Company (lowest tender) for 2 000 yds. 0·5″ and 500 yds. 0·2″ l.t. cable at £560 and £274 respectively (five tenders received, highest £670 and £335). G. & J. Weir, boiler feed pump, £293 (four tenders, varying from £350 to £263).

Liquidations and Bankruptcies.

Fluorandum Flame Carbons, Ltd., is being wound up voluntarily and Mr. F. N. Clarke, 4, Pavilion-buildings, Brighton, has been appointed liquidator.

The Grimsby Electric Welding Company, Ltd., is being wound up voluntarily, and Mr. H. Blanchard, Humber Bank, Fish Docks, Grimsby, has been appointed liquidator.

At Burnley Bankruptcy Court on March 10, the public examination took place of Albert Lord, Electrical Contractor, of, 33, Westgate, Burnley. Liabilities were £977 2s. 6d., and assets £52 5s. 5d. Failure was alleged to be due to heavy household expenses. Debtor commenced without capital, and did small jobs at first, but later took a £565 contract, from which he allotted £250 to a Manchester firm for materials. He lost money on that work. That was one of the reasons for his insolvency.

The Mersey Electrical Engineering Company, Ltd., is being wound up voluntarily, and Mr. T. L. Hanmer, 24, North John-street, Liverpool, has been appointed liquidator.

The first meeting of creditors of Ernest Albert Goodings, trading as Goodings & Son, motor and electrical engineers, The Grove, Watlington-street, Reading, will take place on March 24 at 14, Bedford-row, London, W.C.1, and the public examination on April 21, at the Assize Courts, Reading.

Companies' Reports, &c.

TELEGRAPH CONSTRUCTION AND MAINTENANCE MEETING.

Earl Selborne, K.G., who presided over the annual meeting of the Telegraph Construction & Maintenance Company, Ltd., last week, referred to the trading difficulties experienced in 1920. In explaining the accounts he said the item for stocks, materials, &c. (£1 551 978) showed an increase of £832 122, due partly to having received large sums as instalments on account of contracts in course of being carried out, and partly to unusually heavy stocks of materials and cable in hand, forming part of those unfinished contracts. The other items in the accounts were much as usual, and all their securities were written down to the market prices.

The net profit, after providing for taxation was £110 187, or about £14 000 less than that of 1919; but it must be remembered that the prices of materials were then all on the upward grade, whereas now they were rapidly falling away, and it was very difficult to maintain profits with a falling market. As instances, he mentioned that iron wire had fallen about £20 a ton, steel nearly £30, copper wire about £50, and jute yarn £60 per ton. Those reductions took place mostly in the last months of the year. He wanted them to appreciate the responsibility and anxiety of the management of such a business as theirs during such a year as 1920—verily, he believed, the most difficult year that a manufacturing business had ever had to go through. The managers must order material in advance. If they ordered too little the whole business became hopelessly dislocated, and discredit and loss ensued; if they ordered too much and there was a fall in values, such as actually occurred in 1920, the losses might be simply immense. They were, therefore, very grateful to them for the skill with which they had steered the business through a year of such exceptional difficulty.

Labour Demands and Shipping.

Referring to the purchase of the ex-German cable steamer, "Stephan," his lordship said they had been running the ship for the Eastern Telegraph Company for more than a year, having chartered her from the Ministry of Shipping. She was 4 630 gross tonnage, and had about half the carrying capacity of their largest ship, the "Colonia." It seemed an unfavourable time for buying a steamer when shipbuilding in this country had become so unprofitable that over 2 000 000 tons gross of shipping were now laid up in the ports of the United Kingdom, but they had certain contracts for the execution of which she was required, and there was no other course open to them. From the annual report of the Chamber of Shipping, they learnt that under present conditions very little shipping was run at a profit, and their experience fully confirmed that. Great demands had been made by the Labour unions for increased wages, shorter hours and payment of overtime on behalf of seamen, firemen and stewards. The pay of officers and engineers had correspondingly risen, and the cost of coals, stores and repairs was exceedingly heavy. The cost of coiling cable on board their ships had also been greatly increased, as now the men who did the coiling were paid the dock rates of stevedores. With all those charges it was difficult to make both ends meet. He quoted the result of the year's working of their ships. The "Colonia's" receipts were £181 559, expenses £182 626; the "Stephan's" receipts were £166 904, and expenses £168 167; the "Telconia's" receipts were £49 794, and expenses £45 940. These figures show that in a year in which those ships had been fully employed they had been unable even to earn their depreciation. It was obvious that the operating expenses must come down, or their ships would certainly have to join the ranks of the unemployed. They had serious difficulties to face, as during the war and after the demand for labour was much greater than the supply, and all asked what wages and conditions of employment they liked, and obtained them. To charge more for the services of their ships would mean putting them in the ranks of the laid-up at once, as they would not get employment. They hoped, therefore, that during this year they might get back to an economic basis.

Allocation of Profit and Taxation.

Out of the £110 187 profit they were paying the shareholders in dividends a total of £89 640, adding £20 000 to reserve and increasing the carry-forward by £547. Before arriving at that profit they had to provide for income tax, excess profits duty, Corporation tax, and rates and taxes over £130 000, which was very much more than the shareholders received in dividends; and during the year they had paid over half a million in wages and salaries. A great drag on industry was caused by the rising rates. The assessment and the rate levied were both constantly rising. In 1900 they paid in rates and taxes for both their works £2 619; in 1921 their rates and taxes would be £19 000. As to the suggestion for sub-dividing the shares and making them of a smaller denomination, they had received no support for the proposition. In conclusion, the chairman said there was no royal road or quick short-cut out of the present economic position in which they could only emerge by rigid economy and by the lessening of taxation. What the world wanted was peace—the assurance of peace by the settlement of disputes among nations and the consequent resumption of international trade.

The report and accounts were then adopted and the retiring directors and auditors were re-elected.

The report of the directors of the Telegraph Construction and Maintenance Company, Ltd., for the year 1920, stated that the net profit was £110 187, and with £11 4841 brought forward the total was £225 028. Deducting the interim dividend of 2½ per cent., paid in July (£22 410) the balance was £20 2618. Of this sum the directors propose to distribute a further dividend of 7½ per cent. (tax free), absorbing £67 230 to supplement the reserve fund by £20 000 (making it £160 000), leaving £115 388 to be carried forward. The general business of the company during the past year has been satisfactory. The Company's works and steamships have been maintained in their usual state of efficiency, and before the close of the year the ex-German cable steamer "Stephen" was purchased from the Ministry of Shipping.

CHARING CROSS COMPANY'S MEETING.

The proposals for the reorganisation of electricity supply in London were referred to at some length by Mr. W. F. Fladgate, chairman of the Charing Cross, West End & City Electricity Supply Company, Ltd., at the annual meeting last week. He commenced by stating that their output in both areas reached record figures in 1920, over 14½ million units in the West End and over 20 million units in the City. Their gross receipts in the West End had increased from £265 855 to £311 044, but the cost of production increased from £167 241 to £208 214, the corresponding figures in the City being: Receipts, £418 746 (against £331 322); expenses, £355 061 (against £273 721). The large increase in cost in both areas had been mainly caused by the increase in rates, the increased price of fuel and the amount spent upon repairs. The expenditure on coal for the City station amounted to £215 000, or more than £50 000 more than in 1919, and the increase in the cost of coal in the City automatically increased the price of energy in bulk to the West End. The sum spent on repairs in the West End was over £11 000, while that in the City was £48 000. After giving an analysis of the accounts, he said that for financing the City undertaking they had issued £250 000 6½ per cent. short-term secured notes. A large part of that capital (£160 000) had been expended upon works at Bow. For the whole year every unit of energy delivered from Bow required 4·5 lb. of coal, but that was reduced during December to 3·3 lb.

Position of the Electric Supply Industry.

In regard to the present position of the electrical industry, particularly as it affected London, he said that legislation in the past had not been fortunate, but, notwithstanding the difficulties presented by it, the London companies and municipalities had succeeded in providing a sufficient and a reasonably cheap supply for London. After the war the Government decided that something must be done in order to give a "cheap and plentiful supply of energy," and, therefore, the Electricity Supply Act of 1919 was passed. He had always contended, and he thought still, that London was of sufficient importance to be treated by itself, and in deciding on the area for London that its extent should be settled with one object alone—namely, the economic supply of the metropolis. Before the Electricity Commissioners published the area which was to include the metropolis there were several conferences with the Commissioners, and it was, he thought, more or less at his suggestion that it was arranged that the Commissioners should themselves fix the area rather than that it should be fixed by those who might be preparing to submit schemes. The area which the Commissioners had now fixed was a very large one, and comprised some 1 700 square miles of the surrounding counties, and included upwards of 80 separate electrical undertakings. Had his company been obliged to act alone, he should have had great hesitation in advising them to take any action, but immediately after the passing of the Act of 1919 a small private company was constituted by some of the principal London supply companies with a view to considering the position and submitting a scheme. Such a scheme naturally divided itself into two heads: first, engineering; and, secondly, administrative and financial. As to the engineering scheme, the company committee had been able to work with the London County Council and the local authorities. Four engineers were appointed, two by the company committee (Sir Alex. Kennedy and Mr. Partridge), Mr. Rider by the L.C.C., and Mr. C. H. Wordingham by the local authorities, and those gentlemen had just settled a scheme for dealing with the area which, if it was to be dealt with as a whole, was probably the best that could be devised. Whether the adoption of that area was the in the best interests of London was very doubtful. With regard to the administrative and financial side of the question, under the Act of 1919 the joint electric authority was to consist of representatives of the County Council, the local authorities, the companies, &c. To enable the local authorities to participate in any scheme, further statutory powers were requisite. For that and other reasons the preparation of a joint financial and administrative scheme was considered undesirable. The County Council, the local authorities and the company committee had each been engaged in preparing administrative and financial schemes, which in due time would have to be considered. It had not been practicable for his board to consider fully either the engineering or financial schemes, nor could they be finally settled, so far as the local authorities were concerned, until further statutory powers were given to them. The subject required very careful consideration. If the area of 1 700 miles was to be dealt with as a whole, the money required was a very large sum, and in these times money could not be raised at anything like a moderate rate of interest. In addition to the cash required for new stations and the laying of new mains, connections, &c., there was the purchase money of the generating stations—some 70 in number.

Need for a Give-and-take Policy.

After referring to the difficulties in the way, Mr. Fladgate said that, so far as London was concerned, he did not see why that should preclude the possibility of a practical scheme being devised, if, as he hoped and believed, the London County Council were prepared to work with the London companies. He had great hopes that something might be done possibly on the lines of schemes which were promoted in 1908. There must be, if such a scheme was to be workable, a give and take on both sides, as it was not reasonable to ask the London companies to undertake any additional liabilities unless they were given certain concessions. Those concessions were—first, a reasonable extension of their tenure; and, secondly, an intelligible and practicable purchase clause. So long as the London companies were liable to purchase in 1931 they could not be expected to incur any capital liabilities except such as were absolutely necessary for their own purposes and to enable them to comply with their statutory duties. It might be possible to get the concurrence of the great railway companies or some of them.

The report and accounts were adopted, and a resolution was passed authorising the directors to raise or borrow such further sums as they may think proper for the West End undertakings, not exceeding £250 000, and for the City undertaking not exceeding £250 000.

METROPOLITAN ELECTRIC SUPPLY COMPANY.

At the annual meeting last week the chairman (Mr. A. W. Tait, C.B.E.) referred to the satisfactory progress made during the past year and to the proposals for the reorganisation of electricity supply in the Greater London area. The gross revenue was £516 594, compared with £413 059 in 1919, the revenue from sales of current being £497 675, against £396 590, and the number of units sold 27 798 000, against 25 127 000. The increase was satisfactory when it was remembered that for 1918 and 1919 they had to record some slight decreases owing to the falling off of the power load. Although industry was not working at the same pressure as during the war, there had been a considerable extension of the lighting load, due to the removal of restrictions and to the large increase in the number of new connections. The company was somewhat fortunately situated, as there was considerable industrial development in its western area of supply, where a number of substantial consumers had recently been connected. The new consumers connected during the year represented 3 374 kW, against 2 867 kW. The costs of generation and distribution increased by approximately £59 000, of which £33 000 was due to increased cost of coal. The year's capital expenditure was £72 409, against £53 805, apart from the Uxbridge system. The increase in the load in the Metropolitan and Uxbridge areas made it necessary to proceed with the installation of further plant at the Willesden station, and the laying of further mains. It was hoped that the new plant would be installed in time to give supply before the end of the year, when they would not only be able to give a considerably increased supply to customers, but to effect considerable economies in generation and distribution. To carry out their programme and to repay bank loans it was anticipated that about £500 000 would be required, and negotiations had been entered into for raising that sum. During the last five years the units sold had increased from approximately 20 000 000 to 28 000 000, the gross revenue from £229 000 to £516 000, and the balance available for reserves and dividends from £79 094 to £181 640. They were paying a final dividend at the rate of 10 per cent. per annum, making a total distribution for the year of 7 per cent.

REORGANISATION SCHEME.

He referred at some length to the position created by the Electricity Supply Act, 1919, and to schemes for the establishment of an electricity authority for the London and Home counties district. Those schemes had to be lodged with the Electricity Commissioners by the end of this month. The leading London supply companies, acting in association with the London County Council and the Conference of Local Authorities, had prepared a technical scheme which they hoped to submit. Other schemes might also be submitted, and it is the intention of the Electricity Commissioners to hold an inquiry into the whole matter in the beginning of June next. The important administrative and financial conditions which should govern the creation and powers of a joint electricity authority were having the careful consideration of the companies. In regard to the Metropolitan Company, they had to consider not only their position in the administrative County of London where (in common with the other supply companies) their assets were liable to purchase by the London County Council in 1931, but also their large and progressive area for bulk supply in the West, where they had the powers of a power company under a special Act, and where their assets were not liable to purchase. It was hoped, however, that the scheme ultimately put forward would secure the best use of existing resources and experience.

The directors of the **WESTERN TELEGRAPH COMPANY, LTD.**, have declared a second quarterly interim dividend of 5s. per share, tax free, for the year ending June 30, 1921, payable on March 23, being at the rate of 10 per cent. per annum, as in 1920. The dividend of 4s. per share on the new shares will be paid on the same date.

The directors of the **DIRECT SPANISH TELEGRAPH COMPANY, LTD.**, have decided to pay the following dividends for the year 1920, viz.: At rate of 10 per cent. per annum on the preference shares (less tax) and 6 per cent. on the ordinary shares (tax free). The total distribution on the ordinary shares for the year will therefore amount to 10 per cent., 4 per cent. having been paid on Oct. 1 last.

On the 16th ult. a petition was presented to the High Court by BENN BROTHERS, LTD., for confirming the alteration of the objects of the company and for reorganisation of its share capital. This petition was sanctioned by the judge on Tuesday, March 15. The share capital as reorganised consists of 150 000 ordinary shares of £1 each. This is effected by cancelling the 3 000 preference shares of £1 each in the capital of the company, and consolidating such 3 000 preference shares and the 147 000 ordinary shares of £1 each in the company's capital into a single class of 150 000 ordinary shares, all ranking *pari passu* in all respects.

The directors' report of the **BROMPTON & KENSINGTON ELECTRICITY SUPPLY COMPANY, LTD.**, states that the credit balance for 1920 is £42 903, which, with £1 229 brought forward, £1 000 interest on loan to Brompton & Kensington Accessories Company and £274 balance of interest received and accrued, makes a total of £45 406. After deducting £990 for interim dividend on the 7 per cent. cumulative preference shares, and £7 727 interim dividend at rate of 9 per cent. per annum for the half-year to June 30 on the ordinary shares, the directors recommend that the balance (£36 689) be dealt with as follows:—£369 to be written off investments, £9 655 placed to depreciation account and £10 000 to reserve fund, £963 as dividend on the preference shares and £12 925 as dividend on the ordinary shares for half-year ended Dec. 31 at rate of 15 per cent. per annum (making 12 per cent. for year), and £1 000 as directors' additional remuneration, leaving £1 776, to be carried forward. The equivalent of 472 936 35-W lamps is connected (increase 39 784), the number of consumers is 7 896 (increase 507) and the average price per unit was 5·303d.

The profit of the BRITISH INSULATED AND HELSBY CABLES, LTD., for the year 1920, after making provision for estimated liability for excess profits duty and Corporation profits tax, amounts to £340 713, and with £103 316 brought the total up to £444 029. Deducting directors' and debenture trustees' fees, &c. (£9 665), and interest on first debenture stock (£22 500), and on second debenture stock (£10 000), the preference dividend (£30 000), and the interim dividend on the ordinary shares to June 30, 1920 (£37 500), the disposable balance is £334 364. The directors have appropriated £50 000 for depreciation on Buildings, plant, &c., transferred £50 000 to reserve account, and £5 000 to first mortgage debenture stock redemption account, and they recommend payment of a further dividend of 6¼ per cent. on the ordinary shares, payable at once, together with a bonus of 5 per cent. (payable on June 30 next), making with the interim dividend a total of 15 per cent. for the year, which will absorb £112 500, and leaving £116 864 to carry forward, after making provision for estimated liability for taxation. During the past year, both the Prescot and Helsby factories have again been kept busy to their full capacity. On account of failing health, Dr. E. K. Muspratt has resigned his seat on the board, and Mr. J. A. Smith has recently been elected a director.

The annual report of the directors of W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LTD., for 1920 states that the profit was £240 003, and after deducting directors' and auditors' fees, debenture interest and amount written off for depreciation on buildings and machinery (£46 975) and adding amount brought forward (£141 633) the total is £334,661. Deducting income tax (£45 524), amount transferred to reserve (£18 432) and loss on realisation of Government loans and trustee securities, less reserve, but plus amount transferred to reserve against such loan securities still held (£13 166), and also the dividend on the preference shares (£9 000) and the interim dividend on the ordinary shares (£20 000), leaving an available balance of £228 538. Pension funds appropriation absorbs £5 000 and the directors recommend payment of a final dividend on the ordinary shares of 2s. per share (less tax), making 3s. for the year. This will require £40 000 and leave to be carried forward £183 538.

Provision has been made for the liability for Excess Profits Duty and Corporation Tax to the end of the year. Henley's Tyre and Rubber Company has had a successful year's trading and the capital has had to be increased from £140 000 to £200 000. The Tyre Company, following the practice of the parent Company of purchasing against requirements only, was fortunate in not holding any considerable stocks of rubber, and was able to take full advantage of the fall in prices.

According to the report of the directors of the NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY, LTD., the connections to the Company's system at the end of 1920 amounted to 341 940 H.P., compared with 316 737 H.P. in 1919, or an increase of 25 203 H.P. The profit is £392 643 (against £248 194), from which is deducted £30 000 for reserve for plant renewals and improvements, leaving £362 643 (£218 194), and adding balance brought forward of £9 598, the total available profit is £372 242 (£259 621). Interest on debenture stocks, loans, &c., absorb £57 914, and £25 000 has been transferred to reserve for special depreciation and contingencies, and the directors recommend that the balance of £289 328 (£182 228) should be employed in paying a dividend of 3½ per cent. on the 7 per cent. cumulative preference shares, making with the interim dividend 7 per cent. for the year (£100 541), a dividend of 2½ per cent. on the 5 per cent. preference shares, making 5 per cent. for the year (£71 881), and a dividend of 5½ per cent. on the ordinary shares, making with the interim dividend of 2½ per cent. 8 per cent. for the past year (£103 814), leaving to carry forward £13 091 (against £9 598).

The expenditure on plant renewals and improvements during the year (£44 911) has been charged against the reserve for plant renewals and improvements account. The unsettled conditions in trade, and the continued high labour costs have again adversely affected the trading for the year. The additional capital expenditure for the year has amounted to £475 459 2s., and represents the completion of the remaining extensions at Carville and further extensions at Dunston power stations, and additions to the Company's distribution system generally. The extensions at Carville station were completed during the year and the new plant is now in commission. Negotiations with the North Eastern Railway Company are proceeding in connection with the electrification of a portion of that company's main line. The directors recommend the shareholders to sanction a contribution to the funds of the University College of Newcastle-upon-Tyne of £1 000, payable over two years.

During the past year there has been connected to the SCARBOROUGH ELECTRIC SUPPLY COMPANY'S mains the equivalent of 16 438 30 W lamps, making a total of 161 141. There was an addition of 449 consumers. The number of units supplied during the year was 1 454 377, an increase of 396 670. After placing £4 000 to depreciation, and paying bank interest (£755), the profit was £2 370, which with a revenue of £2 339 from other sources, makes a nett profit of £4 709. With balance forward of £6 683 the total is £11 392. The directors recommend that a dividend be paid at the maximum rate allowed under the Scarborough Electricity Temporary Increase of Charges) Order, 1918, namely 2½ per cent., which will absorb £2 250, leaving £9 142 to be carried forward. Mr. G. Alderson-Smith has retired from the Chairmanship of the Board, and Mr. A. A. Campbell Swinton succeeds him. Mr. G. Alderson-Smith has become Deputy Chairman, and to fill vacancies on the Board, Mr. F. G. Holden and Capt. W. H. L. Wordsworth have been elected Directors.

New Companies.

The following list has been compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, Chancery-lane, London, W.C.2 :—

BRIERLEY'S PREMIER WELDING COMPANY, LTD. (173 371).—Reg. Feb. 25. capital £3 000 in £1 ordinary shares, to acquire and carry on business of electricians and general engineers. Directors: W. Brierley, Florence Brierley, and T. C. Evans, all of 2, Gauden-rd., Clapham, S.W., and F. A. Broadey, Lion Lodge, Deepcar, near Sheffield.

F. B. HELLON & CO., LTD. (173 480).—Reg. March 3, capital £4 000 in £1 ord. shares, to carry on business of electrical engineers and contractors. Directors: F. B. Hellon, "St. Aubyn," Agnes-road, Blundellsands (Chn.) and E. J. Barker.

MARLER & COMPANY, LTD. (173 489).—Reg. March 3, capital £7 000 in £1 shares, to carry on business of electrical, mechanical and heating engineers and contractors. Directors: G. J. Fisher, Penygarn, Pontypool (Chn.), W. S. Marler, C. D. Esnouf, R. Fisher and R. More.

Forty Years Ago.

(The Electrician, March 19, 1881.)

The Society of Telegraph Engineers.—At the next meeting no the 24th inst., a Paper by Mr. Morris will be read on "Japanese Telegraphs."

The Post Office and the Telephone Companies.—We understand that an agreement has been arrived at between these parties on the basis of a payment of 10 per cent. of the receipts of the companies as royalty to the Postmaster-General.

Society of Arts.—On Thursday, March 24, Prof. J. Perry is announced to read a Paper on "The Future Development of Electrical Appliances," and on Wednesday, March 30, Mr. W. H. Preece is announced to read a paper on "Recent Advances in Electric Lighting."

Gas v. Electricity.—In his inaugural address as President of the Manchester District Institution of Gas Engineers, Mr. Chew committed himself to the statement that he was quite convinced that the electric light would not supersede gas for domestic illumination, though it was well adapted for large spaces; and even here he thought that when the novelty had worn off gas would hold its own. He was far more afraid of American oil at 1s. a gallon than of Mr. Swan's, or any other lamp. We hope, for Mr. Chew's sake, that this comfortable frame of mind may long be his, though we should not like to go bail for his peace in the next few years.

Prices of Metals, Chemicals, &c.

			Tuesday,	Mar. 15.
Copper—		Price.	Inc.	Dec.
Best selected.........	per ton	£68 0 0	—	£2 0 0
Electro Wirebars ...	,,	£71 0 0	—	£1 0 0
H.C. wire, basis ...	per lb.	0s. $11\frac{3}{16}$d.	—	$\frac{1}{16}$d.
Sheet	,,	1s. $0\frac{1}{4}$d.	—	$\frac{1}{4}$d.
Phosphor-bronze Wire (*Telephone*)—				
Phosphor-bronze wire, basis	,,	1s. $3\frac{3}{16}$d.	—	$\frac{1}{16}$d.
Brass 60/40—				
Rod, basis	,,	0s. $8\frac{1}{2}$d.	—	—
Sheet, basis	,,	1s. $1\frac{1}{2}$d.	—	$\frac{1}{4}$d.
Wire, basis	,,	1s. $1\frac{1}{2}$d.	—	$\frac{1}{4}$d.
Pig Iron—				
Cleveland Warrants	per ton	£7 15 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£29 0 0	—	—
Lead Pig—				
English	,,	£20 10 0	£0 10 0	—
Foreign or Colonial	,,	£19 0 0	£0 17 6	—
Tin—				
Ingot	,,	£160 0 0	£7 0 0	—
Wire, basis	per lb.	2s. $2\frac{3}{4}$d.	1d.	—

Salammoniac.—Per cwt. 75s. 70s.

Sulphur (Flowers).—Ton £14 10s.

,, (Roll-Brimstone).—Per ton £14 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £35.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 10d.

Sodium Chlorate.—Per lb. $4\frac{3}{4}$d.

Rubber.—Para fine, 0s. $11\frac{1}{2}$d.; plantation 1st latex, 1s. to $11\frac{3}{4}$d.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

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Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics": "Soaring Flight," by Col. R. de Villamil; "Airship Fabrics," by J. W. W. Dyer; and "Vickers Vimy Aeroplane Ambulance."

"The Cabinet Maker": "The National Furnishing Trades Convention"; "Problems of Trade Organisation"; and "Practical Polishing."

"The Chemical Age"; "Recent Progress in Rubber Chemistry and Technology (III.)," by Dr. Philip Schidrowitz; "Colour in Water: Its Nature and Removal."

"Farm and Home": "Labour's Land Policy"; "Better Housing for the Cow"; and "Importation of Canadian Cattle."

"The Fruit-Grower": "Carnation Growing in March"; "The Townsman and Summer Time"; and "Pests of the Mushroom."

"Gardening Illustrated": "Rose Pruning"; "Current Work in the Allotments"; and "Protecting Peaches in Bloom."

"Gas World": "An Appreciation of Lord Moulton," by Sir Dugald Clerk; "Paints and Painting in Gasworks"; and "Welding in the Repair of Broken Parts."

"Hardware Trade Journal": "The Season-Cracking of Brass and Other Copper Alloys"; "Export Credits"; and "Permanent Metal Moulds for Brass Castings."

Arrangements for the Week.

FRIDAY, March 18th (to-day.)

Institution of Mechanical Engineers.

6 p.m. At Storey's Gate, St. James's-Park, London, S.W. Paper on "Contact Pressures and Stresses," by Prof. E. G. Coker and Messrs. K. C. Chakko and M. S. Ahmed.

Institute of Metals.—Sheffield Local Section.

7.30 p.m. At the University, Sheffield. Paper on "The Crystal Boundary," by Dr. W. Rosenhain, F.R.S.

Junior Institution of Engineers.

8 p.m. At Caxton Hall, London, S.W. Paper on "Hand Operated Appliances for Lifting and Transporting with Particular Reference to Application in Awkward Circumstances," by Mr. T. E. Dimbleby.

SATURDAY, March 19th.

Royal Institution.

3 p.m. At Albemarle-street, Piccadilly, London, W. Lecture on "Electricity and Matter," by Sir Ernest Rutherford, F.R.S. (Lecture III.)

MONDAY, March 21st.

Institution of Automobile Engineers.

7.30 p.m. At the Royal Technical College, Glasgow. Paper on "Automobile Steels," by Dr. W. H. Hatfield.

Royal Society of Arts.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "X-Rays and their Industrial Applications," by Major G. W. C. Kaye. (Lecture III.)

TUESDAY, March 22nd

Institution of Engineers and Shipbuilders in Scotland.

7.30 p.m. At 39, Elmbank-crescent, Glasgow. Paper on "The Dalmarnock Power Station," by Mr. R. B. Mitchell.

Institute of Metals: Birmingham Section.

7.30 p.m. At the Imperial Hotel, Temple-street, Birmingham. Paper on "Gun Metal," by Mr. R. T Rolfe.

Institution of Electrical Engineers: South Midland Centre, Students' Section.

7.30 p.m. At the University, Edmund-street, Birmingham. Paper on "Prime Movers in Small Power Stations," by Mr. H. E. D. Carter.

Institution of Automobile Engineers.

7.45 p.m. At the Foremen's Institute, 7, The Quadrant, Coventry. Paper on "The Lay-Out and Design of Engineering Works," by Mr. T. R. Speck.

Faraday Society.

8 p.m. At the Chemical Society, Burlington House, Piccadilly, London, W. Presidential Address by Prof. A. W. Porter, F.R.S., and Papers on "The Forms of Electro-Deposited Iron and the Effect of Acid upon Its Structure," by Mr. W. E. Hughes; "Electrolytic Recovery of Zinc," by Mr. S. Field, and "Notes on the Electrolytic Reduction of Glucose," by Prof. A. Findlay and Mr. H. V. Williams.

WEDNESDAY, March 23rd.

Institution of Railway Signal Engineers.

6 p.m. At the Midland Grand Hotel, St. Pancras, London, N.W. Paper on "Fundamental Calculations of A.-C. Track Circuit," by Mr. D. C. Gall.

Industrial League and Council.

7.30 p.m. At Caxton Hall, Westminster, London, S.W. Lecture on "Works Committees and Their Functions," by Mr. R. Young, M.P.

THE ELECTRICIAN

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Notes.

The Cost of Electricity Enquiries.

IT would seem that the cost of holding electricity inquiries has, like the deaths of certain famous personages, been greatly exaggerated. Mr. GEORGE BALFOUR was credited with the saying that the expenses of the inquiry into the Mersey and West Lancashire district were £40 000, which, as the inquiry lasted in all only eight days, was a sufficiently startling sum, even taking into account the array of legal talent which seems as necessary an accompaniment of such affairs as a bevy of pretty and equally highly-paid actresses at a charity entertainment. We are informed from an authoritative source, however, that the total expenses of scheme A in the inquiry in question were in reality somewhere about £2 500, so that to say £8 500 would cover the total costs of all parties is probably to be fair without being unduly biased. But even if we take these figures as correct the amount is, it will be agreed, quite high enough if no good is to come of it. For neither the industry nor the country exists to provide lawyers with fees. We must, therefore, reiterate that although these inquiries are necessary, every effort should be made to confine them strictly to the matter in hand, with the sole aim of inaugurating a new era of electricity with the least possible delay. So much are we convinced of this that we should like to see the Electricity Commissioners exercising a very much more drastic censorship than they have hitherto done over the length of speeches and the evidence submitted at these inquiries.

Finance of the Electricity Supply Act.

AMONG the subjects discussed at a recent meeting of the Association of Municipal Corporations was the operation of Section 29 of the Electricity Supply Act and the proposed amendment of it by clause 5 of the Electricity Supply (No. 2) Bill. It will be remembered that the Electricity Commissioners are required by the section in question to prepare an annual estimate of receipts and expenditure, and the amount by which the expenses exceed the receipts is to be obtained from the Joint Electricity Authorities and authorised undertakers in proportion to the number of units of electricity generated by each. During the first two years the excess of expenditure over receipts is, however, to be advanced by Parliament, but these advances must be repaid with interest within the three succeeding years. By Clause 5 of No. 2 Bill it is proposed to extend the preliminary period of two years to three and to allow until March, 1925, for the repayment of the instalments. In this way the expenses of the Commissioners would be borne by the electricity supply authorities, so placing upon the industry a burden of at least several thousand pounds a year.

Reasons for Opposing the Burden.

THE Law Committee of the Association rightly point out that this policy is an innovation in departmental administration in this country. For while the Electricity Commissioners, for whom the Minister of Transport is responsible in Parliament are really a Government department, the ratepayers are to pay for them, instead of their expenses being met out of the Imperial revenue as always has been the case hitherto. To the taxpayer and ratepayer, who is one and the same person, this may not matter very much, nevertheless it is an administrative point of some importance, especially at a time when there is an increasing tendency for Parliament to earmark the rates for national purposes. The Association is also opposed to the clause in the projected Bill which would make it compulsory for the constituent members to contribute to the losses of a Joint Electricity Authority, and further considered that 15 years instead of five should be given for repayment of sums advanced by the Treasury. But though we sympathise with the views of the Association we doubt the wisdom of trying to make such fundamental amendments in the new Bill, for to do so can only end in its postponement or abandonment.

Alternatives to Joint Authorities.

WE sincerely hope that no such abandonment will take place as has been confidently asserted by Sir HARRY RENWICK. For if it does, then the portions of the Electricity Supply Act which contemplate the formation of Joint Electricity Authorities will become a dead letter and stagnation will set in, for without adequate financial and administrative powers it will obviously be impossible to make further progress. As it is, unless there is substantial agreement between the municipal and company interests upon fundamental principles, there is little hope for any further Bill this or any other session; and as such agreement seems impossible we should be wise to try and discover some alternative to enable the electricity supply industry to meet the growing demands for energy. In the absence of Joint Authorities we can see no other way of doing this, except by authorising power companies to supply in bulk to all the authorised distributors in the various districts From the engineering point of view this should present no grave difficulties in most places, and though finance will as usual be the real obstacle, some special inducement, such as long tenure and easy borrowing powers, should help to smooth the way to an adequate supply of electricity for all purposes. Though this course would not be agreeable to those local authorities about whose myopic outlook we have already complained, it would, at all events, enable us to tide over the present period of financial stringency and so assist the electrical industry to continue its expansion unhampered.

The Domestic Load in Being.

The history of the Brompton & Kensington Electricity Supply Company, Ltd., is not uninteresting even if we confine ourselves to its more everyday side and neglect for the moment its other somewhat startling activities. Fifteen years ago, it will be remembered, the Company supplied a residential district with a load that was lighting and not much else. To such an undertaking the introduction of the metal filament lamp therefore came as a rude shock, but fortunately the wisdom of the directors and management prevented them from sitting down under what might well have been a disaster and led them to turn their activities in new directions. These activities—once again we speak of the supply side only—consisted generally in the building up of a domestic load with such success that during the past year the maximum load reached in 1906 was passed for the first time since that date. The difference in consumption between ancient and modern lamps indicates what that means, though the new load is of a better load factor and a higher diversity than the old. The other side of the picture is that the kilowatts connected have steadily risen until from being 8 000 kW in 1906, in 1920 they reached the satisfactory amount of 16 600 kW, no less than 1 400 kW being added during the past year, which was in itself a record. The number of consumers has risen from 4 127 in 1906 to 7 896 in 1920, this increase being also progressive. This satisfactory result has been due to some extent to the conversion of the larger houses in the district into flats and maisonettes, but very much more to the demand for electrical cooking and domestic apparatus which such a conversion, with the servantless existence which it entails, demands. Financially, in spite of the fact that the coal costs increased by 36 per cent. and the coal was of inferior quality, matters were equally satisfactory, for the coal cost per unit only increased 20 per cent. The gross receipts during the year amounted to £102 372, as against £74 045 in 1919, and the working expenses to £59 469, as against £44 683 in 1919, the increase in net receipts being £13 541. Such progress and the means by which it was secured are both worthy of imitation.

The Ideal Motorcar Headlight.

The much-discussed problem of the ideal motor-car headlight was dealt with by Major Garrard, in a Paper which he read recently before the Illuminating Engineering Society. The great difficulty with these lights is, of course, to reconcile the requirements of the driver who wishes to be able to see objects on the road in time to avoid them, and the feelings of pedestrians and drivers of approaching vehicles, who dislike being dazzled by an intensely bright beam, and left blinded to run into the next vehicle that comes along. The Paper and discussion formed a useful supplement to one on the same subject which was read before the Illuminating Engineering Society last year, and shows that the ideal solution of the problem has not yet been found on the dark road ahead. At present the most practical step possible appears to be to study the distribution of the light in the beam, so as to obtain a minimum of glare, and it is on these lines that a number of experimenters have been working with some success. We are also interested to see that Major Garrard endorsed the principle that the light should be confined to a certain distance below eye level, and that in order to be effective this boundary must be quite sharply defined. This and other conditions, it was suggested, cannot be met by any simple attachment placed in front of the ordinary parabolic headlamp, but only by some form of projection apparatus involving the use of at least one lens. Major Garrard considered that such a device need not be more complex or expensive than the head lamps usually employed. It is obvious, however, that matters cannot be left where they are, and we hope before long some designer will arrive at a more satisfactory solution than anything that has hitherto been suggested.

Printing Telegraphs in America.

The differences in technical telegraph practice in this country and the United States are well brought out in an article by Mr. J. C. Fuller which we publish on another page of this issue. It is for instance interesting to note that opinion in America is decidedly against the employment of high speed systems, although quite a number of such systems have been developed and some have been put into commercial use. This is entirely opposite to what has occurred both in this country and on the Continent where, as is well known, the Baudot system is mainly employed. On the other hand, a number of low speed systems besides those now in use have at one time or another been tried out, including those connected with the names of Buckingham, Barclay, Rowlands, Wright and Murray, while the Wheatstone system still has a limited application. At the present time, however, the systems most widely employed are that of the Morkrum Company, the multiplex systems of the Western Union and Western Electric Companies, the low speed single channel system of the Western Electric Company, and in a modified degree the Kleinschmidt and the "Tele-type" system of the Morkrum Company. Moreover, there does not seem to be much tendency to employ one of these systems to the exclusion of the others, and the Press Associations are sufficiently large minded to operate all of them. It may truly, therefore, be said that the system used depends on the service conditions, though under given conditions one system may show sufficient advantages over any of the others to make its use in that connection worth while. This is a very live way of dealing with a live matter. For there is no indication of stagnation in the technical development of telegraph science in the United States and no great movement towards standardisation, which in this case may mean very much the same thing.

Electric Traction in the United States.

Those who obtain satisfaction by comparing what American electrical engineers are doing with corresponding performances in this country to the inevitable detriment of the latter may spend an enjoyable half-hour in studying some statistics on the subject of electric traction which were recently presented to the Association of Railway Electrical Engineers in Chicago. From these it appears that the aggregate of "real" railway track in the United States now electrified, as distinct from light railways and tramways, is 2 662 miles, of which it is interesting to note no less than 460 miles were completed in 1917 and no more than 12 miles in 1918, these being the largest and smallest additions respectively in any one year since 1905. This total compares with the 600 miles of electrified lines in this country, or, putting the matter on a fairer basis, of the total railway mileage in the United States rather over 1 per cent. is operated electrically as against about 4 per cent. in this country. It is obvious, therefore, that though we have considerable leeway to make up, the United States has still more, without taking into account the widerspread presence on the other side of the Atlantic of those conditions which are generally supposed to favour the introduction of electric traction, such as water power, populous areas and mountain grades.

Increases in Motor Outputs.

The electrical statistics given on this occasion are, however, likely to give more food for thought to electrical engineers than those we have just quoted. It appears that the first line to be electrified was the Baltimore tunnel in 1893, a track mileage of 7·6 miles being then converted from steam to direct current at 600 V, locomotives with an hourly rating of 720, 800 and 1 120 H.P. being employed. The latest line of which particulars were given is the Othello-Seattle and Tacoma section of the Chicago, Milwaukee and St. Paul Railway, where a track mileage of 250 miles is operated on the direct-current system, motors with an hourly rating of 3 240 H.P. being employed. Between these two extremes a number of other lines have, of course, been converted, mainly on the high-tension direct-current system or on the single-phase system at 11 000 V. And while it is not possible directly to compare the arrangements employed, the progressive increase in the size of the motors used is very evident. This increase may justly to some extent be ascribed to the greater weights hauled and to the increasing severity of the sections operated, but it is also probably due to the conviction, which has been forced on railway engineers, that for efficient operation the motor must under all circumstances be easily capable of dealing with any load likely to be imposed upon it.

The Rating of Railway Motors.

These considerations naturally lead to an examination of the methods employed for rating electric railway motors and to a determination of how performance on the test bed can best be made to reflect the actual working conditions. The usual practice even now is to rate railway motors on their performance during one hour's run, though in America certain firms have advanced beyond this point by getting out service capacity curves for each type of motor manufactured, these curves being based on a large number of test runs on the track under carefully specified conditions. In a recent issue of "Elektrotechnische Zeitschrift," however, Mr. L. Adler points out that this method is not so practical as might seem at first sight and has the disadvantage of demanding an amount of trouble in preparation which is quite out of proportion to the usefulness of the information so obtained.

Rating on Continuous Load.

He therefore prefers to determine the losses that correspond with the service rendered and so to calculate the voltage and current that would give these losses on the test bed, allowing for certain cooling corrections which depend on the average operating speed and using lower voltages where the halts are closely spaced. In addition, commutating pole motors may be rated higher on lines with short distances between the halts than the motor without commutating poles, the position being reversed when the distance between the halts exceeds a certain figure. In a word, Mr. Adler's opinion is that railway motors should be rated on the maximum continuous load that they can carry, though in practice the hourly rating might be given in addition. We therefore have rather travelled in a circle. The hourly rating remains, and the two more recent methods to which we have called attention do not seem to contain any grave points of difference. It would be interesting, however, to have the opinions of railway engineers as to what system, if any, of all these they have found works out better in practice.

The Use of Vegetable Oil as a Power Agent.

Those who concern themselves with the possibilities of employing curious kinds of fuel for the generation of electricity will be interested in a Paper by M. R. E. Mathot, which was recently read in Brussels, wherein is discussed the use of vegetable oils for driving internal combustion engines. This question is naturally important to Belgian interests, as the Congo provides large supplies of palm and cotton seed oils, and at the same time is deficient of native coal. The use of such oils under such conditions seems to be quite economic, as will be seen from the result of some tests given by M. Mathot. These tests were made on English and Dutch engines using both palm oil and cotton seed oil for fuel, and show that with suitable engines one metric horse-power hour was obtainable from either fuel. In one case there was a consumption of 265 gms., the engine being of the four-stroke type with an output of 25 H.P., a compression of from 22 kg. to 24 kg. per square centimetre, and an explosion pressure of from 26 kg. to 28 kg. per square centimetre. The consumption was some 50 per cent. more in a smaller two-stroke engine with less compression, and was rather more in a four-stroke engine with about the same compression. Taking these oils as having a calorific value of 8 600 calories, the thermal efficiencies work out at about 28, 23, and 26 per cent. respectively in the three cases we have just mentioned, as against about 27 per cent. with petroleum with a calorific value of 9 600 calories. The results are, therefore, very encouraging and though there are certain technical obstacles to their use not unconnected with the fact that machinery in the Congo is looked after by relatively unskilled labour, they at least show that the experiment is worth while going on with. We have no doubt that with experience and care the difficulties which now prevent the application of this class of fuel to domestic purposes will shortly be overcome.

The Relief of Taxation.

We shall not be departing much from the truth in saying that the greatest disability under which British trade is suffering at the present time is financial stringency. This stringency exceeds in importance such items of discontent as shortage of floating capital, high prices, unemployment, lack of orders, coal costs, bad transport, unstable exchanges, and is to a great extent the cause of all of them. But stringency in its turn is caused to a large degree by the present oppressive taxation which is depriving many an undertaking of its means of sustenance at a time when vitamines are necessary to assist it to overcome the arrears of maintenance and construction caused by the war. The Federation of British Industries have, therefore, done well in laying these facts before the Government, and we hope that when a deputation from this body is received by the Prime Minister after Easter an opportunity will be taken to press home the many cogent arguments which can be advanced in favour of the relief of taxation to the exclusion, temporarily at least, of the other great difficulty of the liquidation of war debt.

The Need for Good Argument.

Good as the arguments in favour of this course undoubtedly are the Federation will have to use all their powers of persuasion to get it accepted by the Government. Revenue to meet the expenses of the country has to be obtained in some way or other, and direct taxation seems to be the one sure and certain method in which this can be done. As we pointed out some weeks ago the Excess Profits Duty was dropped, not because of the solicitations of the industry, loud and weighty as these were, but mainly because it had ceased to pay. The income tax is, however, in quite another category, and the Government considers quite rightly that it should be the first charge on the resources of the community. The only way to meet the desires of the Federation would therefore be still further to curtail the expenditure of the Government, and we might add of the local authorities, in every possible way until such time as conditions improve. This is a solution which is not likely to endear itself to our bureaucrats, and to secure its adoption will necessitate a good deal both of hard work and determination.

Magnetos on Aeroplanes.

Some paragraphs which should be of interest to manufacturers of magnetos appear in the report of the Advisory Committee on Aeronautics for 1919-20. According to an extract from this report, which is given in "Aeronautics" amongst the possible causes of ignition of explosive mixture on an aeroplane, the magneto holds a certain place. The Air Ministry have therefore divided all aeroplane magnetos on the market into "approved" and "unapproved" classes, the former being those which have so far not been known to cause a fire—a somewhat negative classification, it will be agreed—and the latter being the rest. The Committee are, we feel sure, unduly pessimistic when they say that on account of the great variability in fireproofness of individual magnetos of the same type it is impossible to state that any type of magneto is fireproof, although they are of opinion that designs could be prepared to comply with the standard fireproof test which has recently been modified by the National Physical Laboratory to conform more nearly to the conditions present in flight. Opportunity, which we hope will be seized, to see whether this is the case, will, therefore, be given to magneto manufacturers during the forthcoming competitions.

Trackless Trolley Omnibus.

The present discontent in the tramway industry has led several undertakings to consider the alternative of using trackless trolley cars. In some places, notably at Bradford, Glasgow and Birmingham, experiments are to be made with these vehicles to discover whether economy and efficiency will thereby accrue. These praiseworthy efforts have, however, received a slight check from, as might be expected, the legislative side. For the Glasgow Corporation have been informed that it cannot use trackless trolley vehicles for tramway extensions without specific Parliamentary authority, and further, that if the cars are run outside the city boundary a contribution must be made towards the expense of road maintenance, which is, of course, not at all a pleasant outlook. While, to carry the drama a step further, at Bradford, where it was proposed to run trolley vehicles capable of carrying over 50 persons on the Eccleshill, Idle and Thackley routes, the Ministry of Transport has stepped in with its veto, and informed the Tramway Committee that it cannot authorise the running of vehicles of the weight proposed, because it has no powers to do so. An excellent reason, but not one which will help to solve the traffic problem!

A Hint to the Supermen.

The path of progress and reform has always, of course, been beset with obstacles, but we venture to suggest to the supermen of the Ministry of Transport that obstruction of this kind is not the sort of thing we expect from a modern Government department. If the Ministry has not got the necessary powers it is time it got them; besides, why worry about powers? We know how important rules and regulations are, but, in our opinion, it is equally important that they should be modified if such a course tends to the good of the community. If there be no other objection to the use of these vehicles except their weight, then we think the Ministry might safely go ahead, and allow Bradford to do what it wants.

The Statutory Limitation of Dividends.

We have on several occasions drawn attention to the deleterious effect upon the prosperity of certain provincial electricity supply companies of the Statutory Undertakings (Temporary Increase of Charges) Act, of 1918, and the orders made thereunder by the Minister of Transport. As readers of The Electrician know the Act limits the dividend that can be paid by these concerns in any one year to three-fourths of the standard or maximum rate of dividend. Inasmuch as the majority of the provincial companies only paid very modest dividends in pre-war days, if they paid any at all, it is obvious how inequitable the situation has now become. For instance, the Scarborough Electric Supply Company is limited by Act to a dividend of 2¼ per cent., and at a time when fresh capital cannot be obtained for less than eight or ten per cent., it is strangling enterprise to allow such a small return on capital already invested. We would, therefore, urge upon the Ministry of Transport the necessity of modifying the Act at once, and placing electricity supply companies on the same basis as the tramways in this respect.

The Future of Trunk Telephones.

There is nothing a controversialist dislikes so much as a full and complete answer to his arguments. Such an answer takes the place of the knock-out blow in boxing by preventing the disputant from shifting his ground when it becomes convenient to do so, deprives him of the pleasure of elevating unimportant points in the discussion to the dignity of the main arguments, and so precludes a clouding of the issue. It has long been the cherished supposition in certain quarters that the engineering department of the Post Office are doing nothing to develop our telephone system. The Paper by Sir William Noble on "The Long Distance Telephone System of the United Kingdom," which was read before the Institution of Electrical Engineers last week, is in great part a confutation of this theory.

An Unfortunate Reticence.

So complete is it, indeed, that we regret the author has restricted his outlook so severely to the past and to the schemes which the Post Office have actually in hand at the moment. We suspect that this attitude is not so much due to lack of imagination, or even to official caution, as to the rigid line which is drawn by the Post Office organisation between the technical and the one hesitates to say "commercial"—but the secretarial branches. It is this barrier, for it is nothing else, which must be broken down if any real progress is to be made. For in the Post Office at the moment we have, on the one hand, some enlightenment and a desire to develop, but on the other, sheer darkness. Could, for instance, any other than a Post Office engineer describe the advance from the 800 lb. aerial conductors "erected in the last decade of the nineteenth century" to the 40 lb. cable circuits now in course of construction or to the very large increase in the trunk circuits now in use, and the reduction of annual charges to "approximately one-third those of the first scheme," and not make the slightest reference to the financial side of the question, nor to the enormous increase in telephone intercourse that must occur as soon as a sufficient and satisfactory service is made available at the reduced fees which may legitimately be anticipated as the result of all this?

The Amplifier as a Commercial Asset.

To go a step further with the same argument, as a result of the use of the thermionic amplifier, the conductors which are to be laid between London and Manchester may be compared as regards size with those employed, say, between the London Gerrard-street exchange and Croydon. Or, in other words, the annual charges per circuit-mile which are determined mainly by the capital expenditure involved, will be only a little heavier for the longest trunk circuits than for the junction lines between exchanges a dozen miles apart. The telephone engineer is, therefore, by means of this apparatus, rid of the burden laid upon him by the laws of telephone transmission, which exact that for a given transmission efficiency the weight of copper in his lines increases more rapidly than the square of the distance. Better still, he is relieved of much maintenance responsibility on lines of vital importance, which are necessarily erected in situations where they are exposed to storm damage. Incidentally, under ordinary circumstances it is almost impossible to design lines to withstand the stresses to which storms like that of March, 1916, may submit them, and it is entirely uneconomical to do so.

Research and the Amplifier.

Now it is not uninstructive in this connection to trace the development of the device which has rendered possible such far-reaching changes. When a new technical development proves to be of commercial value, it is fashionable to point to it as showing how research with a purely scientific objective has justified itself. Although the results of such research have been of great value in perfecting the amplifier, its main development has been due to work done with avowedly technical ends in view. Prof. Fleming, seeking to apply his observations on the Edison effect in glow lamps to the measurement of the received current in wireless telegraphy, invented the two electrode valve. Dr. De Forest, in his attempts to produce a detector in which the conductivity in the space between two electrodes should vary in accordance with the received signals, discovered, almost empirically, the amplifying properties with which the third electrode endowed the valve. Until this period (1907-8) we may say the results of the scientific investigations of Elster and Geitel, which took place between 1882 and 1899, of Sir J. J. Thomson in 1899, and of Prof. Richardson in 1902-3—in short, the very complete development which the theory of the thermionic discharge had reached—had contributed little or nothing to technical progress. Since then, Langmuir, and the many investigators who have worked upon the subject during the war, have applied the scientific results to improving manufacturing processes and to extending the performance and reliability of the product. The fact, therefore, remains that, although knowledge of the theoretical processes concerned was available in considerable detail, the inventions which made the advantages of the amplifier applicable to practice were developed without any help from theory or theorists. While therefore expressing once again our sense of the benefits theory has conferred on practice, we should do well when the need for purely scientific research is emphasised to remember that such research does not of itself necessarily result in any technical advance.

The Development of Telephonic Measurements.

It is interesting, too, to note how the developments of recent years have extended the practical limits of telephonic science. Measurements and adjustments of the capacity and resistance of cable conductors are now made to an extreme degree of accuracy at frequencies of 800 cycles per second and higher. The amplifiers used are exhausted to a pressure of 0·00001 mm. of mercury, probably the highest vacuum employed in commercial apparatus. These methods and devices, the employment of which a few years ago was possible only in the best-equipped laboratories, now form part of the standard construction and operation of long-distance telephone plant, and are the everyday concern of the telephone engineer.

The Amplifier and the British Trunk System.

In this country, where distances are relatively short, where the number of circuits is large, where towns necessitate the insertion of cable at short intervals on the trunk routes, the conditions generally present tend towards the total replacement of aerial trunk lines by underground cables. This, as Sir William Noble shows, necessitates, and at the same time facilitates, the employment of the amplifier. The British system of to-day is essentially a "trunk network" and not merely a number of "long-distance" lines. In such a network the amplifier offers tremendous economical advantages. Once these can be fully employed, there will be a corresponding increase in the volume of trunk traffic. The present clumsy methods of operating and controlling trunk calls will be relegated to the past to the advantage of all concerned and our telephone system will become what an ideal telephone system should be, namely, one in which any subscriber may be made available to any other subscriber almost immediately on demand and for as long a conversation as may be necessary, no matter what the distance which separates them.

Communication with the Continent.

But the outlook is not limited to that alone. Sir William Noble describes the schemes in hand for improved communication with the Continent. The Paper by Messrs. B. Gherardi and F. B. Jewett, abstracted in our issues of May 7, 14, 21, and June 4, 1920, tells how in America the amplifier has already made transcontinental telephony a practical, and more, a commercial success, while a Paper by Messrs. E. H. Colpitts and O. B. Blackwell read only recently before the American Institute of Electrical Engineers shows in what further directions the art and science of telephony will not only be improved in the future, but is being developed in the present.

Sir William Noble has indeed indicated that, as regard all that is best in the application of telephonic science to our own special conditions, the engineers of the Post Office are not a whit behind those of the United States—hard though this saying may be to some. We therefore look forward, confident that it is not far off, to the day when the combined forces of both countries shall succeed in accomplishing transoceanic telephony, not by the public methods of wireless, but by the private method of the submarine cable.

Behaviour of a Three-Electrode Vacuum Tube as an Oscillation Generator.

By EIJIRO TAKAGISHI
(The Electro-Technical Laboratory, Tokyo, Japan.)

The behaviour of a three-electrode vacuum tube working as an oscillation generator has been much investigated recently, but, so far as I am aware, the methods of investigation are not adequate, and the processes are complicated. Accordingly, the results seem to be of little practical value.

The oscillating phenomena of the tube should be dealt with starting from "dynamic or derived characteristics," which differ greatly from "static characteristics," which can be experimentally determined with ease, as is generally known. The term "derived characteristics" was first proposed by L. A. Hazeltine, who confessed, however, that they were difficult to determine. It has been found that the characteristics can be derived solely from the circuit conditions, and thereby the oscillating conditions of the system can be explained fully enough for practical application, though not rigorously correct, as will be outlined hereafter.

A Duplicate Circuit.

For the sake of brevity, we may begin with one of the simplest circuits arranged for generating oscillations, as diagrammatically illustrated in Fig. 1. As will be seen from a grid voltage-plate current characteristic curve shown in Fig. 2, when the potential of the grid in the tube with respect to the filament is oscillating around a point, *O* on this curve, the wave forms of the plate current are much distorted from those of the grid oscillating potential, which is nearly of sinusoidal form, as the other oscillating components—*i.e.*, $\dot{E}_p$, $\dot{I}_1$, $\dot{I}_2$, &c. In spite of this distortion, the only important component of the plate current is its fundamental one, so far as the oscillating power output from the tube is concerned. If this oscillating component of the plate current be denoted by $\dot{I}_p$, the fundamental oscillating power supplied from the tube to the oscillating circuit is expressed as

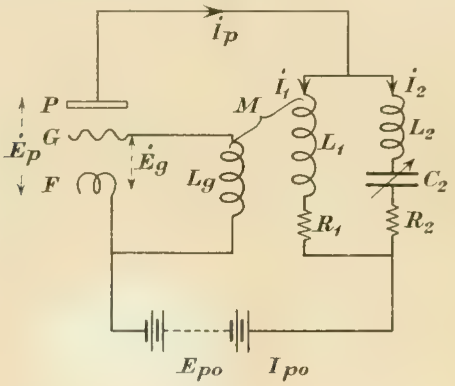

Fig. 1.

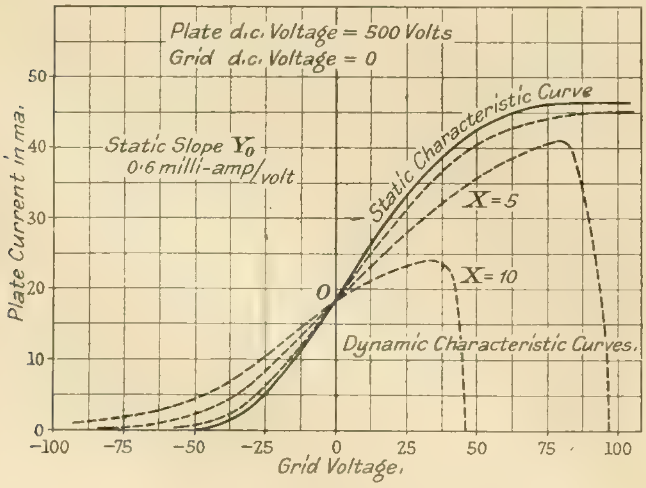

Fig. 2.

$$P_1 = \dot{E}_p \times \dot{I}_p. \quad \ldots \ldots \quad (1)$$

With the notations given in Fig. 1, we have for the plate oscillating voltage, neglecting the voltage drop $\dot{I}_1 R_1$.

$$\dot{E}_p = j \,.\, \omega \,.\, L_1 \,.\, \dot{I}_1$$
$$= j \,.\, \sqrt{\frac{L_1}{C_2}} \sqrt{\frac{L_1}{L_1 + L_2}} \,.\, \dot{I}_1, \quad \ldots \ldots \quad (2)$$

and for the grid oscillating voltage

$$\dot{E}_g = j \,.\, \omega \,.\, M \,.\, \dot{I}_1$$
$$= j \,.\, k \,.\, \sqrt{\frac{L^g}{C_2}} \,.\, \sqrt{\frac{L_1}{L_1 + L_2}} \,.\, \dot{I}_1. \quad \ldots \quad (3)$$

Equations (2) and (3) lead to the following relations :—

$$\frac{\dot{E}_p}{\dot{E}_g} = \frac{L_1}{M}. \quad \ldots \ldots \quad (4)$$

The manner in which the plate oscillating current depends on the oscillating voltage on grid and plate may be expressed by the equation

$$\dot{I}p = -g\left(\dot{E}_g + \frac{\dot{E}_p}{\mu}\right), \quad \ldots \ldots \quad (5)$$

where $g = f(\dot{E}_p, \dot{E}_g)$

μ = voltage amplification factor.

Being combined with equation (4), equation (5) may be written

$$\dot{I}_p = -g \,.\, \dot{E}_p \left(\frac{M}{L_1} + \frac{1}{\mu}\right). \quad \ldots \ldots \quad (6)$$

Combining equation (6) with equation (1), we have for the oscillating power delivered

$$P_1 = -g(\dot{E}_p)^2 \left(\frac{M}{L_1} + \frac{1}{\mu}\right), \quad \ldots \ldots \quad (7)$$

which must be positive in order to make the system oscillate, which condition can be fulfilled only when

$$\frac{M}{L_1} + \frac{1}{\mu} < 0, \quad \ldots \ldots \quad (8)$$

that is to say, M should be kept negative and larger than $\frac{L_1}{\mu}$ in magnitude. Accordingly, equations (4), (6) and (7) take the following forms

$$\frac{\dot{E}_p}{\dot{E}_g} = -\frac{L_1}{M} = -\sqrt{\frac{C_1}{L_g}} \quad \ldots \ldots \quad (4')$$

$$\dot{I}_p = g \,.\, \dot{E}_p \,.\, \left(\frac{M}{L_1} - \frac{1}{\mu}\right) \quad \ldots \ldots \quad (6')$$

and

$$P_1 = g \,.\, (\dot{E}_p)^2 \,.\, \left(\frac{M}{L_1} - \frac{1}{\mu}\right). \quad \ldots \ldots \quad (7')$$

Equation (4′) shows that the oscillating voltages of plate and grid are opposite in phase and are determined from the constants of circuit, the ratio of which will be denoted later by the letter *X*.

Effect of Reactance in the Plate Circuit.

In the present case it is assumed that the plate circuit is entirely non-reactive, which leads to the above results. If the plate circuit has any reactance, the two oscillating voltages are not exactly opposite in phase, and therefore $\dot{E}_p$ and $\dot{I}_p$ are a little out of phase. Yet if $\dot{E}_p$ and $\dot{I}_p$ remain within quadrature in phase, the system may possibly oscillate. Fig. 3 represents a family of contour lines of anode current, having grid voltage as abscissæ and anode voltage as ordinates, which are straight and parallel over a certain range. If the potentials on grid and plate oscillate around a point, O, in this figure, the anode current will oscillate along a straight line, AB, having an inclination to the horizontal corresponding to the equation (4′). The alteration in the anode current with the grid voltage under this condition is plotted as derived characteristic curves shown by dotted lines in Fig. 2. As the straight line AB becomes steeper and intersects the abscissa at a point nearer to the operating point O, the value of X getting larger, the derived characteristics of anode current to grid voltage correspondingly flattens more and more, and the vertical portions travel farther to the left. Thus it will be seen that, the larger the value of X, the more the plate current is distorted, much higher harmonics being introduced. As for the effective fundamental of the plate current, its curve will be of the form $OMB_1''K$ in Fig. 4, the curve OB_1B_2' showing the actual plate current. The problem can be solved by aid of this fundamental plate current characteristic curve when investigating the phenomena of fundamental oscillations alone. If an oscillation current is maintained in a closed circuit having a resistance, there is a power loss due to this resistance. Referring to Fig. 1, we have for this power

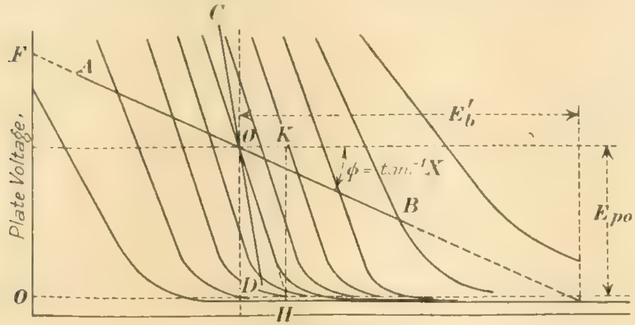

FIG. 3.

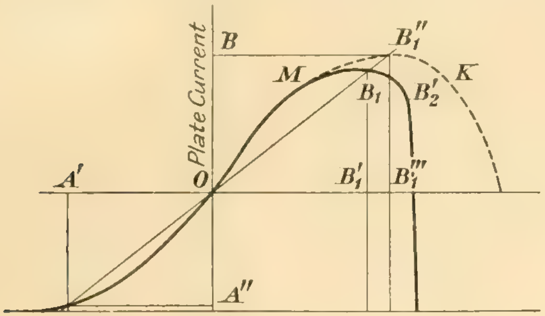

FIG. 4.

$$P_2 = (I_1)^2 \,.\, R_1 + (I_2)^2 \,.\, R_2$$
$$= (I_1)^2 \,.\, (R_1 + R_2)$$
$$= (E_p)^2 \,.\, \frac{C_2 R}{L_1} \,.\, a, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (9)$$

where $R = R_1 + R_2$, total resistance in the closed circuit, and $a = (L_1 + L_2)/L_1$. When a stationary state of oscillation is attained in the system, the oscillatory power input to the main oscillatory circuit from the tube must be equal to that lost in this circuit. Therefore equating (7′) and (9), we get

$$g(E_p)^2 \,.\, \left(\frac{M}{L_1} - \frac{1}{\mu}\right) \quad (E_p)^2 \,.\, \frac{C_2 R}{L_1} \,.\, a.$$

Therefore $$\frac{\dot{I}_p}{\dot{E}_g} = -\frac{C_2 R}{M} \,.\, a = -\frac{C_2 R}{k\sqrt{L_1 L_g}} \,.\, a. \quad . \quad . \quad . \quad . \qquad (10)$$

Thus the oscillating plate current and grid voltage are opposite in phase when operating, and their ratio has a definite value determined from the constants of that circuit. Denoting this ratio by the letter Y, it is seen this fixes an oscillation line, *e.g.*, OB_1B_1'' on the fundamental dynamic characteristic curve shown in Fig. 4. Then the grid potential oscillates between points A' and B_1''' round the point O, and the plate current between points B and A'' round the same point. Thus the amplitude of the oscillating grid potential $\dot{E}g$ being determined, the main oscillating current $\dot{I}_1$ is calculated from the equation (3), to be

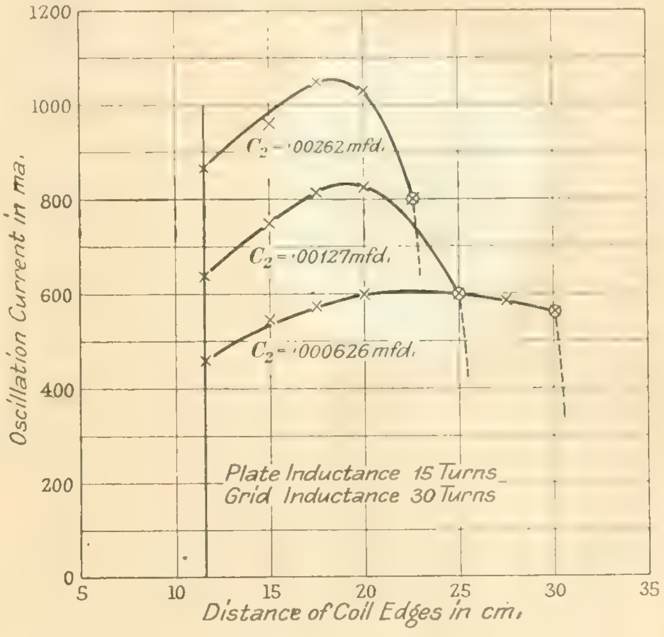

FIG. 5.

$$\dot{I}_1 = -j \,.\, \frac{1}{k} \,.\, \sqrt{\frac{C_2}{L_g}} \,.\, a \,.\, \dot{E}_g. \quad . \quad . \quad . \qquad (11)$$

Now the amplitude of the oscillation current in the main oscillatory circuit, *e.g.*, an antenna circuit, can be determined from the values of constants of the circuit for given conditions of a tube, and the effect of the constants of the system upon the oscillation current is also known.

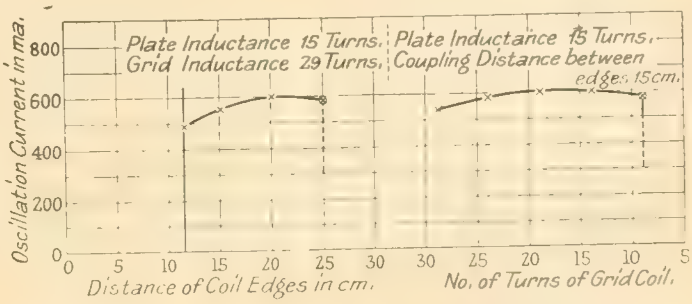

FIG. 6 (A). FIG. 6 (B).

COMPARISON OF EFFECT OF GRID COIL TO THAT OF COUPLING.

SOME EXPERIMENTAL RESULTS.

We will now proceed to substantiate the above stated theory by some experimental results. For the sake of brevity, a simple case where a is unity is considered. It is interesting to note that with a tube having a voltage amplification factor, X (which is nothing but μ previously mentioned), and a maximum value of mutual conductance Y_0, the increase of X decreases the maximum mutual conductance, Y, about the point of operation which the dynamic characteristic curve allows. The relation which should hold between these quantities is found theoretically to be given by the following equation in an ideal case where the contour lines are straight and parallel to one another, the point of operation lying in the middle of the characteristic curve :

$$\frac{Y}{Y_0} \quad 1-\frac{X}{X_0} \quad \ldots\ldots \qquad (12)$$

Now, an inspection of the values of X and Y reveals the fact that both are inversely proportional to the coupling coefficient.

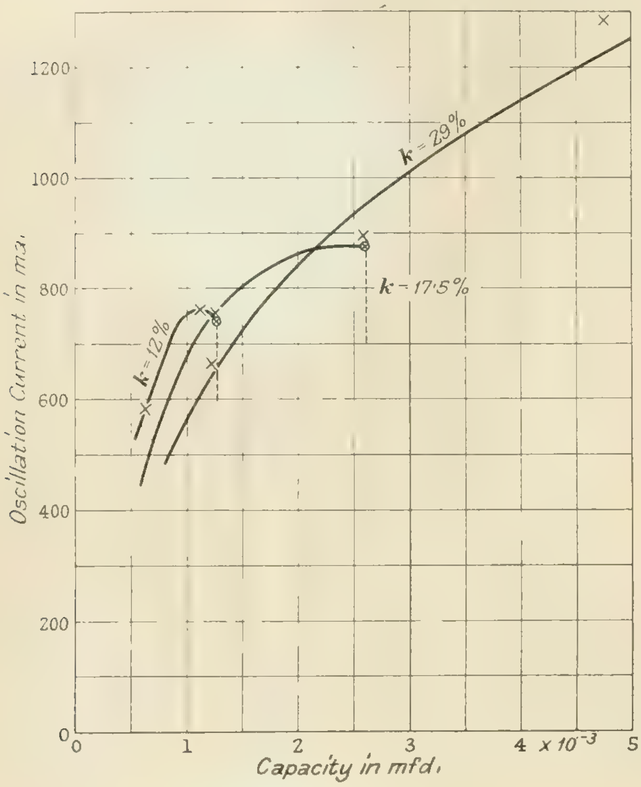

FIG. 7.

A fairly close coupling, making both quantities small enough to lie within the maximum permissible limits of X and Y respectively, allows the system to oscillate, and in the course of lessening the degrees of coupling, we anticipate there may exist a point of maximum oscillation current of $\dot{I}_1$ or $\dot{I}_2$, which, beyond that critical point, rapidly falls as the amplitude of $\dot{E}_g$ decreasing much faster than k does in the equation (11), until finally a point is reached at which the oscillation disappears, the equation (12) having been satisfied. In short, the range of oscillation is

$$\frac{Y}{Y_0} < 1-\frac{X}{X_0}. \quad \ldots\ldots \qquad (13)$$

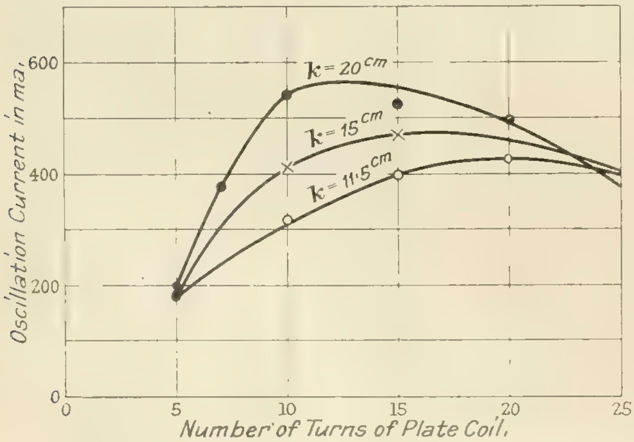

FIG. 8.—PLATE CONDENSER CAPACITY 0·000626 mfd. GRID INDUCTANCE, 440 micro-henries.

The validity of the above method of predetermination of the effect of the coupling upon the oscillation current has been satisfactorily substantiated by experimental results, as shown in Fig. 5, which illustrates the relation between the main oscillation current and the degrees of coupling (distance of coil edges in centimetre). The fact that the points, where the oscillations stop, shift to a shorter distance of coupling as C is increased, may be understood by inspecting the equation (10).

A glance at the equations (4′), (10) and (11) allow us to predict that the grid inductance L_g is similar in nature to the coupling coefficient, k, in respect to the effect upon the oscillation current, I. A comparison of the curves illustrated in Fig. 6 (A) and (B) is evidence of this.

THE EFFECT OF CAPACITY.

Fig. 7 shows how the capacity, C_2, in the main oscillation circuit affects the current in that circuit, too high values of C_2 stopping the oscillation. The effects of inductance, L_1, upon the oscillation current are illustrated in Fig. 8. Both of these effects will be understood by aid of the present method o analysis. Further, an experimental fact that the rate of change of an oscillation current is large when the value of M is smaller, can satisfactorily be proved by equation (10).

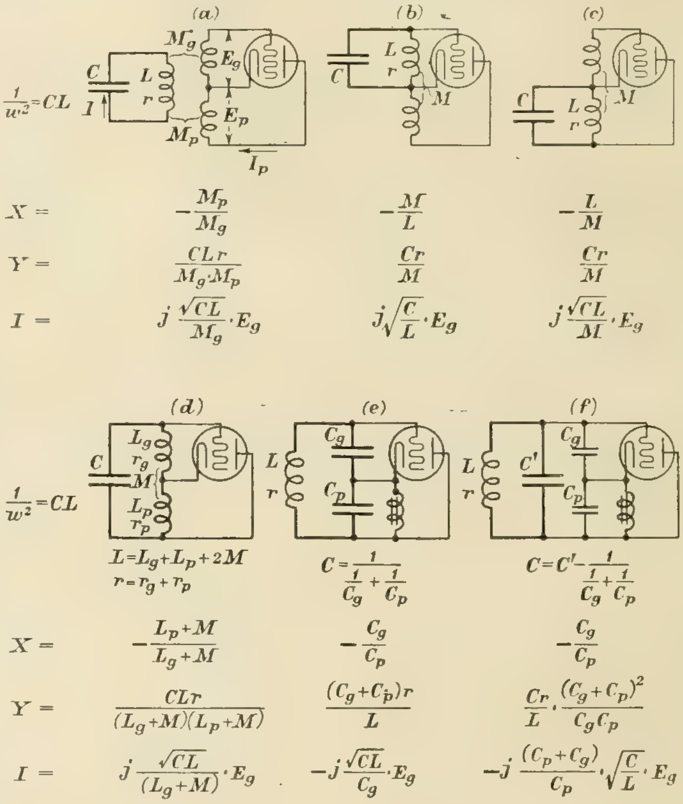
(a)
(b)
(c)
$\frac{1}{w^2}=CL$
C
L
r
I
M_g
E_g
E_p
M_p
I_p
M
$X = \quad -\frac{M_p}{M_g} \quad -\frac{M}{L} \quad -\frac{L}{M}$
$Y = \quad \frac{CLr}{M_g \cdot M_p} \quad \frac{Cr}{M} \quad \frac{Cr}{M}$
$I = \quad j\frac{\sqrt{CL}}{M_g}\cdot E_g \quad j\sqrt{\frac{C}{L}}\cdot E_g \quad j\frac{\sqrt{CL}}{M}\cdot E_g$
(d)
(e)
(f)
$\frac{1}{w^2}=CL$
L_g
r_g
L_p
r_p
C_g
C_p
C'
$L=L_g+L_p+2M$
$r=r_g+r_p$
$C=\frac{1}{\frac{1}{C_g}+\frac{1}{C_p}}$
$C=C'-\frac{1}{\frac{1}{C_g}+\frac{1}{C_p}}$
$X = \quad -\frac{L_p+M}{L_g+M} \quad -\frac{C_g}{C_p} \quad -\frac{C_g}{C_p}$
$Y = \quad \frac{CLr}{(L_g+M)(L_p+M)} \quad \frac{(C_g+C_p)r}{L} \quad \frac{Cr}{L}\cdot\frac{(C_g+C_p)^2}{C_gC_p}$
$I = \quad j\frac{\sqrt{CL}}{(L_g+M)}\cdot E_g \quad -j\frac{\sqrt{CL}}{C_g}\cdot E_g \quad -j\frac{(C_p+C_g)}{C_p}\cdot\sqrt{\frac{C}{L}}\cdot E_g$

FIG. 9.

For a circuit such as is illustrated in Fig. 1, it is only necessary to introduce a factor, a, into the above procedure. This process of explanation may be extended to any other circuitual arrangements, some of which are, for example, diagrammatically illustrated in Fig. 9, corresponding values of X, Y and main oscillation current being added.

(*To be concluded.*)

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Office on receipt of published price, plus postage.]

"Elementary Telegraphy." A Manual for Students. By H. W. Pendry. Second Edition. London: Sir Isaac Pitman & Sons.) Pp. x+237. 7s. 6d. net.

"Physical and Chemical Constants and Some Mathematical Functions." By G. W. C. Kaye and T. H. Laby. Fourth Edition. London: Longmans, Green & Co.) Pp. 161. 14s. net.

"The Practical Engineer" Electrical Pocket Book and Diary 1921. (London: The Technical Publishers Co., Ltd.) Pp. cxlii+610. 2s. net.

Extension of Heaviside Principle to Operator Functions.

By A. PRESS.

The symbols employed in ordinary algebra refer to numbers. The mathematical manipulations of such symbols depend upon the application of certain laws called the associative, distributive, commutative and index laws. Without having any thought of quantitative applications in the above number sense, we may regard the generalised algebra of Oliver Heaviside, as employed by him in his electromagnetic theory, as being still governed by the above-mentioned laws. The two algebras are therefore to be regarded as entirely distinct as to interpretation. Thus from this standpoint, as a mere matter of formal symbolism we may develop the fraction

$$\frac{1}{x-1} = x^{-1} + x^{-2} + x^{-3} + \quad . \quad . \quad .$$

without regard to the computational limitation, $x < 1$. The equality sign under these circumstances can no longer have attributed to it the set of meanings as of old.*

We shall be led to a study and development of such a non-computational algebra by suggestions drawn from the manipulations of common algebra when dealing with integral positive numbers symbolised by the character "n."

The Heaviside Principle.

In fact we shall formulate the doctrine or principle that developements valid in the common algebra true for n have a corresponding symbolic counterpart in the Heaviside generalised algebra, without regard to any computational significances, based upon n being taken as positive, negative, fractional, or, otherwise. The two algebras will then appear to be overlapping as it were with n taken in a certain way only.

As an example of such symbolic correspondence, we may take the general formula of differentiation of ordinary algebra

$$\frac{d^n(x^m)}{dx^n} = \frac{\underline{|m}}{\underline{|m-n}} \cdot x^{m-n} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In ordinary algebra n must at least be integral. By correspondence in the generalised algebra of pure symbolism, totally irrespective of computational reference we assume that formula (1) "holds" whether n is integral, fractional, positive or negative, &c. As for the "meaning" and value of such an indefinite algebra the sequel will show.

Experimental Interpretation of the Generalised Algebra.

Strangely enough it is found that although the symbolic developments of the new algebra lead to divergent forms, if an attempt is made at true numerical substitution, nevertheless, it is found that a computational use can be made of such divergent developments if certain purely experimental methods are employed when bodily translating the symbolic developments of the one to the narrower numerical algebra of ordinary mathematics.†

Evidently the interpretation of the equality sign employed suffers a decided transformation in the latter step. It is this feature, however, which makes the one algebra "interpretive" of the other. An example of such a type of interpretive transformation is given in the "Harmonic Algebra" of the writer (Univ. of Calif. Pubs.), page 161.

A New Generalised Development of Unity.

A method of developing unity by means of the generalised algebra can be made use of to explain and clarify much of the work of Heaviside on the generalised developement of ε, Bessel's Functions, &c.*

It is quite a common practice when dealing with ordinary series developments (assuming an existence theorem, or convergency test) that a method of indeterminate coefficients be employed. Correspondingly in the generalised algebra of pure symbolism, without regard to a computational use, we can employ an analogous device, with, of course, no corresponding limitations. Thus let us assume that

$$\frac{1}{x+b} = \quad . \quad . \quad . \quad + a_{m-1}x^{m-1} + a_m x^m + a_{m+1}x^{m+1} + \quad . \quad . \quad . \quad (2)$$

is a possible development in this non-computational algebra of pure symbolism.

Cross multiplying according to established rules regarding indices we have

$$1 = (x+b)\widetilde{\Sigma} a_m x^m = \Sigma a_m(x^{m+1} + bx^m). \quad . \quad . \quad . \quad . \quad , \quad . \quad . \quad (3)$$

In this symbolic algebra we similarly assume the "forms of differentiation" can take place. Thus differentiating to x according to symbolic rules, pure and simple, we have

$$0 = \Sigma a_m[(m+1)x^m + mbx^{m-1}]. \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

For equation (4) to be "true" we have at least as one necessary condition that all the coefficients of the x's as that of x_m for example, shall individually equate to zero. This gives the condition

$$a_m + a_{m+1} \cdot b = 0, \quad . \quad . \quad . \quad . \quad \quad . \quad . \quad . \quad (5)$$

from which all the a's can be determined in terms of a_m and b.

We have therefore on factoring out the common term a_m that

$$\frac{1}{x+b} = a_m \left[\quad . \quad . \quad . \quad + b^2x^{m-2} - bx^{m-1} + x^m - \frac{1}{b}x^{m+1} + \quad . \quad . \quad . \quad \right]. \quad (6)$$

It is the quantity a_m that corresponds to what Heaviside had designated as the "satellite" factor.†

It will be found that the new treatment overcomes many of the difficulties in the Heaviside treatment of the subject.

To evaluate the satellite term let us take $x=1$, we then have

$$a_m = (1+b)\left[\quad . \quad . \quad . \quad + b^2 - b + 1 - \frac{1}{b} + \frac{1}{b^2} - \frac{1}{b^3} + \quad . \quad . \quad \right]. \quad (7)$$

Clearly a_m is a function of the b's and not of the m's alone, as one might be led to think. By substitution therefore, we have finally as a generalised development *for operational purposes*

$$\frac{1}{x+b} = \frac{x_m}{1+b}\left[\frac{\quad . \quad . \quad . \quad b^2/x^2 - b/x + 1 - x/b + x^2/b^2 - \quad . \quad . \quad .}{\quad . \quad . \quad . \quad b^2 - b + 1 - \frac{1}{b} + \frac{1}{b^2} - \quad . \quad . \quad .}\right]. \quad (8)$$

This is an important method, and will be applied to the evaluation of the generalised forms both of ε^{-bx} and ε^{ax}.

Generalised Development of Exponential.

The operational form of ε^{-bx} in terms of the Heaviside unity operand x^0, which is non-existent for values of x less than zero and unity for all values of x greater than zero, is given by

$$\varepsilon^{-bx} = \frac{x_1}{x_1+b} \cdot x^0 \; \ddagger \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

---

* Compare in this connection Richardson and Landis, Numbers, Variables, &c. (Open Court Pub. Co.)

† A good résumé of the literature of divergent forms is given in Bromwich's "Infinite Series."

* *See* "Electromagnetic Theory," Vol. II., chapter VIII., pp. 434-492; Vol. III., page 216.

† *See* pages 464-466 of "Electromagnetic Theory," Vol. II.

‡ *See*, for example, "Electromagnetic Theory," Vol. II., pp. 129-130.

The dash beneath the x implies existential values only for $x>0$. It is the quantity $x_1\underline{x}^0 = d/dx\,.\,\underline{x}^0$ that corresponds to the Heaviside unit impulse function, that is, zero for all values of $\underline{x}$ greater than zero and infinity for $\underline{x}=0$.

Applying the development (6) to the expression $1/(x_1+b)$ of (9) we have

$$\varepsilon^{-b\underline{x}} \quad a_m\Big[\dots b^2x_1^{\,m-2} - bx_1^{\,m-1} + x_1^{\,m} \quad \frac{1}{bx_1}{}^{m+1} + \frac{1}{b^2}\cdot x_1^{\,m+2} - \dots\Big]x_1\underline{x}^0 \quad . \quad . \qquad (10)$$

Performing the indicated integrations (or differentiations) and again evaluating a_m by taking $\underline{x}=1$ we have the formula

$$\varepsilon^{-bx} \quad \frac{\varepsilon^{-b}}{\underline{x}^m}\left[\frac{\dots + \frac{bx}{\underline{|1-m}} - \frac{1}{\underline{|-m}} + \frac{1}{bx\underline{|-m-1}} - \dots}{\dots + \frac{b}{\underline{|1-m}} - \frac{1}{\underline{|-m}} + \frac{1}{b\,\underline{|-m-1}} - \dots}\right] . \qquad (11)$$

Correspondingly, we also have therefore

$$\varepsilon^{a\underline{x}} = \frac{\varepsilon^a}{\underline{x}^m}\left[\frac{\dots + \frac{a\underline{x}}{\underline{|1-m}} + \frac{1}{\underline{|-m}} + \frac{1}{a\underline{x}\,\underline{|-m-1}} + \dots}{\dots + \frac{a}{\underline{|1-m}} + \frac{1}{\underline{|-m}} + \frac{1}{a\underline{|-m-1}} + \dots}\right], \qquad (12)$$

with no trouble regarding signs that Heaviside encountered.

Thus, we see that Heaviside had assumed, rather tentatively it is true, that for the "satellite" term (taking $b=1$ above) that perhaps cos $m\pi$ may sufficiently replace the expression

$$\frac{\varepsilon}{\dots + \frac{1}{\underline{|1+m}} + \frac{1}{\underline{|m}} + \frac{1}{\underline{|m-1}} + \dots} \quad . \quad . \quad . \quad . \qquad (13)$$

It will be found moreover that with the new development difficulties of differentiation and integration are avoided. It also is seen to explain why only plus values of x are to be taken.

The Long-Distance Telephone System of the United Kingdom.*

By SIR WILLIAM NOBLE.

The subject of this Paper has not been brought before the Institution since 1905, when, in his inaugural address, Sir John Gavey referred to two fundamental problems awaiting solution: (1) an effective telephone relay or repeater; (2) a method of extending the range of communication in submarine cables.

The second matter was dealt with by Col. W. A. J. O'Meara† in 1910. Subsequently a solution of the first problem has been found, leading to the developments now to be described.

During the past four or five years long-distance telephonic transmission has been almost revolutionised by the evolution of the three-electrode thermionic tube amplifier and its use in the telephone relay or repeater.

At the present time long-distance telephony divides along two main lines of development, namely:—(*a*) Communication between the principal commercial centres of the country; (*b*) communication with remote districts, and international communication.

In the former the demand is for the provision of large numbers of circuits over distances up to 450 miles, *e.g.* London and Manchester, London and Glasgow; in the latter the requirement is for a few circuits, *e.g.* one or two only, over much longer distances, *e.g.* London to Belfast, London to Brussels, Paris and Marseilles, and in due course to Rome, Madrid, Constantinople or even Cairo.

Until recently the ultimate possible efficiency in long-distance telephone transmission appeared to have been reached, and was attainable only with the heaviest practicable copper conductors. The maximum economical conductor was proved to be one weighing 600 lb. to the mile, and for a commercial long-distance line the maximum length of a 600-lb. circuit was about 900 miles, at 92½ per cent. efficiency. Owing to the necessity for short lengths of underground cables in passing through town areas or across obstructions 60 per cent. efficiency was the average obtained in practice.

DEVELOPMENT OF UNDERGROUND CABLES.

From 1896 until about 1910 it was possible to accommodate on pole lines along the public roads and railways all the wires required to meet the public demand for trunk service. But the congestion on main aerial lines was becoming serious in 1910. At this juncture, however, the loading of telephone circuits with inductance coils, in accordance with the principles described by Pupin in 1900, indicated another line of development.

The earliest underground cables used in the long-distance telephone system were made up with copper conductors weighing 40 lb. to the mile, covered with 50 lb. of gutta-percha to an overall diameter of 174 mils. The inefficiency of transmission restricted the use of these cables in telephone trunk lines to the terminal sections in large cities, and to the leading in at testing points.

Trunk Circuits Radiating from London to Provincial Towns.

	1902	1905	1908	1914-15	Estimated 1920	1925	1930
Birmingham	4	7	14	32	37	60	76
Liverpool	8	10	14	35	37	63	80
Manchester	6	6	10	17	21	47	61
Leeds	2	2	9	13	14	20	24
Newcastle	1	2	8	10	9	14	17
Glasgow	4	4	4	6	6	10	12
Bristol	3	5	6	15	17	27	30
Cardiff	2	4	10	14	18	26	29
Southampton ...	1	4	6	11	11	20	25

Rubber-insulated conductors were used to some extent, but gave less satisfactory results.

The introduction of air-space cables with paper insulation and lead sheathing appeared to offer a solution of the difficulty in carrying telephone circuits underground.

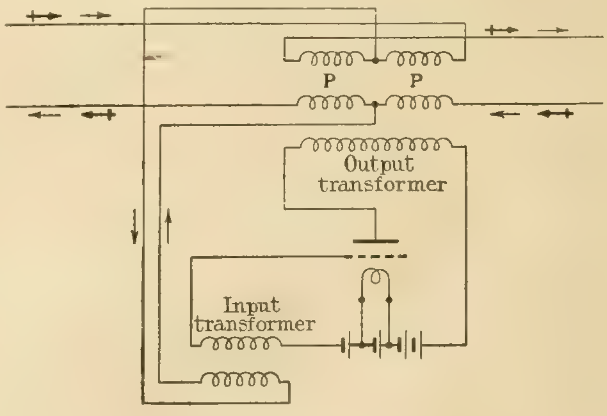

FIG. 1.—TWO-WAY TELEPHONE REPEATER WITH SINGLE AMPLIFIER.

However, short sections of such underground cables connected with long lengths of highly-insulated aerial wires form effective spark gaps for lightning discharges unless efficiently protected. The standard type of lightning protector was a small vacuum tube with platinum electrodes, which only imperfectly fulfilled requirements, but the design of a more efficient protector and improved workmanship in handling and jointing lead-sheathed cables soon established the air-space cable for trunk-line purposes. But the end of the last century gutta-percha subterranean telephone cables were obsolescent.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

† *See* THE ELECTRICIAN, Vol. LXVI., p. 375.

The superior transmission efficiency of the air-space cable permitted longer underground sections on trunk routes, but a fresh difficulty cropped up, namely, increased cross-talk between adjacent circuits.

The close packing of conductors of the air-space cables and the increasing length of cable sections introduced conditions of mutual disturbance which seriously affected long-distance circuits.

THE ELIMINATION OF CROSS-TALK.

Accordingly Messrs. F. Tremain and A. W. Martin in 1899 made a full investigation of a 93-mile air-space underground cable between London and Leamington. The section included 28½ miles of quadruple-core formation, the remainder being wires twisted in pairs. In spite of every effort to produce symmetrical cable speech telephonically transmitted over a loop made up of diagonal wires in a core of the quadruple formation could be heard in a telephone joined to the other pair of wires in the same core; but between diagonal pairs of neighbouring cores, no such cross-talk was observed.

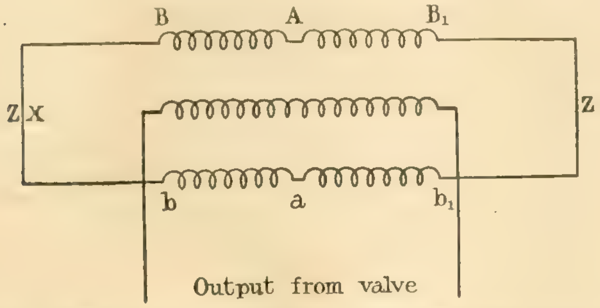


FIG. 2.—LINE CIRCUIT OF TELEPHONE REPEATER CLOSED THROUGH TWO EQUAL IMPEDANCES.

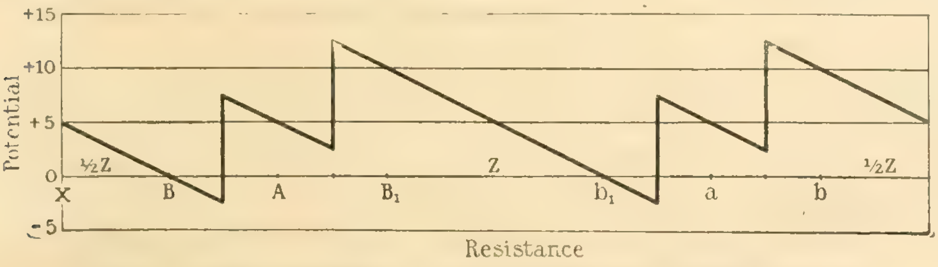


FIG. 3.—DIAGRAM SHOWING THAT *A* AND *a* (FIG. 2) ARE EQUIPOTENTIAL POINTS.

The investigators ultimately found that they could eliminate cross-talk between the two circuits carried by a quad core, by making crosses of individual wires, and pairs of wires, at six intermediate points in the 28-mile section. It appeared that no appreciable cross-talk would occur when crosses of pairs were made at intermediate crossing points, to ensure that no two pairs of wires remained parallel and adjacent for more than 10 per cent. of the total length of the circuit. Later a systematic method of balancing by crossing cores wrapped with paper of different colours was adopted to satisfy this condition, the balance thus obtained being very effective. Further, so long as no two pairs of wires were parallel and adjacent for more than 10 per cent. of the whole length of the cable, loops could be used indiscriminately for telephone or telegraph circuits. Various difficulties, however, subsequently arose and it became necessary for a time to provide separate cables for telephone and telegraph purposes—a condition which proved uneconomical on trunk circuits. Ultimately the whole question of cable design and balancing by selection of conductors for jointing was taken up afresh in 1913. A formula was obtained connecting the amount of cross-talk between circuits and the capacity relations of the conductors, and a method developed of reducing unbalances of capacity by joining contiguous lengths of cable having opposite and nearly equal characteristics. The method differed only in degree and detail from that previously adopted by Messrs. Tremaine and Martin.

MODERN METHODS OF BALANCING.

The modern method of balancing underground cables which require to be loaded and to carry superposed loaded circuits was first applied in 1913, when a composite telephone and telegraph cable had to be laid between Leeds and Hull. This cable of approximately 52 miles in length involved the making of over 90 000 capacity tests. Without any modification or adjustment it was found suitable for working simultaneously, without cross-talk or disturbances of any kind, loaded physical telephone circuits, loaded superposed or phantom circuits, and high-speed Wheatstone automatic telegraph circuits.

In 1915 a main cable-duct route from London to Liverpool via Birmingham was commenced, and the first cable completed as far as Birmingham in 1915 and extended to Liverpool in 1916. The cable was designed to give 30 circuits between London and Liverpool, and 42 between London and Birmingham and Birmingham and Liverpool.

The results obtained removed all doubts as to the future success of the underground trunk cable in relieving congestion on the aerial lines. But the very success of the cable opened up new problems.

The improved quality of service afforded led to a rapid increase in traffic. Individual circuits were more free from extraneous noise, and the whole groups of cable circuits more reliable; being unaffected by adverse weather conditions.

Within two years of the completion of the London-Liverpool cable, every available circuit had been allocated, and the question of providing a second cable arose.

It appeared that in order to obtain the necessary quality of transmission for direct service between centres 400 miles apart, *e.g.*, London and Glasgow, it would be necessary to use conductors of much heavier gauge or, as this stage was of doubtful practicability, to increase considerably the capacity of the underground duct routes.

THE NECESSITY FOR REPEATING APPARATUS.

At this juncture the solution of a fundamental problem, the construction of an effective telephone relay or repeater, became possible. The introduction of the three-electrode thermionic tube completely changed the aspect of the telephone repeater problem. The "soft" valve, used in the early experiments, has now been superseded by the "hard" valve for all telephone repeater work. The ideal thermionic valve for telephone repeater service should fulfil the following conditions:—

(*a*) Its general design should facilitate manufacture in large quantities with uniform electrical characteristics.

(*b*) These characteristics should remain constant throughout its working life.

(*c*) Small variations in filament current due to the normal voltage-drop of the filament battery during discharge should cause no appreciable change in the amplifying power of the valve.

(*d*) Its amplifying factor, in association with its input and output transformers, should be practically constant over the range of speech frequencies, and over the required range of input voltage amplitude.

(*e*) The electrodes and their supports should be sufficiently rigid

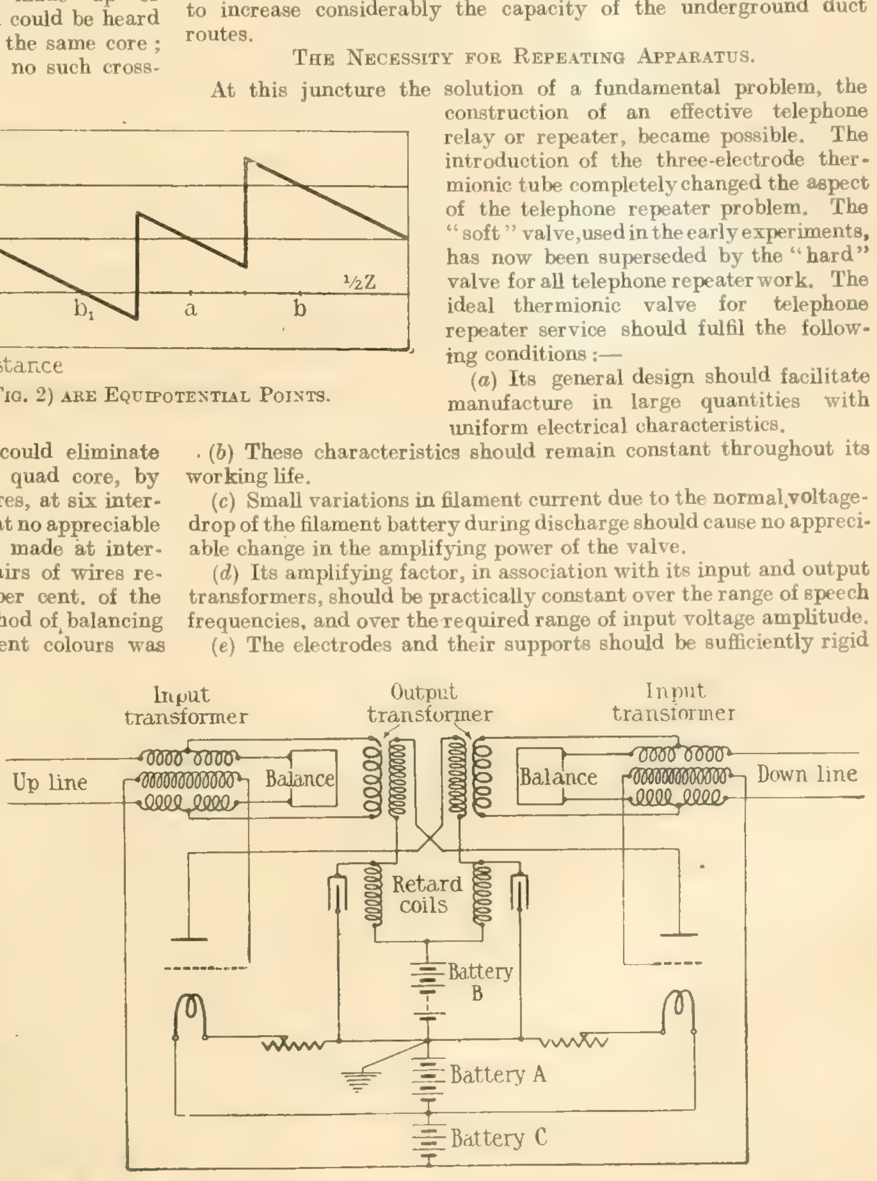


FIG. 4.—TWO-WAY REPEATER WITH SEPARATE AMPLIFIER FOR UP AND DOWN LINES.

to ensure that no vibration from external sources affects the performance of the valve.

(*f*) Power consumption in the filament should be as small as possible.

(*g*) Long operating life.

The thermionic valve has only a unilateral action as an amplifier. In the ordinary two-wire telephone circuit it must be duplexed in order to transmit and amplify speech currents in both directions through the circuit. The duplexing is effected on the principle of the duplex telegraph relay, by the use of differential winding on the line side of the output transformer (*see* Fig. 1). Speech currents from the up or down lines pass round the line windings, P, P, of the output transformer in series. The primary of the input transformer being joined across the middle points of the windings is a shunt on the line circuit, and a portion of the line currents passes through it and is amplified by the valve. The amplified outgoing currents are transmitted to the up and down sides of the line in series, and if these two sides are electrically equal the potentials at the middle points of the windings, P, P, are equal, and no part of the amplified current is fed back into the input circuit.

In a properly constructed transformer (*see* Fig. 2) with an equal number of turns in all the windings, AB, AB_1, ab, ab_1, the E.M.F. generated in all the windings by an alternating current flowing through the secondary will be equal. The impedances of the windings will also be equal. If the circuit be completed by the two equal impedances, Z, the circuit may be represented in straight-line form as in Fig. 3, the point X being taken as the starting point. Here the E.M.F. of each winding is assumed to be concentrated at the centre of the winding. The impedances are represented to scale. A drop of 5 volts has been assumed between X and B. There will be a corresponding drop between any two points having the same resistances between them. The total will therefore be 40, and each winding must produce an E.M.F. of 10 volts. Evidently under the conditions given, the potential of A will be equal to that of a. This applies in any case if the circuit is symmetrical about these points, so far as E.M.F.'s and impedances are concerned.

LIMITATIONS OF THE SIMPLE DIFFERENTIAL REPEATER.

In the early day of relatively insensitive microphone amplifiers unbalance difficulty did not cause serious trouble, but with it the thermionic valve amplifier has become one of the chief difficulties. In practice, the use of the simple differential repeater circuit (Fig. 2) is limited to cases where the repeater can be inserted at the electrical centre of a homogeneous and stable line circuit, *i.e.*, only in well-constructed cables, and seldom on aerial lines.

Under the best conditions the simple differential repeater may give a transmission improvement equivalent to the suppression of 16 miles of standard cable in a circuit having an equated length of 30 miles of standard cable. But it is generally impracticable to use it for tandem working, owing to the effects of reaction between repeaters at adjacent stations.

This limitation led to the development of the double differential repeater (Fig. 4). The line circuit is divided at the repeater station; each side is terminated in a duplex repeater and balanced by an artificial line representing the electrical characteristics of the actual line over the range of speech frequency. In practice, absolute balance is not obtained at all frequencies, but can be made sufficiently accurate by the use of simple apparatus to permit the operation of as many as four repeater stations in tandem, each giving a transmission improvement equivalent to the suppression of 16 miles of standard cable. The minimum residual transmission equivalent of a repeatered circuit using repeaters of this type singly or in tandem is found in practice to be about 12 miles of standard cable.

To be concluded.)

Electric Supply Legislation at the Cross Roads.

General Acts versus Special Acts.

By "POTENTIA."

The most important question agitating the electricity supply industry at present is whether it is possible to form Joint Electricity Authorities. If it is possible to form these bodies, then the assumptions underlying the 1882 Act and subsequent general legislation are confirmed, and will henceforth determine all future Acts. But if the attempt to constitute Joint Electricity Authorities fails, then the opposite assumptions on which the special or power Acts were framed will in future hold the field. The various enquiries will be therefore really the occasion of pitched battles between these two utterly antagonistic legislative policies.

For practically throughout the whole history of electricity supply in this country we have had two wholly incompatible theories underlying the legislation that has been introduced. The one theory (that underlying the series of general Acts of which the 1882 Act was the first) is that electricity supply should be carried on by each separate Local Authority and that supply companies are merely temporary interlopers to be tolerated only until the defaulting local authority of the district comes to a sense of its responsibility, and takes up its duty. This is obviously the correct reading of the purchase clause. The second theory (that forming the basis of the various Power Acts or Special Acts) is that it is meet for electricity supply to be carried on by a company or big corporation, and that local authorities are not to be formally anticipated as taking up the business (as witness "perpetual tenure").

UNAVOIDABLE ANTAGONISM.

Here then we have an unavoidable antagonism between the two sets of Acts, and the anomaly of two forces in the same field each supported by legislation. There is obviously no way of reconciling the developments proceeding from these two lines of legislation, since these two types of Acts are founded on almost diametrically opposite theories. A further fact which emphasises this irreconcilability comes from the engineering side—namely, that the territorial limitations involved in the municipal conception of the General Acts is incompatible with adequate electrical development, technically considered. The Special Acts were thus indisputably in the right in this respect.

The question then arose how to restore the balance so that the bias once more fell on the General Acts. The Electricity Supply Act, 1919, was designed to accomplish this Herculean task, namely that of reconciling local authority operation with an obliteration of "parish" boundaries. Hence arose the quasi-municipal bodies the District Electricity Boards, which later gave place to the almost indistinguishable (in the respect we are speaking of) Joint Electricity Authorities. The Joint Electricity Authority is thus the lineal descendant of the 1882 Act, and has entered the lists for final combat on behalf of the principle underlying that Act. Success means obviously the defeat for all time of the principle of the Special Acts. On the other hand, seeing that this is the last throw, the failure to form such Authorities will mean that once and for all the 1882 principle will go overboard, and the Power Acts theory will be left in possession of the field.

As a matter of fact it seems inevitable that some such sort of pitched battle must sooner or later have taken place between the two dissimilar forces backed by their respective Acts of Parliament. And if it has got to be fought out, it is certainly an advantage to do it all over the country at once and on a single issue.

POLITICAL v. PURE ELECTRIC ACTS.

In thus contrasting the General Acts with the Special or Power Acts we do not use these two terms as synonymous with municipal and company operation respectively. The distinctive principle is that the General Acts are fundamentally local government measures, whereas this is not the case with the Special Acts which are concerned exclusively with the supply of electricity.

As regards the prospect, the Joint Electricity Authority schemes are very much handicapped by the startling innovation in local government which it pre-supposes. Local Authorities, as their designation implies, are essentially limited in their jurisdiction and their responsibilities to their own most definitely delimited areas. The 1919 Act, in proposing that Local Authorities should corporately function as members of a wholly external corporation (as the Joint Electricity Authority will be) are asking them to do something quite unprecedented, which their constitution did not anticipate. So it is a somewhat hazardous venture. But anyhow the sooner the issue is decided the better for all parties concerned, not forgetting the poor, patient public.

Printing Telegraphs in America.

By J. CONRAD FULLER.

Although America has been responsible for the invention of many systems of machine telegraphy, it is only within the past few years that such systems (other than "stock-tickers") have received systematic and extended employment.

During the past 20 years or so a large number of printing, machine, automatic and high-speed systems have been proposed, and in many cases put on the market, but only three can be said to have attained any large degree of commercial success; these three being, in the order of their introduction:—(*a*) the low speed single channel system of the Morkrum Company; (*b*) the multiplex systems of the Western Union and the Western Electric Companies (which may here be considered as one system), and (*c*) the low-speed single channel system of the Western Electric Company. Two other systems have been recently developed and are now making their appearance on the market; they are:—(*d*) the low speed single channel system of the Kleinschmidt Company, and (*e*) the low speed single channel "Teletype" system of the Morkrum Company.

All these systems use a 5-unit code and all with the exception of (*b*) operate on the start-stop principle. In a start-stop system the 5-code impulses are preceded by a starting and are followed by a stopping impulse so that the code, in so far as line transmission is concerned, is really a 7-unit code. Such systems, however, are not frequently operated over lines in which the limit of the transmission capacity is approached and so these extra impulses have little practical importance. These systems derive their name from the action of the distributor brushes, which are normally at rest, but commence to rotate upon receiving the starting impulse and stop on receiving the stop impulse.

DETAILS OF PRINTERS.

It is not possible in these notes to give any mechanical details of the above systems, but a few words may be said regarding the printers, it being here that the greatest variation is found. The Morkrum page printer has a stationary platen, the type wheel being moved along in front of the platen, being thrown against it to effect printing. The Western Electric original page printer has a movable paper carriage, the type wheel remaining stationary and the paper being forced against it to effect printing. The Western Electric later page printer is of the type bar pattern, it has a stationary platen the whole basket of type being carried along in front of the platen. The Kleinschmidt page printer is also of the type bar pattern, it has a movable platen and is in appearance very similar to an ordinary typewriter. The Morkrum tape printer as used on the Teletype is a typewheel printer very similar in appearance and action to the Baudot receiver.

OPINION AGAINST HIGH-SPEED SYSTEMS.

Opinion in the United States appears to be decidedly against the employment of high-speed systems and it is doubtful if any such are in regular use except a few undulator or similar circuits working in conjunction with long-distance submarine cables. A number of high-speed printing systems have been developed, but it is doubtful if, from a practical point of view, any of them deserve very serious consideration.

Practically all public telegraphic communication in the United States is handled by two companies, the Western Union Telegraph Company and the Postal Telegraph-Cable Company. Of these two the Western Union is the larger, dealing with between two and three times as many messages as the Postal Company. In addition there are a number of smaller operating companies, but in a general survey they can be ignored as, taking them all together, they deal with less than 5 per cent. of the total traffic.

SOME DISCARDED SYSTEMS.

Both the Western Union and the Postal Telegraph Company have been very enterprising in investigating new systems and many have been put into actual service; a few recent cases may be mentioned. The Western Union about 1899 introduced the Buckingham and a few circuits were worked; this system had various disadvantages which were eliminated in the equipment as redesigned by Barclay and in its improved form it was brought into fairly extensive use; at one time about 85 duplex circuits were working, the last not being put out of service until 1915-6. The Postal Telegraph was interested in the Rowlands system and at one time had several circuits in operation; they also made exhaustive tests and trials of the Wright system, and in 1900 bought the United States rights of the Murray automatic, which however, does not appear to have been put into actual service. Both companies worked Wheatstone on a number of circuits and in connection with this they successfully designed keyboard perforators and perforating receivers, and tried out most other systems (with the possible exception of the Baudot) which showed any promise.

The present telegraphic position in the United States is that the Western Union, and many private users such as railways, news distribution associations, brokers, &c., are installing printing telegraphs as rapidly as the necessary equipment can be obtained; on the other hand the Postal Telegraph Company operates all its lines by means of sounders, the use of printing and machine telegraphs being discontinued from April 1st, 1919.

REVERSION TO SOUNDER WORKING.

The fact that the Postal Telegraph Company have reverted to sounder working on all their circuits would appear to raise a question as to whether machine or manual systems are the better. In this connection attention must be drawn to a few points of comparison between the Postal Company and Western Union; both companies are comparable in size, they handle similar classes of message over the same area, they both employ the same class of operator. Even so the one operating company finds printing telegraphs best on all its busier circuits, while the experience of the other company gives an opposite result.

The writer will not attempt to offer any explanation of this apparent contradiction, but a few points which may have some bearing on the question may be referred to. The Postal Telegraph in addition to its telegraph business operates a system of telephone toll or trunk lines. The telephone loops being formed from the existing telegraph wires, and the telegraphs being worked on the composite principle, this joint use will naturally reduce the annual line charges which can be fairly debited to the telegraph part of the business and so, with cheaper wires, the question of the full use of the maximum signalling capacity of the circuit loses some of its significance. Another point is that it is the universal practice to take down all sounder messages on a typewriter and so, from the point of view of the addressee, there is no apparent advantage in a printer system.

POINTS FOR CONSIDERATION.

In making a decision as to the type of equipment to be employed many points have to receive consideration, some of the more important being: accuracy, reliability, speed, output, operating costs, maintenance costs, annual charges, &c., &c. In any particular case values must be assigned to each of these factors and then, after carefully weighing all the points, a satisfactory system can be decided upon. These factors may have different values for different users, thus with a railway or broker absolute accuracy may be of greater importance than costs, while with a telegraph operating company the relative values of these factors may be reversed.

After making due allowances for the practices of the Postal Telegraph Company the situation in the United States may be summed up as follows:—

(i) Printing telegraphs are found to be satisfactory for all classes of service.
(ii) They are already employed on a very large number of circuits.
(iii) Their use is being rapidly extended.

It is difficult to obtain any definite figures as to the number of circuits working, but some details can be given of the Western Union; this company had at the beginning of the year over 1 800 duplex channels of their multiplex system in operation and in addition about 200 Morkrum "start-stop" duplex circuits; this means a total (allowing for spares) of considerably over 5 000 terminal printer sets. This figure should be sufficient answer to the question of whether printing telegraphs are successful and whether they have come to stay.

Some of the largest private users of printing telegraphs are the news distributing associations and agencies; some of these operate over the whole of the United States, but in the following table are given particulars of those circuits which are worked direct from New York; other printer systems are used by the same organisations

Name of News Organisation.	System employed.	Speed in words per min.	Number (approx.) of stations worked direct from New York.
Associated Press ...	Morkrum ...	60	50
.. ..	Kleinschmidt ...	60	14
.. ..	Western Electric	35	4
International News Service	Morkrum ...	35	30
	Western Electric	35	3
Standard News Association	Morkrum ...	35	22
United Press Associations	Western Electric	30	9

for sending out news from Chicago and other large cities. In all cases the "start-stop" type of apparatus is employed and the receiving stations may or may not be able to break in and speak to the transmitting station. The receiving stations are grouped according to their geographical position, four or more being placed on one wire; their line relays are in series with the line, the far side of the most distant relay being earthed. A number of such circuits are operated in parallel from the one transmitter. It is usual for the receiving equipment to be in duplicate with a switch for connecting either set to the line.

Page printing apparatus is generally employed in the United States, all the systems mentioned above, with the exception of the Teletype, being designed to receive in this manner. The last named prints on a tape as in the Baudot and it may further be mentioned that the Kleinschmidt people are developing a tape receiver. There are many arguments for and against tape reception:—

(*a*) It adds considerably to the complexity of the apparatus and therefore, to its capital and maintenance costs.

(*b*) It requires a number of extra signals for "line feed," "carriage return" and for feeding up a new line at the end of every message; such functional signals will vary with the length of the message, but will average from 15 to 20 for each message. Some functional signals will, of course, be required with tape printers to separate the address from the text, &c., but their number will be very considerably less.

(*c*) With tape reception considerable labour is required to gum the tape on the message forms.

(*d*) The appearance of a page-printed message is generally far superior to that of a gummed-on one. This is an important point in the United States, where, as stated above, all sounder circuit messages are neatly typed on the form.

As far as can be seen, page reception will remain the standard practice for all except the less busy offices; here, where the traffic is light and the skilled attention necessary to maintain a page printer is not available, it is probable that tape printers will be largely installed.

History of the Development.

The present large-scale development of printing telegraphs may be said to date from November, 1911, when the Western Union obtained options on the multiplex patents of Donald Murray and with the assistance of the Western Electric Company, perfected their present multiplex system. By the end of 1913 it was sufficiently advanced to be put into operation, and it has since been installed on a very large number of circuits.

Previous to this the only system which had achieved steady commercial success was the single-channel duplex system of the Morkrum Company. These people began the design of a printing system early in the century, although it was not until 1909 that they were sufficiently satisfied with their product to put many on the market; in this year some circuits were put into operation by the Postal Telegraph Company and various railways; some of the equipment supplied to a Chicago railway is still in operation. Since 1909 the Morkrum system has undergone several modifications, the last (about four years ago) being in order to adapt the system to work in conjunction with the Western Union multiplex.

When it was seen that the Western Union was going in for the multiplex system in a whole-hearted manner and that a considerable and steady market was thereby assured, an impetus was given to inventors and manufacturers to design apparatus which would work in with the Western system. Several firms are now engaged on this work, the more important being the Western Electric, Morkrum and Kleinschmidt companies. These three firms look to the Western Union as one of their best customers, and so the design of the apparatus is generally in accordance with Western Union ideas and practice.

Details of the Systems.

Multiplex or start-stop systems consist of a number of pieces of apparatus which are quite independent of each other but which are connected together to form the complete system. Four pieces of the equipment, the keyboard perforator, the tape transmitter, the auto-control (if used) and the printer are identical for either multiplex or start-stop working, provided, of course, the same 5-unit code is used, the only difference being in the distributor and its driving and speed-control gear, and in the lay-out and wiring of the operating tables. It is the practice of the Western Union to purchase their apparatus from various manufacturers, and so it is not uncommon to find a terminal set built up of the patented designs of three or more companies. This enables the equipment to be bought in the open market and, at the same time, renders it easy and economical to take advantage of any improvement in design. Fig. 1 gives a view of a Morkrum Press receiving set.

Maintenance Questions.

One of the most important questions in connection with printing telegraphs is that of maintenance and freedom from mechanical and electrical faults, but, at the same time, it is a question on which there is little available information. In America the writer gave considerable attention to this matter and was impressed with the reliability and freedom from trouble of all modern printing systems. The first point aimed at by those responsible for the operation of such systems is to keep all the equipment in such a condition that faults are unlikely to occur. To this end it is the practice to make, at stated intervals, a rigorous overhaul of each piece of apparatus. During this inspection all adjustments and spacings are checked with special gauges, and any piece which shows signs of wear is changed, provided such wear is sufficient to be a possible cause of trouble. These inspections take place at intervals of one or two weeks, the latter being the more frequent period. The time taken for an inspection is comparatively little, about 20 hours being sufficient to overhaul all the equipment on a quadruple duplex terminal set; this, assuming a 2-week period, only requires about one and a half hour's work a day. With efficient inspection, faults rarely occur during operation, such as do develop usually being on an operating table, faults on the distributor table or equipment being practically unknown. When a fault is noticed the piece of apparatus is changed for a known good piece from the test table, the operating set thus only being out of order for a few moments.

"Automatic" attendants are usually on duty the whole time that the apparatus is working, the number of sets under the charge of each attendant depending upon the importance of the circuits, number of circuits in the office, &c. Under ordinary duplex circumstances one man will carry out all the maintenance work on two quadruple sets and, as they work in three 8-hour shifts, each operating set (sending and receiving) will then require 3/8 man-days of attention per day.

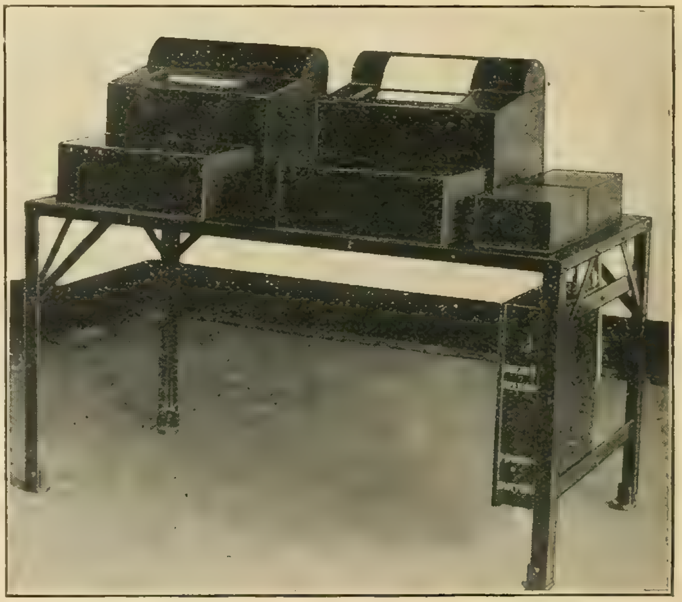


Fig. 1.—A Morkrum Press Receiving Set.

Spare apparatus is kept in all offices, the quantity depending upon the number of circuits working in the office. Thus in an office with only one working set, it will obviously be necessary to have a duplicate set, in which case there will be 100 per cent. spares; in large offices the percentage is much less, being about 25 per cent. to 30 per cent. in the case of printers and parts which are more liable to develop faults, and about 10 per cent. for distributors and other parts which have less liability to faults.

In a short article it is difficult, or even impossible, to make any comparisons between the different systems; all those mentioned at the beginning of the article are at present in everyday operation and the service from all appears to be about equally satisfactory. As will be seen above, the Press Associations operate all types and, as far as can be seen, there is, in the United States, no tendency to adopt any one system to the exclusion of the others. The "best" system will depend very greatly upon the service conditions, and under given conditions each system may prove the best. Thus if the traffic over each wire is sufficiently heavy, a multiplex system will be necessary; if it is moderate, a tape-transmission page-printing start-stop system may be the best; if light and continuous highly skilled attention is not available, the Teletype will prove the most suitable.

The Reason Why:

Process Changes are Necessary.

By W. J. HISCOX.

Trade Union rules say that a piece-work time for any one process, when once made, must not be cut, and this perforce must be observed by the works management. The operators, however, often feel they have a grievance, because directly they earn in excess of what is considered an adequate bonus the process is either modified or changed entirely, so that they are being penalised for speedy working. They claim that in so doing the management is getting round the trade unions' rule of "no cutting," and they retaliate by "going slow," with a view to misleading the management in regard to their earning capacity. This means, of course, that output suffers, for it is obvious that if, on any one process, the operator takes 16 hours when he can do it in 12 there is a period of wasted time. It may be well, therefore, to give some consideration to this matter, and see if we can discover the reason why a change in processes is necessary.

We have before urged that industry, to maintain its position, must be progressive. There can be no marking time or standing still, for this simply means going backward. This being so, it follows that each individual factory must also be progressive, and a change of method must be continuous. The world is ever on the move—conditions are constantly changing—and the factory must move with the times, in order to cope with these changing conditions.

Meeting New Conditions.

It is not that the management wishes to get round the rules made for the benefit of the workers, but rather that these new conditions have to be met. The change at the outset may result in some little trouble and hardship, but in the end the worker reaps the benefit. The following illustration may show this more clearly: The blacksmith's shop was the most crowded department in the factory, and the demand for work was so great that overtime had to be resorted to continually. The capacity of the shop was limited, every yard of space being utilised, and there was no possibility of extending. Despite the pressure which was brought to bear, and the improvements which were effected, this department could not keep pace with the demands, and so it became the limiting feature, so far as factory output was concerned. That is to say, the other departments could turn out 100 sets per week, if the material were available, and that meant that the factory output would be 100 finished units each week.

The smithy, which was, of course, a feeding department, could not satisfy the demands of the other departments. Instead of 100 sets per week, it could produce but 70, and so output from the other departments, and also from the factory, was limited to this latter figure. This meant, of course, that in the other departments the maximum number of operators could not be employed, machines were not being worked to their fullest extent, whilst the firm was losing the value of 30 finished units per week, saving only on the direct labour cost, as administration and overhead charges were practically the same. Apart from this, a vast amount of tool work had to be sacrificed, which meant that the facilities afforded by new and up-to-date tools were denied the factory.

The Benefits of Altering the Process.

It was certain that such a state of affairs could not continue indefinitely, and as there was no possibility of the smithy coping with the demand, steps were taken to alter the process wherever possible. The power press was selected as a medium, new punches, dies and press tools were devised and made, and eventually a huge volume of work was diverted from the smithy to the press. The outcome was that, although there was no shortage of work, the smithy could meet the demand, whilst the press department was equally successful.

The output from the other departments rose in proportion, for more operators were engaged and all the machines were working at full speed, and, as a consequence, more labour was employed in the fitting departments in order that output from the factory could be increased. Thus, through the changing of a process, everyone benefited—the operators, the management and the firm, and although the parts were produced at a lower cost, the labour earnings individually were higher.

Sometimes it is owing to a better quality raw material that a process is changed. In one case a certain type of sheet metal was extensively used, but on account of the amount of work involved in the factory, one of the departments was very hard pressed, and output from the factory was again limited to the capacity of this department. A more expensive metal was experimented with, and although the first cost was heavy, it was found that certain processes could be altogether eliminated, and others considerably modified, so that the total cost of this new material was much less than the total cost of the first named.

This would, of course, be gratifying to the firm, but what really benefited both the firm and the operators was the fact that so much more of the new material could be handled each week, that more money was earned individually and that the factory output showed a distinct increase.

It may be argued that, whilst such instances as those quoted undoubtedly benefit the operator, no such advantages accrue from the changing of machining processes. It is observed that in the up-to-date factory the tool-room is ever busy, turning out tools for the purpose of reducing labour costs, and the operator notes that with the advent of these, certain well-paid jobs are denied him.

The Need for the Skilled Man.

In certain cases individual hardships occur, for it means the passing over of a hitherto "skilled job" to the semi-skilled man, but the factories in which the change results in a man losing his employment are very few. There is always work for the "skilled man." The unemployed returns to-day show that, despite the trend of modern methods, it is the "unskilled" and "semi-skilled" man for whom a job cannot be found. The whole idea of the changed process is the elimination of unnecessary energy, and for the skilled man there is always something more worthy of his skill.

Take the case of the capstan lathe. Work is performed on this machine which a few years ago would not have been considered possible, yet the operator is not a skilled turner. It cannot be said, however, that the latter has been victimised, for his position is even better than before. Before the advent of the modern capstan, all high-class turning was done on the centre lathes, and output was limited. Now the output is considerably increased, and this has opened the door to more business. The factory has a firmer hold upon the market—its products are more in demand, and it is enabled to meet that demand.

Planning and Output.

The firm must get after business, and it can only do this in accordance with the capacity of the factory. If the capacity is 100 units per week, it is of no use seeking for 200, but if, on the other hand, by introducing new methods and processes, it is found possible to deal with 200, then it is up to the firm to get the business. The factory may be well planned at the outset, the capabilities of each department being proportionate, but if the firm is progressive, then sooner or later one department will forge ahead, and then it is that the other departments must be brought into line. The one department cannot be allowed to stand alone, neither can it be brought back to its former level, otherwise waste and inefficiency, the result of neglected opportunity, must ensue.

Unemployment is a serious thing, both to the individual and also to the State, for it represents waste, and the man who has a job must not think it is no concern of his. It is up to everyone to make openings for employment, and this can be done by increasing the capacity of the factory. It *is* necessary, therefore, for the process to be changed in order for this to be achieved.

An Improved Form of Battery Separator.

The sheets of grooved wood now commonly employed as separators in secondary batteries, though a great advance on the original glass rods, suffer under the disadvantage of having a somewhat limited life, with the result that the maintenance costs are increased to a not inconsiderable item, and the efficiency of the battery is reduced owing to taking down and setting up being necessary when replacement occurs. These disadvantages have, it is claimed, been overcome by the separator invented by Mr. T. A. Willand, of the Willard Storage Battery Company, Cleveland, U.S.A. This separator consists of a base of the purest Para rubber reinforced with a very large number of thin cotton threads. These threads act as a capillary channel through which the acid solution can percolate. This percolation takes place without the qualities of the insulator being impaired, and as it is obvious that the rubber is practically indestructible the life of the battery is thereby considerably prolonged. Another advantage of the arrangement is that it allows heavier discharges from the battery to be obtained. We understand that this type of separator has been introduced into the automobile batteries now being manufactured by Messrs. C. A. Vandervell & Company, and we shall be interested to know the results of this departure, especially from the points of view of first and running costs and upkeep.

Institution of Electrical Engineers.

There was a full, not to say overcrowded, meeting at the Institution of Electrical Engineers on Thursday, March 17th, to hear a Paper, of which an abstract will be found on another page of this issue, by Sir WILLIAM NOBLE on "The Long Distance Telephone System of the United Kingdom." This state of affairs at least indicates that interest in the technical developments of telephony is as great as that in its commercial shortcomings, though loyalty to a popular chief may be another explanation for the packed theatre. Curiously enough, the only part of the room that was not fully occupied was the Council Table. What omen is to be drawn from this?

Mr. J. S. HIGHFIELD, who occupied the chair in the absence of the President, said that Mr. ATKINSON and the Hon. Treasurer were paying a visit to the Royal Engineers at Chatham to cement the friendly relationship which had grown up between the Institution and the military engineering authorities during the war. We need hardly say that we wish them every success in this endeavour.

SOME HISTORICAL DETAILS.

The discussion on the Paper was opened by Dr. J. A. FLEMING, F.R.S., who we are sorry not to see and hear oftener at these gatherings. He began by saying that it was probable that successful attempts to find sensitive detectors for wireless telegraphy had led to the thermionic valve being recognised as an ideal telephone receiver. In fact, so much was this the case that what was now used in telephony was one of the standard forms of valve evolved during the war as a wireless detector. Sir Wm. Noble had said something about the immense amount of research work which had been done during the war on the valve, but did not mention what had been done in the United States on the New York-San Francisco and Los Angeles telephone line. Here, by the aid of the thermionic valve, 140 miles of standard cable—about five times the possible distance of good speech—had been made equivalent to an equated length of 12 miles of standard cable by using 13 repeater stations. For telephone work it was important to know that the ideal characteristic curve should be a straight line. No reference was made in the Paper to an oxide coated filament in the valves, but a great deal of work had been done in this direction in the United States during the war, and twice as many oxide coated valves had been made there as plain tungsten valves. The life of the valve depended on the temperature of the heated cathode, and it was claimed that the oxide coated filament had advantages over pure tungsten for this reason. Helium filled valves had also been used largely during the war as repeaters, and they were also an improvement on the hard tungsten valve.

A SEMI-DETACHED OFFICIAL VIEW.

Mr. A. J. STUBBS said in 1914, that 42 circuits was the largest size cable that could be constructed between, say, London and Liverpool, but by using the thermionic valve, the number of circuits could be increased from 42 to 90, while by the simple process of sub-dividing that circuit into three instead of two, the number of circuits could be increased from 42 to 240 equally efficient telephone circuits at about the same cost. From the point of view of the semi-detached official he emphasised the fact that the telephone system was not entirely isolated or inert, nor was the Post Office telephone engineer very far behind the most able and most advanced of the telephone administrators of the world in his accomplishments. We are glad that opportunity was taken to bring an important but little realised truth forward in this way.

THE REPEATER'S LIMITATIONS.

Mr. R. L. JONES (Chief Engineer, Western Electric Company, New York) then gave the meeting some idea of what an American engineer thinks of our effete telephone system. In such a complicated system as that in the United Kingdom, where there were several hundred thousand circuit elements in which abnormal losses might occur, a very high standard of transmission maintenance must, he said, be aimed at if the money value of these losses was to be kept from reaching a very high figure indeed. So far so good. But from this point of view a repeater was not without its drawbacks. For in a repeater cable circuit, the repeater might intensify about 95 per cent. of the total losses in the circuit, so that if they rose only another 5 per cent. they would render the circuit uncommercial and even inoperative owing to speech distortion. Turning to the trunk system in America, Mr. Jones said there was recently put into service a 4-wire cable circuit about 1 000 miles long between New York and Reading (Penn.) The circuit was of 20-lb. conductor, loaded in phantom. There were 22 repeaters, the gross equivalent being 550 standard miles and the net equivalent 10 standard miles.

THEN AND NOW.

Mr. J. E. KINGSBURY considered the Paper gave a record of work unequalled by any other branch of engineering with the same period. In 1905 when the trunk lines were inaugurated it was stated officially that the heaviest copper wire, weighing 800 lbs. per mile, ever used, had been employed, and that efforts had been made to reduce the underground portion as much as possible, so that the efficiency and clearness of the speech should not be impaired. The backbone system, which contained not a particle of underground cable, was to consist of 2 719 miles of 800-lb. copper, 4 914 miles of 600-lb. and 3 025 miles of 400-lb. copper. This, in itself, was sufficient to show the advances which had taken place since that time. The developments since 1891 were such that the size of cable then capable of giving speech only between London and Croydon could now be used, in conjunction with repeaters, between London and Rome or between Glasgow and Milan. It would be interesting to know whether the development study which Sir William Noble had referred to was on a no-delay basis. That was very important, because with cables and repeaters it was possible to have alternative routes, and development on a no-delay basis was the thing to aim at. A telephone line to be of any use must be available just when it was wanted.

Mr. P. E. ERIKSON, who dealt mainly with technical details, said that accuracy of transmission depended very largely on the precision with which it was possible to make the artificial balancing line resemble the actual line. It was always possible to design a network to simulate the constants of almost any line, but obviously that was a cumbersome and rather expensive method. In his opinion this was a case for standardisation. The impedance-frequency curves for a 70-lb. loaded cable circuit given in the Paper was a little misleading, because the conditions under which the tests were made caused the curve to indicate that the impedance rose with the frequency, whereas, as a matter of fact, the normal slope of an impedance curve on a long, loaded cable showed an actual decrease with increasing frequency.

THE DISADVANTAGES OF AIR SPACE.

Mr. F. TREMAIN said air-space in telephone cables led to a spongy condition, and necessitated very careful balancing, and it would be interesting to know what the percentage addition to the cost of the cable would be as a result of having to balance it in this careful manner, and what the additional cost was of loading the cable. It might, in fact, be worth while to go back to something approximating the solid conductor, so as to get greater radial stability. Good results might possibly be obtained with two wires combined together with enamel between them as the only insulation. A number of such pieces could be made up into a wire rope by symmetrically winding the wires, and though the result would have a low capacity, that was not now such a vital factor as it used to be. He wished Sir William Noble could add a complete bibliography of the subject to the Paper; it would be exceedingly useful. Here we thoroughly agree with Mr. Tremain.

The CHAIRMAN (Mr. J. S. Highfield), in calling upon Mr. F. Gill to speak, reminded his audience that Mr. Gill had been the Chief Engineer to the National Telephone Company, and had had the pleasure—some people said it was a mistake—of selling his Company to the Post Office. Perhaps this was not the most felicitous way of putting it that could be devised.

THE "CARRIER" SYSTEM.

Mr. F. GILL, in order to show the degree of improvement that had taken place in telephone transmission, showed some slides illustrating the amount of copper required for telephonic communication over 500 miles with overhead wires, with plain underground wires, with underground wires loaded, and with underground wires with repeaters in tandem respectively. These curves indicated that not only had a very great saving in the copper required been effected, but very much larger distances could be covered than were possible before. But the repeater was not going to be the last stage in telephonic progress. In the United States there were at present in commercial service carrier circuits for telephony and telegraphy together over lengths of 3 500 miles of equivalent to 19 000 miles of extra channels, some of these additional facilities being for telegraph and some for telephone. On a circuit of this kind between New York and Chicago, a distance of 742 miles, there were four intermediate repeater stations. At the first repeater station only the carrier current was repeated, at the second repeater station both the carrier and the voice was repeated, at the third station the carrier current was repeated again, and the voice broke off and continued on another line. At the next station the same thing happened, the voice broke off, the carrier was repeated, and recommenced on another line. This carrier system indeed fulfilled all the requirements of high grade long-distance service. It had proved flexible, had been maintained by the ordinary personnel, and it fitted into the plant the same as any of the other circuits. The apparatus was on engineering lines, and had got far beyond the string and glue stage.

Mr. G. C. **MORRIS** said that the transformer could not be considered alone, but must be taken in conjunction with the valve, and both valve and transformer could be improved if considered as one problem. Even as it was, the valve as a telephone repeater had been put to far more refined uses and pushed to further limits of uniform behaviour than in any other of its applications.

Mr. E. H. **SHAUGHNESSY** hoped the Continental authorities would develop underground loaded circuits, in order that there should be continuous equipment of this nature between London and Paris or London and Brussels. It was important that the trunk system should be completely underground, and not partly underground and partly overhead.

Sir **WILLIAM NOBLE**, in the course of a brief reply, said that development studies were on a no-delay basis, because experience had shown that when the public was provided with lines which did not get out of order, more revenue was obtained from them. The improvement effected by repeaters was shown by the fact that between London and Manchester 240 circuits could be got into one pipe, whereas without repeaters only 36 circuits could be so placed.

Some Thermal Characteristics of Electric Ovens and Hot Plates.

We give below an account of discussion which took place at Birmingham on Dr. E. Griffiths and Mr. F. H. Schofield's Paper on "Some Thermal Characteristics of Ovens and Hot Plates," an abstract of which appeared in our issue of February 18th.

Prof. W. **CRAMP** said that research of a scientific character upon electrical heating apparatus had for a long time been urgently needed. There were indeed few electrical matters upon which so much nonsense had been talked as upon heating apparatus and its efficiency. The present Paper attempted to deal with two aspects of the problem. One aspect was the formulation of standard tests whereby apparatus could be compared and judged, and the other was the efficiency of the apparatus. It was to be regretted that the expression "efficiency" had been used in the Paper for the ratio of the heat absorbed by the proposed test block to the heat equivalent of the energy supplied to the plate, for this debited the plate with the heat energy emitted by the block. The results obtained by the authors had an interesting bearing upon similar apparatus for gas, for it would seem that gas rings constructed upon the radiant energy principle would be more efficient for boiling purposes than those of ordinary type.

Mr. N. B. **ROSHER** said he welcomed the Paper because he thought that if the use of electric cookers and heating apparatus was to become universal in the home there was much need for further research and practical experiment. One of the chief reasons in his opinion for the extensive use of gas cookers was the high cost of the electric cooker, which could be taken as about double the cost of a gas cooker of equal capacity. Another reason was that supply authorities had not followed the example of the gas authorities in providing cookers on the hire or hire-purchase system.

Mr. H. **JOSEPH** criticised the Paper on the ground that the authors had departed radically from working conditions in their tests. He would like the authors to make it clearer why they had discarded the homely method of heating lagged vessels with specially-prepared contact surfaces. With regard to oven experiments the absence of working conditions appeared to leave room for further experiments. In his opinion the thermometer was not an essential accessory. Practice soon produced the requisite ability to judge heat.

Mr. S. H. **HOLDEN** mentioned that with some systems of domestic supply it was usual to fit a limit switch. This produced an objectionable intermittency of supply if the prearranged current was exceeded. It was a question to him as to whether this device would be suitable as a safeguard for the supply authorities in the case of cooking apparatus, and he would like to know the effect of intermittency of current on the performance of a cooker.

Reviews.

The Mathematical Theory of Electricity and Magnetism. By J. H. Jeans, M.A., F.R.S. Fourth edition. (Cambridge University Press.) Pp. vii. 627. 24s. net.

This book promises to become one of the classic works on the mathematical theory of electricity, viewed from the physical standpoint on the lines of Clerk Maxwell. It is somewhat difficult to deal adequately with it without repeating much that has been said before, since it has already run through three editions, and since the alterations in this new edition are comparatively slight until the last few chapters of the book are reached. Here, in view of the ever-increasing importance of electric waves and of the electron theory, the chapters on these branches of the subject have been entirely rewritten; it is these chapters and an entirely new one dealing with the Relativity theory which render the new edition specially interesting. It should, however, be noted that the book, particularly in the later chapters, presupposes a mathematical knowledge somewhat greater than that at the command of the ordinary student of physics reading, for example, for the Cambridge Natural Science Tripos, unless he has previously taken the Mathematical Tripos.

The most striking feature of the book is possibly the admirable style in which it is written and arranged; this, coupled with the excellence of the work done by the Cambridge University Press, gives a book which is easy to follow, and the reader is greatly helped by the selection of examples at the end of each chapter. The general lines on which the subject is developed are quite orthodox, and employ no methods which are strikingly new; but the author's aim has been to produce a complete standard text-book which is somewhat more elementary than some older books, such as that of Maxwell. One slight criticism may perhaps be admissible here; although it may have been impossible in a new edition of a book, as contrasted with a completely new work, to alter some of the symbols throughout so as to fall into line with the recommendations of the International Electro-technical Commission as revised in 1914, yet it is much to be regretted that this could not have been done. All scientific readers have been faced with the necessity of learning a new set of symbols at intervals, and one can only hope that the writers of new books will fall in with these recommendations, which are practically universal in America and on the Continent—so much so that some British authors have found that their books have no sale in America for this reason.

Turning to the new matter, one feels that although the treatment of the Relativity theory is short—only some thirty pages—the author is able to give a very clear outline which embraces all the chief points. Whilst it does not, of course, aim at being in any sense complete, it nevertheless serves as an introduction which enables the beginner to get some grasp of the theory, and in particular, the bearings of the theory on electrical phenomena; the few pages summing up the arguments for and against the existence of an "ether" may be specially mentioned as weighing the evidence admirably. The rewritten chapters on electric waves and the motions of electrons have been brought up to date, and it must be difficult to keep them so in view of the rapidity with which the scope of the science broadens; here again it is not possible to give more than an outline, and the theory of Quanta has been definitely ruled out of the book. The author has also included elsewhere a section on transmission of signals along a wire, showing how the "KR" law is established.

To the engineer who has had the requisite mathematical training, a book of this type, though primarily written for the physicist, proves specially interesting because it starts from a point opposed to that from which practical engineering books usually start. Except when he deals with capacities, the engineer has very little to do with electrostatics, and he is inclined to forget that there is such a branch of the science. He can start by assuming Ohm's law as an axiom, and never feel the want of an exact definition of "potential"—in fact, he would probably wonder how it was possible to "bring a unit charge from infinity." The ideas of electrostatics come to him accordingly as a means of broadening his outlook, although much of the mathematical theory has little direct application in practice.

F. J. DYKES.

Elements of the Mathematical Theory of Electricity and Magnetism. By Sir J. J. THOMSON, O.M., Fifth Edition. (Cambridge University Press.) Pp. 410. 25s. net.

This book forms an excellent introduction to the mathematical theory of electricity. Unlike most modern books on the subject, the word "electron" is not mentioned. Neither are we warned of the danger of putting too much faith in Maxwell's theory of the electromagnetic ether. In fact, it is definitely stated that "the electromagnetic is the only theory of light yet advanced in which the difficulties of reconciling theory with experiment do not seem insuperable." This is comforting to those who, like the reviewer, have been struggling with the theory of relativity and have been almost persuaded that the ether is a purely imaginary conception.

The only criticism we can pass on the book from the engineering point of view is that it is too short. Very few mathematical engineers have time to do more than master this volume. From their point of view, therefore, it seems a pity that the formula for the self induction of a circular current is not given and they miss also the formula for the capacity between two parallel cylinders. The author rightly lays stress on Maxwell's coefficients of capacity and potential, and from them deduces the definition of the capacity of a conductor and the capacity between two conductors. The engineer, however, generally knows all about the capacity between conductors before he knows about Maxwell's self-capacity coefficient. He looks at this coefficient as the capacity of the condenser formed by the conductor on the one side and on the other side all neighbouring conductors connected with the earth. It readily follows that the self-capacity coefficient of a spherical conductor equals its radius plus the capacity between the spherical surface on the one side and the images in the sphere of all neighbouring conductors connected in parallel on the other. This gives him some idea of its numerical value.

In Chapter V. a very neat solution of the capacity of two spheres in contact is given by the method of images, and it is incidentally proved that if the charge on one sphere be five times the charge on an equal sphere then their potential energy is the same when they are made to touch as it is when they are at an infinite distance apart. Hence no work is done in bringing them together, and as they repel one another when far apart they must attract one another when close together owing to the induced electrification. We think that it would be of value to give in this chapter a brief table of the capacity coefficients of two equal spheres and of the rates at which they vary.

It is now also of great importance to the engineer to know the formulæ for the maximum value of the potential gradient between wires, spheres, &c., so as to enable him to compute the voltage at which the corona forms or at which a spark takes place. These formulæ could easily be given.

On p. 265 the formula for the magnetic force due to an element of linear current is attributed to Ampère. It is sometimes also attributed to Biot and Savart, as they published it in a Paper in the "Annales de Chimie et de Physique, Vol. xv. 1820, a few years before Ampère published his classical Paper. As a matter of fact, however, Biot always attributed it to Laplace, and so French electricians call it Laplace's formula, although Laplace himself has left no record of it.

A. RUSSELL.

Rotary Converters—Their Design, Construction and Use. By C. Sylvester. (London: S. Rentell & Co., Ltd.) Pp. 57. 2s. net.

The author gives this little book a send-off rather in the form of a challenge when he says: "The use of that most useful machine, the rotary converter, is dealt with in almost every textbook, but the limit of the information is invariably confined to the fact that the rotary converter will transform alternating current to direct current and *vice versa*. . . . If the book is carefully studied from the first to the last page, there will be very little doubt in the student's mind about the action of the machine. If a fault should occur, with this information he will be able to place his hand upon it with certainty."

Without arguing about the first statement, beyond indicating our amazement how so much information concerning the rotary converter has got abroad if all textbooks have been so faulty, we must confess that we cannot endorse the author's view that a careful study of his book will produce the results claimed. The booklet certainly contains much practical and familiar information, but mixed up with all the good matter we read, for example: "If in two separate circuits currents are alternating at the same rate, but not simultaneously, or, in other words, are not 'in phase' with each other, so that the current in one circuit is continually behind the other, the supply is called '2-phase.'" Again: "The power-factor of any machine is largely dependent upon its design, but it is perfectly obvious that it should be as high as possible." Or, again: "We will now consider a lap-wound armature, irrespective of the number of poles in the yoke, that is, we will presume that there are two brushes on the commutator set at an angle of 180 degrees . . .," and "although it is stated above that the tappings from the armature to the slip-rings should be a certain number of degrees apart, it may be said that, to a certain degree, this condition is not possible. This is because the magnetic strength of the pole-pieces more or less differ from each other." While the only equation in the book, $R=c(D\div d)-c$, is written as, $R=(D\div d)\times c(-c)$.

Now, what has the "person in charge of an electrical machine" done to be ill-treated in this way? Perhaps one well versed in these matters may know or guess what is m[illegible] but our sympathy is with the reader and not with t[illegible]ter. With careful revision of text and diagrams, the v[illegible] of the book would be increased by 100 per cent.

STANLEY PARKER SMITH.

Shorter Notices.

Science German Course. By G. W. PAGET MOFFATT, M.A. 3rd edition. (London: University Tutorial Press.) Pp. xii.+270. 5s.

Any reviewer must approach with some diffidence the task of noticing a book which has reached its third edition and its sixth impression. Nevertheless, we are not favourably impressed with this work, which it is presumed has been compiled to comply with examination syllabuses of the University of London and other bodies which requires that a candidate for a science degree should have a certain knowledge of foreign languages. According to the preface the ordinary German grammar is as much a hindrance as a help to the student, whose object is to read scientific books which deal with a special line of scientific study. In spite of this dictum we suggest that the student who really wants to know something about German, as distinct from being able to pick out the English meaning of German words from a simple sentence, would do better to take for his guide a well-known German grammar, such as the famous Otto, than to rely upon a book of this kind. Seventy-nine of the pages of the book are devoted to grammatical details with which, having in view the statement in the preface, little fault can be found. If, however, the author had pretended anything other than he does there are certain things with which we should feel obliged to find grave fault. The remainder of the book is taken up with a number of pieces for translation, most of which have a scientific basis, and these, together with the sentences in the earlier part of the book, form a useful and pleasing departure from those usually found in books of this kind. Very little attention is paid to syntax, and as in this rests the chief difficulty which an elementary student of German finds, the book must also be marked wanting in this respect.

Useful Hints for Motorists. By VICTOR W. PAGE, M.S.A.E. (London: Henry Frowde, Hodder & Stoughton.) Pp. 163. 5s. net.

We are pleased to find that in this book a large amount of space is devoted to a consideration of electrical troubles. This is the more necessary as the book is of American origin. The author does not commit the mistake of describing too closely what may be called the major failures, but tries to persuade the earnest seeker after knowledge to look for something simple rather than to give way to the temptation of taking something to pieces to see how it works. It may truly be said that for the amateur the two most important causes of failure in the electrical apparatus on a motor car are loose connections and dirt. These are given fair, though not undue, prominence in the book. We should like to have seen cracked porcelain given among the things that may easily go wrong with a sparking plug, and some of the hints regarding battery maintenance require amplification.

Home Mechanics' Guide Workshop Companion. By Andrew Jackson, Junr. (London: Henry Frowde, Hodder & Stoughton.) Pp. 222. 6s. net.

This book, which is of American origin, is not unlike a number of similar works which are on the market over here. It is written by an amateur for amateurs and is the result of the author's study of trade periodicals and his experience in his own home. A good deal of space is given to the upkeep of electrical installations, but it mainly deals with "weak-current" applications, such as bells, very little with lighting and not at all with domestic equipment. The book is well put together, but seeing that it deals with American conditions, it is rather difficult to see its exact use over here.

Correspondence.

THE OPTOPHONE.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the letter of Mr. Campbell Swinton on the subject of a loud-speaking Optophone, which appeared in The Electrician of March 11th, it may be of interest to record that thermionic amplifiers were applied to the optophone a considerable time ago with the object of increasing the sound in the ordinary telephone, but although it was evident that the sound could be amplified, it was decided that to increase the cost and complexity of the instrument to the extent involved by the addition of an amplifying set was not justified.

In 1919 Messrs. Barr & Stroud, Ltd., applied to Messrs. Marconi, of Chelmsford, who were kind enough to prepare a special amplifying set.

At a later date, through the kindness of Major Henrici, the valuable advice and assistance of officers of the Signal Department at Woolwich were also obtained.

Mr. Swinton, by the application to the subject of his great experience of amplifiers, has attained most encouraging results in making the optophone notes audible for instructional and demonstration purposes.—I am, &c.,

Glasgow, James Weir French.
March 15, 1921. (Director, Barr and Stroud, Ltd.)

Standard Cable Sockets.

The British Engineering Standards Association have issued a standard specification for electric cable soldering sockets. This is published by the Association at 28, Victoria-street, and is obtainable from the secretary, price 1s. 2d., post free.

It deals with electric soldering sockets for cables from 0·0018 to 1·000 sq. in. sectional area, and has been prepared at the request of the Institution of Electrical Engineers. The specification includes definitions and clauses relating to the material and dimensions of cast and wrought lug sockets, and clamp sockets and their clamps. At present these are the only two types of socket standardised.

Attention is directed to the care which should be taken to ensure that the cable should fit the hole in the socket without too much clearance, so that the current will not have to traverse an undue amount of solder. For each size of cast lug socket a maximum diameter of hole is specified, and for use with smaller cables a smaller hole should be used. In the case of the wrought lug sockets made from copper tubing it is not so easy to overcome this difficulty.

In the case of clamp sockets there are only nine sizes, and the actual diameter of hole to be bored for each size of cable is specified. The question is of chief importance when the maximum current is being carried.

It is to be hoped that all makers of cable sockets will do their utmost to restrict the number of sizes within the limits dealt with in this specification to the standard sizes, and to make prominent mention in their lists and advertisement of the fact that these sizes are British standard

Mercury Arc Rectifiers.

At a recent meeting of the Informal Section of the Institution of Electrical Engineers a discussion was opened by Mr. R. L. Morrison on "Mercury Arc Rectifiers." The opener had brought with him some good photographs of rectifiers in service and some drawings, including a full scale one of a 900 A converter.

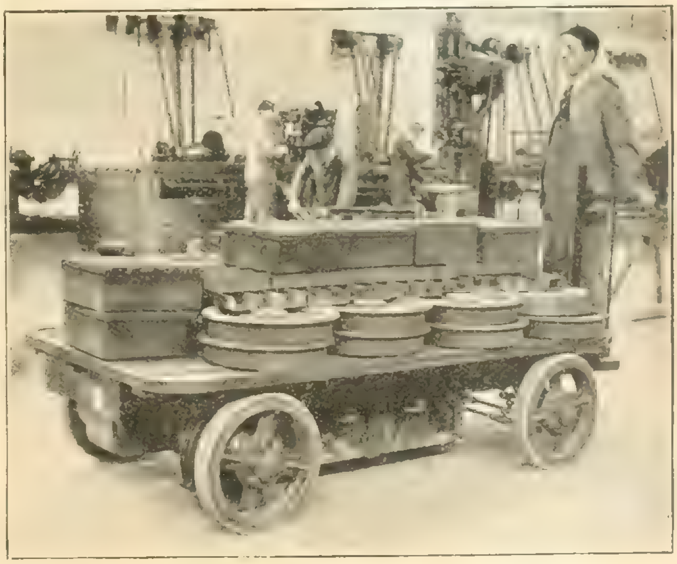
In the course of his remarks Mr. Morrison explained the function and construction of the rectifier, and the utilisation of each half wave by the two halves of the transformer centrally connected. He claimed superiority for the mercury arc rectifier chiefly because of its high general power factor, saving in floor space and weight, also because it was noiseless, vibrationless, stationary and required no heavy foundations.

Then followed a keen and animated discussion opened by Mr. G. A. Juhlin, who thought the simplicity of the apparatus was bound to occasion its adoption and development, but disputed that rotary converters were at a disability. He also asked for information regarding possible interferences with telephones due to the ripples and harmonics. The general trend of the discussion was very critical, and Mr. F. Pooley, who spoke late in the evening, urged that antipathy to the novelty of the apparatus was hardly constructive. Nevertheless, some most useful ideas were mooted.

Mr. Morrison, in his reply, was able to point to extensive installations of the rectifiers, and though he agreed the experience of them was only of a few years' duration, the makers were able to declare that the renewals and maintenance charges were negligible. With regard to telephone disturbances no data were available, but no complaints were known of. Research and developments were proceeding, and at an early date it was anticipated any direct-current ripple will be entirely eliminated.

The "Super-Giant" Electric Truck for Docks.

The increasing employment of electric industrial trucks on railways, in factories, and for dock work is well illustrated by the statement that British Electric Vehicles, Ltd., have recently received an order from the Port of London Authority to supply 31 of their "super-giant" electric industrial trucks for use in the London dock premises. This type of truck of which we give an illustration herewith was adopted by the Port of London Authority after exhaustive tests of other makes, including a number marketed by leading American manufacturers. The decision was arrived at not so much on price but on the actual performance the "Super Giant" was able to give, and especially owing to its accessibility and simplicity.



The B.E.V. "Super-Giant" Truck

Mechanically these trucks are built of heavy steel channel, 4 in. by 2 in., in section with cross stays of the same section, gusset plates being provided at the corners. The driver's platform is made up of angle iron frame, 3 in. by 3 in. angle iron dash brackets being provided for carrying the steering handle and controlling lever. The wheels are detachable, the hubs being mounted on roller bearings of the Timken type. The truck is steered by an up or down lever motion which is transmitted to the wheels through ball and socket joints, an arrangement which it is claimed ensures efficient control, and makes for simplicity. The front wheels are tied together by a substantial bar beneath the truck, and are so designed that the wear from turning corners is reduced to a minimum. A thrust bearing is provided in the stub axle to ease the steering operations. Transmission to the rear wheels is by means of a countershaft, the drive from the motor to the differential being of the spur gear type which makes for high efficiency. The wheel gearing is detachable, and can be replaced in a few minutes. The countershaft and differential are mounted on Skefko ball bearings, and every means is taken to provide for efficient lubrication and easy interchangeability. Indeed, it may be said that accessibility is the keynote throughout, while another important point is that the truck has been designed to withstand the rough usage which normally prevails in docks, warehouses and engineering works.

The electrical equipment of the truck consists of a B.E.V. standard motor with an output of 1 H.P. constant rating, when running at 1 200 revs. per min. on a 40 V circuit. This motor is specially designed for truck work, has ample power for what it is called up to do, and high efficiency. It may be noted that the motor unit may be detached in 10 minutes from the truck without interfering with any of the other parts, while the countershaft can be taken out and replaced in the same time.

The controller, which can be removed in under five minutes without disconnecting any of the wiring, and without taking out any bolts, is mounted under the platform at the driver's end of the truck. It is of a robust design, and is operated in conjunction with special patent trip gear. This arrangement renders the truck absolutely fool-proof, and also avoids the use of mechanical interconnections which are, it is found, a constant source of trouble. It especially prevents any accidental starting of the truck by depressing the truck pedal, for in order to start the controller must first be brought into the neutral position. The following additional special features of the controller may also be noted. The drum can be taken out without dismantling any of the parts, the fingers are adjustable, and are held in contact with springs: the trip gear, which is interlocked with the brake, interrupts the main circuit when the brake is applied, and the controller can be taken out without disconnecting any of the wiring. The efficiency of the motor under normal running conditions with the truck fully loaded and running on a hard level track is 80 per cent., the current consumption being from 30 to 32 A.

The whole of the controller, switches, &c., are mounted in a dustproof and watertight case. The wiring is very accessible, and in case of faults can, we are informed, be replaced with a minimum of labour. The battery consists of 20 cells of the Chloride Exide ironclad type, and has a capacity of 161 Ah. It is slung in a well-designed cradle which is sprung on the countershaft springs.

Municipal Engineers and Osram Lamps.

On Friday last a visit of members of the Institution of Municipal and County Engineers was paid to the Osram-Robertson Lamp Works at Hammersmith, so as to give members an opportunity of seeing the advances which had been made since 1893, when the General Electric Company began to manufacture the well-known Robertson carbon filament lamp. At the present time the modern Osram factory employs over 3 000 workers who, with the assistance of some of the most ingenious automatic machinery in the world and a research department where scientific enthusiasts constantly link up theory with practice, turn out lamps in ever increasing quantities. This development has been made in a number of stages, among the most important of which occurred in 1908, when the General Electric Company acquired the patent rights of the manufacture in Great Britain of Osram lamps. Since that day, of course, these lamps have progressed from those of the squirted filament type to the drawn wire filament with its greater strength, and finally to the gas filled lamp with its higher efficiency, a series of steps which have, in the aggregate, caused a revolution in the science of illumination. A further point of interest about the General Electric Company's organisation as evidenced in the Osram lamp factory is the fact that that is independent of outside aid, and it will not be going too far to say that that is one of the secrets of its success. This is true, whether the remark is applied to tungsten ore, to glass, to argon or to lamp caps.

Members of the Institution of Municipal & County Engineers were taken in small parties through the works and saw the various stages in the process of manufacture of the Osram lamp. In general, these processes are familiar to readers of The Electrician, and need not be dealt with here.

We were not surprised to see the interest that was shown by the visitors at all stages of the inspection, and that special attention was paid to the movable trolley seats provided for the operatives who are engaged in working the apparatus which allows six or eight bulbs to be exhausted at one time. In this way supervision of several groups of exhausters is accomplished with very little trouble. Admiration was also expressed at the care which is taken at every stage of the process to see not only that the particular process itself has been carried out correctly, but that the embryonic lamp is fit to go on to a further stage of its existence. This applies equally to such operations as ageing, candle power testing as to the details such as caps, bulbs, &c.

At the conclusion of the visit those taking part were entertained to lunch by the General Electric Company at the Clarendon Restaurant, Hammersmith.

Mr. T. W. A. Hayward, borough engineer of Battersea, in replying to the toast of the "Institution of Municipal & County Engineers," said that their Institution represented a body of men who deserved to have more recognition than had been the case in the past. The borough engineer was the man who made or marred the district which he supervised. In spite of this, he was often paid a miserable pittance, though he could quite easily lose on one job as much as his year's salary. Such a visit as they had paid that morning was really of an educational nature, as the more they knew about these things the more interesting their business became. He hoped that the Institution would have an opportunity of visiting some of the other works of the General Electric Company.

Mr. Norman Scorgie, borough engineer of Hackney, in proposing the health of the "General Electric Company," said that if boroughs wanted efficient engineers they must pay for the brains and experience and if they did so pay they would not find any man leaving municipal life for private enterprise. Their thanks were due to the General Electric Company for having given them an opportunity of visiting their fine works, to Major Palmer and to Mr. Spurrall for making the necessary arrangements, and also to Mr. Fletcher who was to be congratulated on the organisation of a works which were a credit to the country and must also be of great benefit to Hammersmith's rateable value.

Mr. J. Y. Fletcher, in reply, said that they were determined to make the Hammersmith factory the leading factory of its kind in the world. Plans for extensions had been stopped by the war, but he hoped that in spite of the very difficult period through which they were passing they would within the next two or three years be able to put themselves abreast of their international competitors.

Ex-British Westinghouse Association Dinner.

Annual dinners of Old Boys and similar Associations frequently become stereotyped, and therefore boring. The annual Re-Union of Ex-British Westinghouse men will be a long time reaching this stage judging by last Friday's third gathering at the Holborn Restaurant, London, under the chairmanship of Mr. H. M. GILLESPIE. The idea of *re-union* has always been prominently before the Committee, and this year the company of about 150 was "departmentalised" at separate appropriately labelled tables. Each member also had his corresponding clock card bill, though neither ordinary or overtime was paid, (because every thing was at "piece" rates, including the toast-list. The latter included "The Association," given by Mr. J. S. Peck, and replied to by the Chairman and Mr. J. Turnbull (still bearded); "The Chairman," humorously presented by Mr. R. G. Mercer (who forgot the show was morning dress), and "Absent Friends and Old Associates," by Mr. G. Layton. Major O. P. L. Hoskyns called on the company for the "Silent Toast to memory of Ex-B.W. men."

During the evening occasion was taken to make a presentation to the hon. secretary and re-union agitator, Mr. L. S. Richardson for the valuable services he has rendered in assisting the formation of the Association, and organising the first three functions. The gifts were an after-dinner coffee set with silver spoons, a gold watch fob and a gold bracelet watch for Mrs. Richardson.

The souvenir programme was in great demand, and no further copies are available. Ex-B.W. men are reminded that new names and over-due "subs" (without which the good work of the Association cannot go on), should be sent to the honorary secretaries at 14, Sidney-road, Richmond, Surrey.

The "Terry" Anti-Dazzle Device for Motor Vehicle Lamps.

Mr. Alfred E. Terry, of Messrs. Herbert Terry & Sons, Ltd., has invented a useful apparatus which abolishes the usual diffused glare from motor car lamps, and enables drivers in the opposite direction to see whether the road is clear. It consists of a grid composed of thin aluminium plates crossing at right angles and forming a network of square tunnels about ⅜ in. wide and 2 in. long. These are held in a frame which fits on to the lamp. The result is that the beam is concentrated about 4 ft. or 5 ft. in front of the lamp, whence it widens out to give sufficient light laterally, while at the same time an increased range directly ahead of some 20 yds. compared with bare lamps is obtained. A demonstration shows that glare is largely avoided.

"Crete" and "Isco" Cutouts.

The difficulties with which manufacturers of ironclad service cutouts have been beset during the last two or three years are only just beginning to be overcome. These difficulties coupled with an excessive demand from all over the world, have set the manufacturers a task which they appear to have tackled with much zest and considerable success. The shortage of porcelain was one of the chief causes of delay in production, and it is only recently that larger supplies have become available. The moulders' strike also accounted for much delay in output, but this has now righted itself, and with the overhauling of machinery and the installation of up-to-date plant the leading manufacturers are pushing ahead in producing this useful line of equipment.

Messrs. W. T. Henley's Telegraph Works Company, Ltd., who are among the leading makers of this class of apparatus, tell us that, although the numbers of orders they are executing daily are continually creating new records, the orders still being received seem to show that the war-occasioned lull in manufacture means an abnormal demand for some time to come. Their "Crete" cutout seems to be of special interest to many engineers, and it is becoming almost a "household" word in many districts. The new trade-mark Messrs. Henley's have adopted for their ironclad service cutouts is also finding its way into the market. This registerd word ISCO is derived from the initial letters of the words ironclad service cutout.

The Osram Miners' Hand Lamp.

Beyond doubt, that painful affection of the eyes known as nystagmus, to which miners are very subject, is mainly due to nervous trouble caused by the fatigue of working by a very weak light, and that the light from the modern miners' electric hand lamp is the best for the coal-getter. The Osram miners' hand lamp pattern bulbs with "bow" filaments are the outcome of long and careful research in an endeavour to produce the best lamp to withstand the working conditions in mines. They comply fully with H.M. Home Office regulations applying to miners' hand lamps and give a minimum illumination of 1 c.p. at the rated voltage. The bow-shaped filament, which has been adopted, gives a uniform brilliance over its whole length, and as it possesses great mechanical strength, it can withstand the severe handling to which miners' hand lamps are subject. These lamps are made at the Osram G.E.C. Lamp Works, Hammersmith, and maintain the reputation for excellence and reliability which has always been associated with the name Osram. Full details and prices of the lamps are given in Leaflet No. O.S.2465 issued by the General Electric Company, Queen Victoria-street, E.C., who will forward copies on application. The illustration shows a lamp with a small peg cap.

A New Vehicle Battery.

One of the disadvantages of the ordinary storage battery is that as time goes on sediment collects in the bottom of the cells, the removal of which necessitates the plates being handled and exposed to the air, thereby reducing their efficiency. The longer, therefore, the active material can be kept in its place in the cells the longer the useful life of the battery and the larger the saving in maintenance costs. We are therefore interested to learn that the D. P. Battery Company have recently placed on the market a battery which possesses the special feature of never having to be cleaned out or at least so seldom that it does not really matter.

In connection with battery upkeep, too, it is of great importance that cells intended for ordinary commercial use should be able to stand a good deal of abuse and negligence owing to their being placed in the hands of unskilled personnel. This condition has also been met in the new D.P. vehicle cells by employing plates of high capacity and of the greatest possible strength in conjunction with separators of a special material which is designed in such a way that the active matter cannot disintegrate. We understand further that the watt hour capacity per pound of battery is very high.

Externally the D.P. Battery Company's new cells are similar in appearance to the usual traction pattern, and they are being turned out to standard vehicle dimensions. In case it may be thought that the claims made for this battery are too like one of the late Baron Munchausen's tales to be credited we may quote some results obtained on a trial run in which the battery was used. At starting the specific gravity was 1265. On the run out of 40 miles 110 Ah were expended and the specific gravity was then 1 200. The battery, which consisted of 42 cells with a capacity of 145 Ah at the five hour discharge rate, was put on charge at a constant voltage of 110 V, the charging current at the start being 40 A. This charge was continued for three hours, at the end of which time the charging current had fallen to 20 A. At the beginning of the return run the specific gravity of the cells was 1 250, and at the end of the run it had fallen to 1 175. The 40 miles of the return journey was done in two hours 15 minutes, there being a very strong head wind for the last 20 miles. On the return trip the wind was behind the car to start with, but gradually died away.

Parliamentary Intelligence.

WEST INDIA CABLE SERVICE.

On Tuesday the House of Commons approved the Agreement, dated March 16, 1921, between H.M. Government and the West India & Panama Telegraph Company, and supplemental to the agreement of Aug. 10, 1914, between the Government, the Government of the Dominion of Canada, the Crown Agents for the Colonies, and the company.

Mr. Pike Pease explained that the company were in a very bad way at present, and their increased expenses had more than absorbed the increased revenue. The need for the whole of the State subsidy was greater than in 1914, and if the refundments due under Clause 14 of the agreement were insisted upon they would probably have to cease working. The whole question of the West Indian telegraph communication was being fully considered by a sub-committee of the Imperial Communications Committee, and it would not be possible at present to bring into operation an alternative service, whether cable or wireless.

ST. HELEN'S MOTOR OMNIBUS BILL.

This Bill of St. Helens Corporation for conferring powers to run motor omnibuses has been passed in a modified form by the Local Legislation Committee of the House of Commons.

Mr. J. B. Hamilton, manager of the Leeds Corporation tramways, gave evidence in support of the scheme, and stated that while one route might not pay at first, the others would pay very well. Originally there were nineteen routes, covering 25½ miles outside the borough, but the modified scheme only covered eight miles. By the Bill it was proposed to authorise the Ministry of Transport to enable the Corporation to substitute trackless trolleys for tramways. There was a deficiency on the working of the St. Helens Corporation tramways which had to be made up out of the rates.

Before hearing the opponents the Committee threw out those portions of the scheme which proposed running powers for trackless trolleys or 'buses over existing tramway routes into and from Prescot, Rainhill, Haylock and Ashton, Newton and Leigh.

Mr. Thomas, K.C., for Widnes Corporation, undertook that his Corporation would have 'buses running within three months after the passing of the Bill on their authorised route from Widnes through Whiston area to St. Helens.

The Chairman then announced that on that undertaking the Committee would strike out the similar route proposed by St. Helens, and that they would pass the remaining parts of the scheme with appropriate words to be inserted giving the Lancashire County Council and the L. & N.W. Railway Company as a road authority power to apply to the Ministry of Transport in respect of any claim they might take with regard to the cost of adaptation of roads.

The Industrial Situation.

A communication has been addressed to the Prime Minister by Sir Peter Rylands, president of the Federation of British Industries, on the present industrial situation, and asking him to receive a deputation of manufacturers in order to submit their considered views as to the grave dangers which confront British industry, and to discuss urgent trade problems, including the question of taxation.

The communication points out that the social and economic condition of the country is absolutely dependent upon the prosperity of its industries, and proceeds to deal with the principal difficulties which confront us. At home we are faced with a coal situation of unprecedented gravity. The cost of coal is already above that ruling in any other coal-producing country, and we seem now to be threatened with a material rise in prices or the danger of many pits closing down. The position with regard to transport is no less serious. Before the war the per ton-mile cost of railway transport was substantially higher than that ruling in competing countries. To-day the burden is crushing, and, in spite of the enormous increases in railway rates, which have already added seriously to costs of production, the railways are running at a substantial loss.

The Exchange Problem and Taxation.

Conditions abroad are even more menacing than at home. There has been a widespread breakdown in the machinery of exchange, which has gravely jeopardised our trade relations with all the important markets of the world. The exchange position is also seriously intensifying the competition which our industries are meeting from many Continental countries, notably Germany, where the level of wages, measured in the value of British currency, is far lower than that ruling in this country.

The Federation are, however, convinced that in some directions the Government can materially relieve the position, more especially by reducing the general level of taxation. Existing taxation imposes a burden upon the community which reacts most prejudicially upon industry. The removal of excess profits duty will ultimately reduce the load, but taxation is still proportionately heavier in Great Britain than in any competing country, and the pressure upon the general taxpayer remains a deadening weight, which removes all buoyancy from the home market and seriously interferes with the finance of industry. The Federation appreciate the difficulties of the Government, but they reiterate the opinion that the wisest policy for the Government, during the critical period through which the country will pass in the next 12 months, will be, while exercising every economy in administration, to reduce the income tax and to consider the restoration of industrial activity as of paramount national importance, even taking precedence of the liquidation of debt. In order to have a full and free discussion of these urgent problems, the Federation desire to have an interview with Mr. Lloyd George.

Electricity Supply.

Southend Corporation has asked the County of London Electrical Supply Company to state its terms for a supply of electricity in bulk.

Bethnal Green (London) Electricity Committee proposes to convert the Oval Chapel into an electricity sub-station, at a cost of £3 400.

Dartford Board of Guardians are reorganising the electric light installation at the workhouse, at a cost of £1 000.

Newark Town Council has agreed, in consequence of a report of Mr. C. H. Wordingham, to apply for a special order to establish electric supply works.

Grays Urban Council has asked the electrical engineer (Mr. E. Grime) to prepare an estimate of the cost of laying cables to the Grays Hall Estate.

Burton-on-Trent Corporation has applied for sanction to borrow £50 930 for a new 5 000 kW generating set and for extensions of mains, &c.

The official inauguration took place last week of the new converting plant, put in by the Dewsbury electric supply department to deal with the bulk supply taken from the Yorkshire Electric Power Company.

An experiment with gasfilled lamps having proved successful, a subcommittee of Aberdeen Watching, Lighting and Fires Committee recommend that the lighting inspector be authorised to take steps to have a section of King-street lighted with these lamps next season.

The Derbyshire & Nottinghamshire Electric Power Company is applying to the Electricity Commissioners for a Special Order for Belper and Heage Urban Districts, and the parish of Milford in Belper Rural District.

The Aberdeen Electricity Committee is considering a scheme for the extension of the electricity works, at an estimated cost of £210 000, and particulars of the scheme have been submitted to the Electricity Commissioners.

The Yorktown & Blackwater Gas Company has completed negotiations with the War Office for a supply of electric current in bulk from the power station at Aldershot, and the company propose to supply electricity for lighting at 8d. per unit and for power at from 4½d. to 5d.

The Midland Electric Light & Power Company, Ltd., is applying to the Electricity Commissioners for Special Orders for (1) Wigston Magna Urban District, certain parishes in Blaby, Hinckley and Lutterworth Rural Districts; (2) the Parish of Bedworth in Foleshill Rural District, and Bulkington Urban District; (3) Atherstone Rural District, the parish of Caldecote, in Nuneaton Rural District, and certain parishes in Tamworth Rural District, and in each case to transfer the powers, &c., under the Order to the Leicestershire and Warwickshire Electric Power Company or any other company or person.

Bradford is one of the four municipalities which run up-to-date showrooms for the exhibition and sale of electric light fittings, motors, domestic appliances, &c. At the new showrooms of the Corporation electricity department in Sunbridge-road there is a fine display of domestic apparatus, including heaters, cookers, grillers, toasters, &c., and also washing machines and vacuum cleaners, small motors and every variety of domestic electric appliance. All articles on display are for sale, but purchase is not pressed, the primary object being to popularise the service of electricity in the home.

The award of the Industrial Court on the claim for minimum rates and conditions in certain electricity undertakings in East Anglia has been issued. The claim for time and a half for shiftmen between midnight (Saturday) and midnight (Sunday) has not been made out, and no extra payment is to be made for the work of blowing out plant by compressors. Rates for fitters and turners as from Jan. 1 are to be the standard rates of the respective districts, plus the bonus. After twelve months' continuous service shiftmen are to have an annual fortnight's holiday with pay, day workers to have an annual holiday of twelve days.

Hereford Corporation has authorised the Electricity Committee to enter into negotiations with the coal owners of the Forest of Dean to give them a supply of electricity energy under the Hereford Rural Electricity Scheme. The Development Commissioners recommend the Treasury to advance by way of loan £34,000 for the transmission line to Ross and Lydbrook, and numerous parishes will be supplied en route.

The Corporation is also applying to the Electricity Commissioners for a special order to extend its area of electricity supply to Bromyard and Kington Urban and Bredwardine, Bromyard, Dore, Hereford, Kington, Leominster, Ross, Weobley, Whitchurch and Wigmore Rural Districts, parts of Ross Urban and Ledbury Rural Districts. &c.

Kirkcaldy Corporation recently decided not to adopt the suggestion to sell their electricity undertaking to the Fife Power Company, but they are now faced with the necessity of extending their present generating station at a cost of £70 000 and of erecting a new power station later. The electrical engineer (Mr. O. F. Francis) reports that there is no room on the existing site for further steam plant extensions, and he thinks that a steam turbine power station on a new site has become inevitable. The Council are now unable to supply any new consumers, and something must be done to relieve the situation. For this purpose he advises the purchase of two 750 b.h.p. Diesel-driven alternators, to be placed in a temporary building alongside the existing station. These would give the Council security of supply, and enable them to connect up all new small consumers, with a limit of 50 kW to any one consumer, until the new station is completed. This preliminary extension would cost approximately £70,000.

Electric Traction.

Burnley Finance Committee will levy a rate of 5d. in the £ to meet the deficit on the Corporation tramways. Last year the loss was about £12 000. The Tramways Committee have hitherto allowed 10 per cent of the money realised on the articles found on tramcars and not claimed to the employees reporting the matter. It has now been decided to retain all articles for a year and then to sell the same, allowing 25 per cent. of the net amount to the employees concerned.

The London County Council, having completed the Eltham-road tramway track, inaugurated a service of cars on it on Monday. There is now a through service from Southwark Bridge and Eltham—to Beresford-square, Woolwich. It will also give a through route from Beresford-square to Lewisham, and a quicker route from Shooter's-hill to Lewisham.

In the report of the district auditor on the tramway accounts of the County Council it is stated that the total income on revenue account for 1919-20 amounted to £4 295 846, compared with £3 578 256 in the previous year. The passenger traffic receipts increased by £699 347, or 19·5 per cent. The total expenditure, excluding repairs and special charges, amounted to £2 650 456, compared with £1 995 172 in 1918-19, an increase of 32·8 per cent. The cost of repairs during the year was £996 324 or 4·50d. per car-mile run. Special charges fell from £168 786 to £34 118, attributable to the cessation of the payment of War Service allowances. After paying debt charges, income tax and other expenses, there was a deficiency of £100 712. The investments of the renewals and general reserve funds were realised, and £81 898 was transferred from those funds towards meeting a portion of the deficiency, leaving a debit balance of £18 814.

The renewals fund has been charged with only half the year's cost of renewals of tramway track, the Treasury having assented to the proposal that half the cost should be charged against capital for the years 1919-20 and 1920-21 and treated as payable in twelve years. The only justification for charging a portion of renewals to capital account would appear to be the existing serious financial position of the undertaking, and the desire to prevent a charge being made on the special county rate. The deficiency on net revenue account of £18 814 has been carried forward to the current year. The auditor regards the carrying forward of a deficiency from one year to another as both financially and legally unsound.

A long report on methods of relieving traffic congestion in Glasgow has been prepared by the tramways manager, Mr. Jas. Dalrymple. In the course of his report Mr. Dalrymple states that since the 1st June last, when the tramway fares were increased, the tramways department had been carrying only 8 700 000 passengers per week, compared with 9 700 000 a year ago, and 10 200 000 during May, 1920. He had no doubt, however, that in a short time, if work continued plentiful and wages remained high, they would again have difficulty in coping with the traffic. After discussing the various proposals made, including overhead and underground transit, he states that he has no hesitation in recommending the Tramways Committee to set aside all underground and elevated schemes. Apart altogether from the enormous capital cost involved the traffic in Glasgow would not yield sufficient revenue to meet the working expenses. The congestion was confined to a remarkably small area, and the real solution of the problem was better cross-river communication in the centre of the city. They required a bridge over the river at the foot of Oswald-street, and another at the foot of Dixon-street. At present the Tramways Department, notwithstanding the huge business that was being done and its enormous revenue, was not paying its way. They could not, therefore, honestly ask the public for money to carry out any of the schemes suggested.

After discussing the report the sub-committee recommend that the Statute Labour Committee be asked to make arrangements for proceeding, as soon as possible, with the construction of the new bridge over the Clyde at Oswald-street, and that, simultaneously with the erection of the bridge, the construction of the new lines of tramways from the existing tramways in Cowcaddens-street, along Hope-street and Oswald-street, thence over the new bridge at Oswald-street, and along Commerce-street to the existing tramways in Bridge-street, be undertaken.

Personal and Appointments.

Messrs. H. W. Smith & Co. (1920), Ltd., have appointed Mr. J. S. Dyas, 63, Dawson-street, Dublin, as their representative in Ireland.

Mr. Ben Hall, of Wigan, has been appointed general manager of the Halifax Corporation Tramways, at a salary of £900 per annum.

Mr. F. H. Hatch, Ph.D., M.Inst.C.E., has been appointed technical adviser to the Department of Mines on questions relating to the metalliferous mining industry.

At the end of the present session, in June, Prof. P. P. Bedson will retire from the position of Professor of Chemistry at Armstrong College, Newcastle-on-Tyne.

Mr. F. G. Nesbitt has been appointed the Carron Company representative for London and the Southern Counties for their electric cooking and heating department in succession to Mr. C. McKinlay, who has left the Company's service.

Mr. B. Mouat Jones, M.A., professor of chemistry at Aberystwyth University College, has been appointed principal of the Manchester College of Technology.

The following appointments of presidents of sections at the British Association meeting, to be held at Edinburgh in September, have been made: Engineering Section: Prof. A. H. Gibson; Economics Section: Mr. W. L. Hichens; Chemistry: Dr. M. O. Forster; Mathematics and Physics: Prof. O. W. Richardson; Education: Sir W. H. Hadow.

Imperial and Foreign Notes.

Among the improvements foreshadowed in the annual report of the general manager of the South African Railways (Sir Wm. Hoy) are the electrification of the Cape Town-Simonstown suburban line and the Natal main line between Durban and Maritzburg, including the lines to the Point and Bluff, at an estimated total cost of £4 385 400. Amongst other improvements completed or in process of completion by the Railways Department are locomotive erecting and boiler shops, overhead electric cranes, pattern shops, electrical workshops, spring-smiths' tube and erecting shops, and the extension of foundries. For the financial year 1920-21 a sum of £470 670 has been set apart for workshop improvements and machinery, and this sum added to the amount previously sanctioned for work not yet carried out brings the total expenditure authorised for these purposes up to something more than a million pounds.

The New York Telephone Company was recently authorised to increase its rates by 28 per cent. from April 1. The reason for the increase, which has aroused considerable opposition, is the great increase in salaries and other additional expenses of the company.

A Bill recently presented by the Finance Minister to the Peruvian Congress deals with the nationalisation of water power in Peru. Under the Bill all water power concessions will be granted under the provisions of the Mining Code. A translation may be seen at the Department of Overseas Trade, 35, Old Queen-street, S.W. 1.

The Marconi Wireless Telegraph Company has been authorised by the Swiss Federal Government to erect a wireless telegraph station for operation by a Swiss Company over a period of 25 years. The station will be erected near Horne, about 1 500 ft. above sea level, and will employ a Marconi-valve continuous-wave transmitter of 25-kW capacity, the aerial being carried on two towers each 300 ft. high. Up-to-date apparatus for high-speed automatic working will also be employed. The new station will afford special facilities for Press traffic, besides conducting a commercial telegraphic service.

Apparently the Soviet Government of Russia has realised the urgent Necessity of Training Engineers, and judging by a note in our contemporary "Engineering," it has adopted a truly remarkable expedient for training them. In the opinion of the Upper National Economic Council, Russia requires a supply of 4 500 engineers annually, and that number must be obtained from existing colleges and high schools. It has therefore been decided to fill all the colleges to their utmost capacity, and to compel students to work at the highest pressure. "Technical education has been decreed to be a special form of conscription; the students are interned at the colleges and have to give an undertaking to devote all their time to studies." Any youth showing a capacity to follow the lectures will be admitted as a student without examination. Though the authorities admit difficulties they are sanguine of good results, more particularly as "there are no longer any trade secrets, and the students can work anywhere." We are not surprised to learn that a council of professors has expressed doubt as to whether eight hours a day at the college and 200 hours' home work per month will enable the student to absorb the instruction given.

Institution Notes.

The Institution of Civil Engineers is making a fresh attempt to get authority to define more clearly the term "civil engineer." Having failed to get support for a private or public bill, it is now proposed to apply to the Privy Council for a supplementary Royal Charter to confer the use of the professional description "chartered civil engineer."

At the annual general meeting of the Batti-Wallah Society, held on Monday last, the following officers were elected for the ensuing year:—*President:* Mr. W. F. Ireland; *Vice-Presidents:* Messrs. E. Barralet, C. Newton Russell, E. P. Barfield and R. W. Hughman; *Committee:* Messrs. A. W. Blake, H. Foulds, L. S. Richardson, J. P. Maginnis, A. F. Harmer and M. R. Gardener; *Hon. Sec. and Treasurer:* Mr. F. Pooley; *Hon. Entertainment Sec.:* Mr. A. J. Greenly.

At a meeting of the Council of the Royal Society of Arts last week the chairman (Mr. Alan A. Campbell Swinton, F.R.S.), in the unavoidable absence of H.R.H. the Duke of Connaught and Strathearn, K.G., President of the Society, presented the Albert Medal of the Society to Prof. Albert A. Michelson, awarded to him in 1920 for his optical inventions which have rendered possible the reproduction of accurate metric standards, and have provided means of carrying out measurements with a minute precision hitherto unobtainable.

The British Engineering Standards Association has British Standard Specification No. 139 on "Red firwood poles for telegraph and telephone purposes." The work of revising the Engineering Standard Committee's Report No. 16 for telegraph and telephone line material was commenced early in 1918, and it was then decided to enlarge the scope of the work and to issue separate specifications for the various sections dealt with in the old report. The specification for red firwood poles is the first of this revised series, and deals with three types of poles—light, medium and stout, of lengths varying from 16 ft. to 85 ft. Other sections to follow will include steel poles, insulators, g.i. line wire, bronze wire, h.d. copper wire, &c. It is also hoped to add a specification for home grown larch poles and soon as experiments and research on the subject are completed. In view of the large number of telegraph and telephone poles which are now preserved by means of creosote, a section dealing with creosoting has been added to the specification, copies of which can be obtained from the Secretary of the Association, 28, Victoria-street, S.W.1, price 1s. 2d. post free.

Business Items, &c.

After April 4 the registered office of the General Electric Company, Ltd., will be Magnet House, Kingsway, London, W.C.2.

Twiss Electric Transmission, Ltd., has removed to more commodious offices at 39, Victoria-street, Westminster, S.W.1.

Messrs. Meldrums, Ltd., are now represented in the Birmingham district and the Black Country by Mr. H. Astbury, A.M.I.M.E., Empire House, Birmingham.

The offices and works of the Jackson Electric Stove Company, Ltd., 143, Sloane-street, London, S.W. 1, will be closed from the 24th to the 29th inst. for the Easter holidays.

Wm. Leo Ferguson and Alfred Edward Ryeland, trading as Ryeland & Ferguson, electrical engineers and contractors, 44, Weston-street, London Bridge, S.E.1., have dissolved partnership. Debts by Mr. Ryeland, who continues the business.

Arthur Edwin Outhwaite and Arthur Geo. Hartley, trading as the Sunbeam Electric Company, 63, Lancaster-avenue, Manchester, have dissolved partnership. Debts by Mr. Hartley, who continues the business as the Sunbeam Electric Company.

The partnership between Fredk. Smith Ormerod, John Tierney and James Wood, electrical engineers, 484, Oldham-road, Failsworth, near Manchester, has been dissolved so far as regards Mr. Ormerod. Debts by Mr. Tierney and Mr. Wood, who will continue the business as Tierney, Wood & Company.

Frank Wm. Harbord and Fredk. John Bolt, carrying on business as Edward Riley & Harbord, metallurgists and analytical and consulting chemists, 16, Victoria-street, S.W., and 6, Finsbury-square, E.C., London, have dissolved partnership. Debts by Mr. Harbord, who continues the business.

The partnership between Arthur Johnson, Harold Hirst and Lewis Harding, trading as Johnson & Company, electrical engineers, 23, Piccadilly, Bradford, has been dissolved so far as Lewis Harding is concerned. Debts by Mr. Johnson & Mr. Hirst, who continue as Johnson & Co., at the same address.

The Automatic and Electric Furnaces, Ltd., announce that Messrs. C. Lorenz Aktiengesellschaft, Berlin, have purchased the Wild-Barfield patent rights for Germany, Poland and the former Austria Hungary. Messrs. Lorenz have already placed a first order with the company for various parts to complete nearly one hundred furnaces.

The partnership between Wm. Alfd. Gardner, Arnot Wyle Fellows and Alice Hester Harry, trading as the Gardner Engineering Company, electrical and general engineers, Greyhound Works, Milton, Northamptonshire, has been dissolved so far as regards Mr. Fellows. Debts by W. A. Gardner and Alice H. Harry, by whom the business will be continued.

Catalogues, Price Lists, &c.

The "Classic" pulpit and desk fitting is supplied by the Isis Electrical Company, 57, Albert-road, Aston, Birmingham. A leaflet giving particulars and prices of the fitting, which is intended for lighting pulpits, reading desks, &c., has been issued by the company. One of its advantages is that it avoids glare.

In a leaflet issued by Pope's Electric Lamp Company, Ltd., Elasta House, 5, Arthur-street, W.C.2, illustrated particulars and prices are given of the new "Elastalite" candle lamp which they are putting on the market. It is of simple design, with no wearing parts, and it always remains absolutely rigid in the lamp holder, being held by an adjustable threaded collar.

Messrs. Alfred Herbert, Ltd., of Coventry, were recently appointed sole agents in this country for the Sliding Extension Gap-bed Lathe of the Barnes Drill Company, Rockford, Ill. The company has also issued well-illustrated leaflets giving particulars of these lathes and of the wide range of work which can be performed by them in general engineering shops, repair depots, &c.

Recent trade literature issued by Messrs. Meldrums, Ltd., Timperley, Manchester, include two nicely illustrated leaflets, printed in colours, on the "Meldrum" Forced Draught Furnace and the "Meldrum" Mechanical Stoker. Among recent contracts executed by the company is the fitting of their forced draught furnaces for economising in fuel consumption to a large water-tube boiler at the Barugh power station of the Yorkshire Electric Power Company.

An illustrated pamphlet of 28 pages on Ediswan Petrol Electric Lighting and Pumping Sets reaches us from the Edison Swan Electric Company, Ltd., of Ponder's End. Particulars and prices are given of several types of "Stuart" lighting and pumping sets, of the "Excell" combined lighting sets, of the "Ediswan Acme" house lighting type of batteries, switchboards, &c., and also of the "Lister-Brunton" automatic electric lighting system. Those interested in providing lighting and power for country houses, hotels, cinemas and public buildings will find much useful information in the new publication of the company.

We recently announced a reduction in the prices of Osram-G.E.C. and Robertson Lamps. A new illustrated catalogue, with the revised prices, has now been issued by the General Electric Company. In the first section are illustrated various types of Osram lamps, followed by the Osram gasfilled lamps. The second portion is devoted to Osram gas-filled lamps of the automobile type, and this is followed by particulars of dry battery flash-lights for use with pocket lamps, torches, &c., and similar particulars are given of the various types of Robertson carbon filament lamps. The catalogue concludes with a few good illustrations of lanterns and fittings for street lighting, for workshop illumination, &c

Tenders Invited.

Kilrush Urban Council invite proposals for an electric lighting scheme. Particulars from Mr. E. Counihan, Solicitor to the Council.

Manchester Electricity Committee require tenders by April 6 for consumers' substation switchgear (3-phase 6 600 V. Specification from Mr. F. E. Hughes, Town Hall.

Manchester Corporation require tenders by April 4 for 33 000 and 6 600 V switchgear, induction regulators, &c. Specifications from F. E. Hughes, Town Hall, Manchester.

Worksop Urban Council want tenders by April 6 for e.h.t. and l.t. cables, switchgear transformers, and 500 kW rotary or motor converter. Specifications from the Manager and Engineer of the Electricity Dept.

Wimbledon Corporation require tenders by March 29 for 12 months' supply of electric cables and conduits, joint boxes, transformers, meters, lubricating oils, &c. Specifications from the Borough Electrical Engineer.

Tenders are invited by April 5 for supply and erection of accumulators, &c., at the Telegraphic Office, Eucla (Schedule W. A. , 647). Forms from High Commissioner for Australia, 406, Australia House, Strand, W.C.2.

Tenders are required by April 2 for six months' supply of electric fittings, ironmongery, &c., to the Midlothian and Peebles District Asylum, Rosslynlee. Forms of tender from the Clerk and Treasurer, 19, Heriot-row, Edinburgh.

The Commissioners of H.M. Works, &c., invite tenders by April 12 for the supply of electrical engineering labour in day-work in the Leeds district. Forms of tender and particulars from the Director of Contracts, Storey's Gate, Westminster, London, S.W.1.

Belfast Electricity Committee invite tenders for the supply of materials and stores, including cables, wires, lamps, electricity meters, cut-outs, electrical accessories, carbon brushes, &c. Forms of tender from the city electrical engineer (Mr. T. W. Bloxam), and tenders to the town clerk, Mr. R. Meyer, by April 4.

Bedford Corporation Electricity Department invite tenders from British manufacturers for the supply of electricity meters and h.t. and l.t. cables for the ensuing year. Specifications from the borough electrical engineer, Mr. R. W. L. Phillips; and tenders by noon, March 31, to the Chairman of the Electricity Committee.

The Council of the County Borough of East Ham invite tenders for the supply and delivery of low-pressure concentric cable, with joint-boxes, &c., and two c.i. lighting feeder pillars. Specifications from the borough electrical engineer and tramway manager, Mr. W. C. Ullmann, and tenders are to be sent to the Mayor, Town Hall, East Ham, E.6, by April 2.

Manchester Electricity Committee require tenders by March 31 for high-pressure steam and water valves, weighbridges and automatic coal-weighing machines, and by April 7 for high pressure steam and water pipes, &c., and electric and hand-operated cranes for Barton power station. Specifications from Mr. F. E. Hughes, Town Hall.

Tenders are invited for further plant in connection with the electrification of the Cape Town-Simonstown and Durban-Maritzburg Railways, including overhead equipment of permanent way and overhead transmission lines, switchgear and accessories and track bonds. Specifications and forms of tender from the High Commissioner for the Union of South Africa, Trafalgar-square, London, W.C., after the 28th inst., or from the General Manager, Johannesburg, and further technical information may be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, London, S.W. 1. Tenders to the High Commissioner by June 22.

Tenders are invited in connection with the electrification of the Cape Town–Simonstown and Durban–Pietermaritzburg Railways, for the supply of turbo-alternators, boilers, condensing plant, passenger and freight locomotives, motor coaches and underframes, motor bogies, electrical equipment of coaches, sub-station equipment and transformers. Specifications and forms of tender from the High Commissioner for the Union of South Africa, 32, Victoria-street, London, S.W., or the General Manager, Johannesburg. Further technical information can be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1. Tenders to the High Commissioner by May 3.

Liquidations and Bankruptcies.

A meeting to receive an account of the winding up of the E.I.C. Magnetos, Ltd., will be held at 12, Cherry-street, Birmingham, on April 14.

Claims against Wm. Drysdale, electrician, 24, Paxton-street, Barrow-in-Furness, are to be sent by March 31 to Mr. H. Mossop, 4, Ramsden-square, Barrow-in-Furness.

A first and final dividend of 3s. 10½d. is payable at 14, Figtree-lane, Sheffield, to creditors of Geo. Fredk. Kiveron, electrical engineer, Goulders-place, Attercliffe Common, Sheffield.

Mr. Wm. Carne, Public-buildings, Penzance, has been appointed trustee in the bankruptcy of John Jones and John Richard Jones, trading as J. Jones & Son, electrical engineers, 7 Chapel-street, Penzance.

By an order of Mr. Registrar Stiebel on Feb. 16, Mr. Maitland Chuter, 2, Gresham-buildings, Basinghall-street, London, E.C., was appointed sole liquidator in the voluntary winding up of the Charles Urban Trading Company, Ltd., in the place of Mr. E. A. Davies, who retired from the office.

Miscellaneous.

A petition has been presented by the Council of University College, Reading, for the grant of a charter to raise the College to University ank.

The secretary of the Kelvin Lodge wishes to remind members that, owing to the Easter Holidays, the next regular meeting will be held on Thursday, March 31.

A petition for winding up Portable Electric Lamps (1919), Ltd., has been presented by Electric Tools & Motors, Ltd., and will be heard in the Royal Courts of Justice on April 12.

Sir Isaac Pitman & Sons, Ltd., have commenced issuing their new Technical Primer Series, which promises to be a very large one. The first eight volumes are ready, and several others will be published during this month. These little books are in foolscap 8vo, contain about 120 pages, and the price is 2s. 6d. net each volume.

The Windman Earthing Clip, of which we have recently seen a specimen, consists of a flexible tinned copper strip perforated to take various sized pipes. One end is bent up to form a socket for the cable, and this end is kept in place by means of a triangular washer, bolt, and nut which are copper-covered to prevent corrosion. This clip is now being marketed in this country by Mr. M. Goldsmith, 4, Florence Terrace, Ealing, W.

Members of the Staff of Messrs. Benn Brothers, Ltd., together with several of the directors, spent an enjoyable evening at the Eustace Miles Restaurant, Chandos-street, W.C., on Friday, the occasion being a dance and concert, arranged by the provisional committee of Benn Brothers Social Circle. The programme of musical and elocutionary items, arranged by Mr. H. H. Wardle, was sustained by Miss D. M. Gough, Miss Savage, Mr. H. P. Benn, Mr. Duck and Mr. W. G. Wright, with Mr. Jack Sanders as accompanist, and Mr. J. O. Davis contributed some conjuring items. For the dancing Mr. J. A. Knivett proved an efficient M.C.

At Stoke-on-Trent Police Court last week, Alfred Phillips, a joiner, of Hanley, was fined £10 and £6 costs for preventing his electricity meter from registering the quantity of electricity supplied by the Corporation and for fraudulently abstracting electricity, and for laying wires or conductors to communicate with the electricity supply mains without the consent of the Corporation. It was stated that flexible tubing had been so connected that the supply of electricity abstracted was not registered by the meter. An electric motor was also found which could easily be used in the same way.

It has been pointed out that in the article on "Canal Building by Electricity" which appeared in our issue of Feb. 11, the power consumption of the equipment used is stated to be from 4 to 10 kW per cubic yard for small machines and from 8 to 10 kW per cubic yard for excavators. Tests which have been undertaken by the Westinghouse Electric Manufacturing Company, however, show that for the kilowatt hour consumption per cubic yard is about 0.85 kW when hoisting materials 70 ft. The figures supplied by our original correspondent therefore refer to kilowatt hours and not to kilowatts.

The utility of wireless direction finding apparatus was strikingly illustrated in the recent rescue of the crew of the Norwegian steamer "Ontaneda" by the British steamship "Fanad Head" in the North Atlantic off Newfoundland. A heavy gale had left the "Ontaneda" drifting helplessly and a list of 50 degrees in a heavy sea. Her captain sent out signals for help, but owing to the thick weather he had to estimate his position by dead reckoning. His calculations proved to be 90 miles out. Whilst several vessels, which went to his assistance were steaming about near the position given without finding a trace of the "Ontaneda" the "Fanad Head," by means of her Marconi direction finder, discovered the true position of the doomed vessel, and the distressed sailors were rescued just in time.

At a dinner held at the Connaught Rooms on the 8th inst., the executive, management and depot superintendents of the Edison Swan Electric Company were present. Mr. C. Jermyn Ford, chairman of the Company, presided, supported by Major Eustace Quilter and Mr. E. A. Gimingham (directors), and amongst the visitors were Messrs. R. C. Lanphier and S. B. Rogers, vice-president and European manager respectively of the Sangamo Electric Company. After the loyal toast had been honoured, the toast of the Chairman was proposed by the commercial manager (Mr. C. Horace Cox). "The Depot Superintendents" was given by Mr. J. W. Elliott, joint sales manager, and replied to by Mr. J. Taylor (Glasgow) and Mr. A. McDonald (Dublin). The Visitors, proposed by Mr. E. A. Gimingham, was duly honoured and was responded to both by Mr. Lanphier and Mr. Rogers.

An Inquest was held at Ashington on Friday on a child named Crombie, who was found dead on the previous day near a wooden street box in Sycamore-street. Evidence was given by a witness, who got a slight electric shock by placing his hand on a metal pipe leading from the box up a wall; and by James Watson, an electrician, who also got a shock and disconnected the pipe main from the main cable. The latter said no one could get a shock by merely walking over the ground.

Mr. Bates, district engineer for the Northern Counties Electricity Supply Company, said the box had been locked for two years and was inspected fortnightly. The jury found that death was due to heart failure, caused by an electric shock accidentally received through a defective wire. They added that pipes through which wire passed and which might be touched by the public should be protected by wooden coverings.

Imports.—The following are official values of electrical machinery, apparatus, and material imported into this country (*a*) during February 1921, and (*b*) the aggregate figures from Jan. 1 to Feb. 28, 1921, with increase or decrease compared with corresponding periods of 1920:—

Electrical machinery, (*a*) £64 062 (decrease £25 258), (*b*) £175 063 (decrease £23 258); telegraph and telephone cables other than submarine, (*a*) £9 669 (increase £9 393), (*b*) £25 520 (increase £24 070); telegraph and telephone apparatus, (*a*) £25 877 (increase £8,671), (*b*) £54,693 (increase £29 088); other electrical wires and cables, rubber insulated, (*a*) £3 607 (increase £2 642), (*b*) £6 085 (increase £3 206); with other insulations, (*a*) £10 267 (decrease £591), (*b*) £19 627 (increase £6 883); carbons, (*a*) £10 319 (decrease £997), (*b*) £28 426 (increase £505); glow lamps, (*a*) £21 653 (increase £20 599), (*b*) £41 372 (increase £36 201); arc lamps and electric searchlights, (*a*) £829 (increase £709), (*b*) £4 731 (increase £4 491); parts of arc lamps and searchlights (other thancarbons) (*a*) £3 603 (increase £2 082), (*b*) £4 731 (increase £4 491); batteries, (*a*) £11 859 (increase £7 849), (*b*) £29 623 (increase £24 069); meters and measuring instruments, (*a*) £25 696 (increase £19 670), (*b*) £42 025 (increase £31 948); switchboards, (*a*) £952 (increase £952), (*b*) £1 170 (increase £214); electrical goods and apparatus unenumerated, (*a*) £92 904 (increase £47 550), (*b*) £202 845 (increase £122 886). Total of electrical machinery, apparatus and material, other than uninsulated wire, (*a*) £281 297 (increase £93 271), (*b*) £634 941 (increase £260 045).

Exports.—The exports of electrical machinery, apparatus and material, (*a*) during Feb., 1921, and (*b*) from Jan. 1 to Feb.. 28, with increase or decrease compared with corresponding periods of 1920, were as follows:—

Electrical machinery, (*a*) £392 526 (increase £259 800), (*b*) £837 658 (increase £531 006); including railway and tramway motors, (*a*) £12 919 (increase £10 019), (*b*) £46 206 (increase £40 395); other generators and motors, (*a*) £235 633 (increase £169 397), (*b*) £479 030 (increase £304 607); and electrical machinery unemumerated, (*a*) £143 974 (increase £80 384), (*b*) £312 422 (increase £186 004); telegraph and telephone cables, submarine, (*a*) £106 752 (increase £66 938), (*b*) £200 250 (increase £79 113); other than submarine, (*a*) £152 151 (increase £58 451), (*b*) £349 633 (increase £179 098); telegraph and telephone apparatus, (*a*) £150 703 (increase £61 527), (*b*) £292 556 (increase £104 624); other electrical wires and cables, rubber insulated, (*a*) £143 780 (increase £43 650, (*b*) £329 087 (increase £116 383); with other insulation, (*a*) £175 415 (increase £50 494), (*b*) 382 358 (increase £119 905); carbons, (*a*) £12 151 (increase £814), (*b*) £30 926 (increase £17 267); glow lamps, (*a*) £45 775 (increase £34 705), (*b*) £88 640 (increase £67 074); arc lamps and searchlights, (*a*) £1 135 (decrease £328), (*b*) £2 430 (increase £535); parts of arc lamps and searchlights (other than carbons), (*a*) £1 286 (increase £659), (*b*) £1 950 (increase £ 1 028); batteries, (*a*) £73 950 (increase £47 619), (*b*) £159 953 (increase £97 798); meters and measuring implements, (*a*) £30 952 (increase £11 880), (*b*) £80 094 (increase £40 364); switchboards, (*a*) £9 506 (increase £5 377), (*b*) £31 914 (increase £15 738); electrical goods and apparatus unenumerated, (*a*) £220 244 (increase £112 768), (*b*) £468 903 (increase £260 131). Total of electrical machinery apparatus and material, other than uninsulated wire, (*a*) £1 516 327 (increase £754 354), (*b*) £3 256 357 (increase £1 630 064).

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

12 156/14 Lederer. Electric gasfilled glow discharge lamps. (19/5/13.)

The lighting tube of the lamp is so shaped that the necessary length is disposed in the smallest possible compass, and at the same time the best possible distribution of light in one or more directions is ensured, the leading-in wires to the electrodes being led to a cap or terminal either rigidly or resiliently connected with the lighting tube, and of the same type as used for electric incandescent lamps, with or without a starting device contained therein.

12,158/14 Lederer. Electric gasfilled glow discharge lamps. (19 5/13.)

A lamp in which the electric circuit within the lamp is arranged so as to act as a rectifying value upon an alternating current supplied to the lamp, in order to enable the lamp to be connected directly to an alternating-current distribution system.

13,759/14 B.T.-H. Co. (G.E. Co.) Electric lamps with luminous discharge. (6/6/14.)

24,343/14 Automatic Telephone Mfg. Co. & Savin (partly communicated by Automatic Electric Co.). Telephone systems. (19 12/14.)

104,876 Vulkan Maschinenfabriks Akt.-Ges. Electromagnetic clutch. (22/10/13.)

104,877 Vulkan Maschinenfabriks Akt.-Ges. Electromagnetic friction clutch. (22/10/13.)

134,830 Alexanderson. High-frequency alternators. (4/11/18.)

135,188 Luzy. Electromagnets for magnetising permanent magnets. (1 2/18.)

139,191 Westinghouse Electric & Mfg. Co. Control mechanism for electric cars provided with pneumatic brakes. (18 2/19.)

145,029 Siemens-Schuckertwerke Ges. Production of high unidirectional voltage from an alternating voltage. (15/5/18.)

146,919 Armour Fertiliser Works. Production of aluminium nitride by electrically-generated heat. (10/7/19.)

150,296 Julien & Wolkoff. Magneto-electric machines. (27/8/19.)

155,854 Eccles & Jordan. Application of thermionic valves to production of alternating currents and relaying. (17 4/18.)

Comprises a method of generating alternating or fluctuating current of definite frequency from direct current by arranging that the relative motion of two members whose natural frequency or speed is determined mainly from their mechanical nature produces directly, or indirectly, or partly directly and partly indirectly, an alternating or fluctuating voltage in the control circuit of an ionic tube so that corresponding alternations or fluctuations arise in the current through the anode circuit of the ionic tube and so that this alternating or fluctuating current sustains the motion and is utilised.

155,858 Electrical Improvements, Ltd., and Beard. Systems for supplying electric power for lighting purposes from low-frequency power circuits. (10 4/19.)

155,873 Haslam & Stretton, Ltd., & Jones Miners' electric safety lamps. (22/4/20.)

155,877 Western Electric Co., Ltd. (Western Electric Co., Inc). Electric telegraph systems. (28 8 19.)

155,899 B. T.-H. Co., Ltd. (General Electric Co.). Electric welding-machines (22/9/19.)

155,944 Willard. Paste for electric storage battery plates. (17 10/19.)

155,946 Cardellino. Magneto-electric machines. (18 10/19.)

155,954 Brush Electrical Engineering Co., Ltd., & Sutton. Turbo-electric driving arrangements. (27 10/19.)

155,955 Murrey & Standish. Electric light fittings. (28 10 19.)

155,959 Fairburn. Conductor arrangements of electric traction systems. (31/10/19.)

155,975 Automatic Telephone Mfg. Co., Ltd., Harrison & Smith. Telegraph printing systems. (21/11 19.)

156,408 Holden. Electrically-operated mechanism suitable for driving clockwork trains or the like. (24/12/19.) (Addition to 118,329.)

156,411 General Electric Co., Ltd., & Durdle Enclosed-bulb electric devices. (2/1/20.)

156,415 Imray (Bosch Akt.-Ges.) Magneto generators. (16/1/20.)

156,441 Coles, Cowper—. Apparatus for the manufacture of copper cable tubes and other metal articles by electro deposition. (26/3/20.)

156,443 Igranic Electric Co., Ltd (Cutler-Hammer Manftg. Co.). Method of and means for controlling resistances for electric circuits. (13/4/20.)

156,445 Delen. Electric gas ignition devices. (15/4 20.)

156,462 Zorzi. Apparatus for the automatic protection of three-phase current circuits. (11/6/20.)

156,476 Holslag. Electric arc welding and like operations, and electrodes theretor (30/6/19.) (Divided application on 156,280.)

157,470 Pairard. Fixing of electric insulators. (8/5/18.)

157,477 Marconi's Wireless Telegraph Co., Ltd. (Berry.) Means for controlling the flow of electrons in electric-discharge devices. (14 2/19.)

Comprises a cathode, a thermionic valve having in it a cathode, two anodes and a pair of plate electrodes arranged one on each side of the path between the cathode and the anodes so as to deflect the electrons emitted from the cathode on to the two anodes alternately, and a detector connected to the anodes.

157,481 Willans. Means for controlling searchlights from a distant station. (25/3/19.)

157,496 Thompson. (Hames.) Intercommunication telephone systems. (18/8/19.)

157,498 Gardner. Electrical indicators for railways and the like. (21/8/19. Cognate application, 3,647/20.)

157,499 Candee, Moeser & Pierce. Electric fuses. (22/8/19.)

157,508 B.T.-H. Co. (G.E. Co.) Electrical systems of power transmission. (25/9/19.)

157,509 Boorne. Electrode for use in depositing molten metal and process or method of making same. (30/9/19.)

157,516 Pattison. Electric traction systems having one or more conductor rails. (17/10 19.)

157,521 B.T.-H. Co. (G.E. Co.) Elecric transformers and other stationary electric induction apparatus. (9/10/19.)

157,534 Jones & Alloy Welding Processes. Electrodes, welding rods and soldering sticks. (14/10/19.)

157,536 Railing & Angold. Magneto hand lamps. (15/10/19.)

157,556 Automatic Telephone Mfg. Co. & Harrison. Signalling arrangements applicable to telegraph, telephone and like purposes. (20/10/19.)

157,562 Baumann & Metropolitan-Vickers Electrical Co. Air-cooling apparatus particularly applicable to the cooling of electrical machines. (21/10/19.)

157,585 Caughrean. Incandescent electric lights. (3/11/19.)

157,586 Cooper. Locking holder for electric lamps. (4/11/19.)

157,595 Midland Electric Mfg. Co & Barber. "Ironclad" electrical switches. (6/11/19.)

157,607 Hughes & Turner. Receivers for wireless telegraphy. (14/11/19.)

Consists in employing the periodic variations in resistance between the anode and filament of a valve oscillating at acoustic frequencies to damp the grid circuit of a three-electrode valve connected to the high-frequency receiver circuit and acting as a detector or amplifier in the usual manner.

157,614 Cooper. Device for use in disinfecting telephone instruments. (22/11/19.)

157,626 Palmer & Metropolitan-Vickers Electrical Co. Protective devices for alternating-current systems. (10/12/19.)

158,005 Murray & Robinson. Wireless receiving and transmitting apparatus. (11/4/19.)

158,008 Taylor. Methods of and means for obtaining alternating currents of any periodicity from existing systems of different periodicity. (25/6/09. Addition to 151,294. Cognate applications, 17,384/19, 21,399/19 and 23,724/19.)

158,011 McDougald. Thermionic valves. (28/7/19.)

158,013 Burgess. Magnetic cores for dynamo-electric machines, transformers, electromagnets and the like. (2/8/19.)

158,027 B.T.-H. Co. (G.E. Co.) Cooling transformers and other electrical apparatus (8/10/19.)

158,034 Coxon & Williams. Renewal of the filaments in metal filament electric lamps. (17/10/19.)

158,045 B.T.-H. Co. (G.E. Co.) Controllers for electric motors. (21/10/19.)

158,046 Codd. Electric ignition systems for internal-combustion engines. (21/10/19.)

158,059 Lee. Means for supporting electrical conduits and cables, pipes, rods and the like. (23/10/19.)

APPLICATIONS FOR PATENTS.

August 3, 1920.

22,874 Bolton. Switches.

22,892 B.T.-H. Co. Magneto-electric machines.

22,901 Squier. Radio-communication systems. (3/8/19, U.S.)

22,932 Husband.

22,941 Morris-Airty & Mullard. Thermionic valves.

22,942 Goldup & Macrorie. & Mullard. Thermionic valves.

22,943 Mullard & Shearing. Thermionic valves.

23,109 Franklin. Continuous wave telephony and telegraphy.

August 4, 1920.

22,973 Mull. Process for utilising mica for electrical purposes.

22,980 Alexander. (Stuart Electrolytic Cells Inc.) Electrode and electrolytic batteries

22,996 Burkinshaw. Portable telephones for the deaf.

23,007 B.T.-H. Co. Magneto-electric machines.

23,030 Johnson. (U.S. Chain & Forging Co.) Electric welding machines.

23,045 Glaser. Electrical rectifying apparatus, &c.

August 5, 1920.

23,090 Das. Electric emergency lighting installations.

23,092 Easter. Switches.

23,103 B.T.-H. Co. (G.E. Co.) Induction motors.

23,123 Creedy. Electric machines.

August 6, 1920.

23,142 Aspden & Bowman. Electric transmission of power.

23,143 Cristofoletti & Manetti. Incandescent lamps, &c.

23,170 Harding. Trolley wheels of tramcars, &c.

23,176 Akt. Ges. Brown, Boveri et Cie. Apparatus for starting single armature converters from alternating-current side. (16/8/19, Switzerland.)

23,181 Meyfarth. Electric vehicle controllers. (18 8/19, Switzerland.)

23,185 Carey. Instrument for converting wireless direction finder bearings into Mercator bearings.

23,201 Smith. Electrically treating foods, &c.

August 7, 1920.

23,249 Bennett. Automatic electric indicator for motor vehicles.

23,267 Electric Outlet Co. Electrical connecting and supporting devices. (10/1/20, U.S.)

23,268 Electric Outlet Co. Electrical connecting and supporting devices. (9/4/20, U.S.)

Companies' Reports, &c.

CITY OF LONDON MEETING.

Mr. J. B. Braithwaite, who presided over the annual meeting of the City of London Electric Lighting Company, Ltd., said that notwithstanding the difficulties, the past year's working was fairly satisfactory. The total revenue showed an increase of £128 275, but, owing to increased cost of coal, labour, &c., and the higher rates and taxes, they had only been able to retain £31 266 as net. It was proposed to raise the ordinary dividend to 12 per cent. and to pay a bonus of 2 per cent., which was on account of the shortage of dividend during the war.

Dealing with the position of electricity supply in London, he reminded them that the companies operating within the County of London were purchaseable by the London County Council in 1931, but the local authorities had an unlimited tenure and the capital for their development was raised on the security of the rates. The two classes of undertakings were, therefore, quite different; and the attempt to amalgamate them presented great difficulties. In his opinion, the simplest method of promoting the unification of the London electric supply would have been to remove the harassing restrictions at present imposed, to give the companies a considerable extension of their tenure, which would justify them in undertaking the large capital expenditure required to correct the existing anomalies in the electricity supply of London and then to have left them to work out the problem, which he was confident they were quite capable of doing. A step in that direction was taken by the passing of the Electric Lighting Act of 1908, which substituted the London County Council as the sole purchasing authority and gave power to companies and local authorities to link up their stations. Real progress was being made in the right direction; several interconnecting mains had been laid, and one small power house had been shut down, whilst the company owning the largest area of supply in London had acquired a site at Barking for a large power house for giving bulk supply. The war held up further development, but following the war a serious retrograde step was taken by passing the Electricity (Supply) Act of 1919, which was put forward with a great flourish of trumpets as a measure which would lead to the giving of cheap electricity supply throughout the country.

Joint Electricity Authority for London.

Referring to the scheme for the constitution of a Joint Authority for the Greater London area, he said that of the 28 members of that Authority, six would represent the companies and six the local authorities. Those who were responsible for the supply would thus be in a hopeless minority, and even the authority itself had to obtain the consent of the Commissioners at every step, so that it would not appear that its progress was likely to be very rapid. Of the 80 odd generating stations the scheme contemplated shutting down 60, the construction of four new stations and the enlargement of two of the old ones. For that purpose a capital of 30¾ millions would be required in addition to the cost of acquiring existing stations or inter-connecting mains. No power was given under the Act of 1919 to raise any capital, so that before that could be done further legislation would be required. The net result was that the erection of the one big power-house for which Parliament had granted powers had been blocked, and it was not easy to see how under existing conditions the necessary increased facilities for supply in the London area could be obtained within the time available. The Company was fortunate in having placed orders for additional plant, and laid an interconnecting cable between Bankside and the County of London Company's station at Wandsworth, which would enable them to give that company 10 000 kW in bulk. They had not raised any additional capital since 1900, having paid for all new plant, extensions, &c., out of revenue, but the large additions to the generating plant which they were now making would oblige them to raise a small amount, and they proposed to issue after Easter £300 000 of the £800 000 capital which they still had available in the form of eight per cent. cumulative second preference shares.

COUNTY OF LONDON MEETING.

In moving the adoption of the past year's report and accounts of the County of London Electric Supply Company, Ltd., at the annual meeting last week, the chairman (Sir Harry B. Renwick, K.B.E.) stated that the receipts from the sale of current and meter rentals reached the high figure of £674 105, an increase of £130 821 (or 24 per cent. over 1919). The sum carried to net revenue account showed an increase of £26 779, or over 12 per cent. A sum of £50 000 was placed to reserve for depreciation, and £62 500 to general reserve (£17 500 in excess of last year), and £8 971 had been written off preliminary expenses, which closed that account. The final dividend on the ordinary shares was at the rate of 11 per cent. for the six months, making 8 per cent. for the year, while the carry forward (£18 594) was practically the same as the amount brought into the account. The costs of generation, distribution, office expenses and administration amounted to £454 371, an increase of £95 729 (about 27 per cent.) over the figure for 1919. Rates and taxes had increased by £12 303. In one of their districts the rates had increased from 9s. 4½d. in 1913 to 22s. 2d. at present, and in another district from 8s. to 21s. In one year the rates increased in certain of their districts more than double. To his mind the question of municipal expenditure and local rates was one of the most pressing questions of the hour, the importance of which was not fully realised by the public.

Record Output and Extensions.

There was a record increase of over seven million units sold over 1919, with a total of nearly 50 million units sold. Applications for new business showed a net increase of 5 678 kW, and they had now connected to their mains nearly 90 000 kW, while they were supplying over 35 000 consumers. That indicated in a telling way the continued vitality of the business and the possibilities of the future, which, having regard to the company's extensive areas, were practically unlimited. The Electricity Commissioner's consent to the erection of a power station at Barking had been deferred until after the 31st inst, when the Commissioners expected to have before them schemes for London under the Act of 1919. Although recent legislation had been designed to assist development, it had, up to the present, acted in precisely the opposite direction. Its failure was traceable to the fact that it gave new life and new opportunities to the discordant factor of local politics. From an electrical point of view, it was a perfectly simple matter for the existing undertakers to ensure a cheap and abundant supply of electricity, but mix that up with politics, as electric supply legislation had hitherto done, and all progress was perfectly hopeless. He had already informed the shareholders what the company proposed to do at Barking, which was the company's contribution to the London problem, a contribution of a constructive and practical character, and certainly no other London company could say as much. He understood that the Electricity (Supply) (No. 2) Bill would not be introduced this Session. The Bill was largely a finance Bill, and apparently the House felt that this was not the time to put forward speculative schemes involving many millions of the ratepayers' money. There were signs that the public were awaking to the vital question of municipal borrowing and local taxation, and one could only hope that, now public attention was being aroused, some form of rationing might be applied to local authorities' expenditure.

W. T. HENLEY'S COMPANY.

Mr. Geo. Sutton, M.I.E.E., who presided over the annual meeting of W. T. Henley's Telegraph Works Company, Ltd., on Friday, dealt at some length with the industrial situation and with the effects of foreign competition, &c. At the outset he referred to the recent issue of capital and gave an analysis of the report and accounts. Power had been acquired to increase the ordinary share capital by £400 000, and it might be necessary towards the end of the year to issue the remaining £150 000. The large increase of £102 000 to buildings, machinery and plant was due mainly to the new buildings in course of erection at the Gravesend works. They had been delayed for want of material and labour, especially the latter. After referring to the increase in the capital of the Henley Tyre & Rubber Company, he said they had no reason to modify the great hopes they had as to the future of that company.

Increased Stocks and Profit.

The increase in the stock account was due to two causes—firstly, the need of increasing their stocks of wires and cables at home and abroad, which had been depleted by the war, and, secondly, and principally, the large quantity of partially manufactured stock which was sold, the results of which would come into the present year. That large stock was all good and they were in a happy position in respect of it. The debtors showed an increase of £200 000 due to larger business and, to some extent, to the longer credit sometimes taken. After making ample provision for depreciation, the final net profit on trading was £193 000 (against £168 000) and the carry-forward was increased by £42 000 to £183 000. He did not think he had ever experienced a year when trading had been conducted with so much anxiety. At times there were plenty of orders to be obtained—they could hardly keep pace with them early last year, but the course of prices of their raw materials had needed, to avoid disaster, all the skill of their staff. The principal raw materials were copper, lead, india-rubber and cotton. During the year copper fell from £115 per ton to £71, lead from £45 to £23, rubber from 2s. 10d. per pound to 10d., and American cotton from 30d. to 10d. They must, of course, buy forward for future requirements, and that great fall in values would make apparent the careful and successful way in which the buying had been conducted.

Expansion of Business.

Mr. Sutton said the sale of their products, and what he might call their spheres of influence—their overseas developments—continued to expand. Their year's turnover had been a record, and the orders brought forward into the current year were also a record. The tendency of recent years to a reduced rate of profit on an increased turnover continued. They had done much work in telephone trunk cables at home and abroad, including a new continuously loaded cable which was shipped this month to be laid across the Straits of Georgia. They had nearly completed a contract for the City of Birmingham for what he thought was the largest order yet placed for the construction and laying of super-tension cable to work at a pressure of 33 000 V. Their general trade had gone into countries where hitherto no cable trade was to be done. Jerusalem had become a buyer of Henley's cables, and their products were not unknown in Baghdad and Mesopotamia. In regard to the current year, he said they had a large number of orders and had no normal anxiety in regard to the payment of dividends, but those who had attended their meetings in recent years were aware that that business was not only carried on for paying dividends. Of course, dividends were essential for its continuance, but they absorbed but a comparatively small part of the profits earned. They could possibly give them a prosperous dividend-paying concern by home trading only, but their desire had been, and was, to give as much employment as they could by the extension of their overseas trade. For many years they had set aside a large proportion of the profits for that purpose, but unhappily State necessities had in recent years taken much of those resources from them by taxation. A large export trade was essential to our nation, and they had to bear their part by extending their overseas business and keeping their factories as fully employed as they could.

Before the war British cable-makers held their own in foreign trade; their reputation for quality and reliability was unimpaired, but the red danger light was now showing very clearly. The orders from foreign countries—he did not refer to British Overseas Dominions—had fallen off very seriously during the past six months. Countries which bought from them in considerable quantities had nearly ceased to buy.

Foreign Competition.

There were several causes for that position, but an important one was that they were unable to compete in price with foreign countries. How could they compete in price with German factories, for instance, with their rates of wages three or four times higher than those current in German cable factories? They did not like reducing wages, and no doubt they could earn dividends without doing so, but they could not maintain or increase the employment in their factories unless they were able in competition to secure foreign business. He firmly believed that at the present time lower rates of wages were necessary and a good standard of living must be secured by working more hours in a week.

BRITISH INSULATED & HELSBY CABLES, LTD.

The 25th annual meeting of shareholders of this Company was held on Monday at Liverpool, Mr. James Taylor, chairman of the Company, presiding.

The Chairman, moving the adoption of the report and balance sheet, after a sincere tribute to the long services as chairman and director of Dr. E. K. Muspratt, who had tendered his resignation during the year, said the profit for the year amounted to £340 713, an increase of £12 024 over the previous year. Such a result was very satisfactory, especially when taken in conjunction with the many difficulties that had to be contended with. Two stoppages occurred at the principal works at Prescot, one due to the coal strike and the other to certain unreasonable demands by workmen which resulted in three weeks' work being lost. The workmen suffered a heavy loss in wages and the Company in profits, in addition to which there were disorganising effects and an accumulation of costly raw materials. In addition, men in the wire drawing department adopted the "ca' canny" policy in an effort to defeat the bonus system which had been in operation for many years and to bring about the substitution of a flat rate wage as high as the bonus system ensured. The Company refused the demand with the result that about 70 expert wire drawers who declined to continue on the old system had to leave the service. Some time was required to train fresh hands, but by persistent effort the difficulty was overcome, and now the new men were doing as much per week as the old and more experienced men were doing. It would be understood that when these wire workers adopted "ca' canny" methods it injuriously affected the workers in other departments and resulted eventually in the Company being unable to turn out the usual and proper quantity of cable per week.

Increased Works Efficiency.

Apart from these stoppages the works, both at Prescot and Helsby, had been busy throughout the year and the present state of the order book was quite satisfactory. Present high costs of manufacture and inability to give certain delivery, owing to labour unrest, were preventing the Company from taking orders which were now being placed abroad. Foreign trade could only be retained by a reduction in the cost of production and although a decrease in the present high rate of wages would have a most beneficial effect another and very important element had to be considered, viz., increased efficiency in the mechanical means of production. The Company, therefore, had carried out a re-organisation of the works. They had built what were practically three new factories, fitted with all the latest and most improved appliances, and had enlarged the power plant. They had also greatly improved and increased the facilities for handling raw material and finished products, besides making improvements in other departments which should largely tend to cheapen production. The Company had now been working under the improved conditions and additional facilities for the past two or three months, and while they were feeling the beneficial results of the changes generally, it was noteworthy that they could now turn out all the latest types of special high-tension cables of very long lengths. He was correct in stating that taken altogether the factory could be considered as second to none in the country. It was believed that capital expenditure for some time would be relatively small, and the prices of raw material having fallen and the peak of the Company's financial requirements passed, it would not be necessary to issue any of the new capital already authorised.

Sir Harmood Banner having seconded, the motion was carried. A resolution sanctioning the payment of 6½ per cent. dividend at once and 5 per cent. bonus on June 30, making a total distribution for the year of 15 per cent., was also adopted. Sir Arthur Stanley and Mr. J. Carlton Stitt were re-elected directors and the appointment of Mr. J. Arthur Smith as a director in place of Dr. E. K. Muspratt was confirmed.

The Liverpool District Lighting Company, Ltd., have declared a dividend of 5 per cent. for the past year.

The directors of the Anglo-Portuguese Telephone Company, Ltd., announce that the Portuguese Government has authorised an all-round increase in the tariff averaging about 130 per cent. above the rates fixed in June, 1920.

The net profit of the Clyde Valley Electrical Power Company for 1920 was £149 392, and with £58 301 brought forward the total is £207 693. After transferring to contingency fund £75 000, the directors recommend a final dividend at rate of 10 per cent. per annum on the ordinary shares, making 7½ per cent., carrying forward £69 693. The report and accounts were adopted at the meeting on Wednesday.

The South London Electric Supply Corporation, Ltd., recommends a final dividend of 9 per cent. on the ordinary shares, making 7 per cent. for the year 1920. A sum of £10 000 is placed to reserve for depreciation, &c., £5 000 for taxation and contingencies, £2 500 to reserve for depreciation on trading stock, &c., £10 000 to general reserve, and £1 871 written off outstanding balances on leasehold account and issue expenses of debentures and preference shares, &c., £5 769 being carried forward.

At the meeting of the County of Durham Electrical Power Distribution Company, Ltd., it was reported that the total connections at the end of the year (including the connections of its associated Parliamentary Company, the County of Durham Electric Power Supply Company) amounted to 151 686 h.p., compared with 136 895 h.p. in 1919 or an increase of 14 791 h.p. The profit for the year was £61 394 and with £403 brought forward the total was £61 797. Interest on loans and debenture stock required £12 523, the dividend of 12 per cent. for the year on the ordinary shares absorbed £48 000 and the balance (£1 275) was carried forward. The capital expenditure account at the end of the year was £396 755.

The net profit of the Newcastle and District Electric Lighting Company, Ltd., for the year 1920, after charging interest on debentures, loans, &c., allowing £16 000 for depreciation and placing £16 000 to general reserve, was £11 104, which added to £13 263 brought forward, made a total of £24 367. Out of this the directors have decided to pay a dividend at the rate of 5 per cent. (less tax) for the year (absorbing £10 412), and to carry forward £13 955. A large number of new consumers have been connected to the mains and considerable extensions made to existing installations. The expenditure on capital account during the year was £23 065.

For the year ended September 30 last the traffic receipts of the Isle of Thanet Electric Tramways and Lighting Company, Ltd., (including omnibuses), were £74 110, and from sale of electricity £22 626, the total receipts being £97 244, against £66 394 for 1918-19, and the balance carried to appropriation account £32 144, against £30 553. The sum available is £24 797, and of this amount £2 500 has been placed to reserve, £10 000 to permanent way reserve, and £7 500 to rolling stock reserve, leaving to carry forward £4 285. The directors look forward to the resumption of a dividend on the preference shares for the year ended September 30 next.

The Wemyss & District Tramways Company, Ltd., reports a profit of £8 848 for the past year, and, with £689 brought forward, the total is £9 538. Interest on debenture stock absorbed £1 583, and after paying interim and final dividends of 7½ per cent. on preference shares, interim dividend on ordinary shares of 6 per cent., and transferring £3 000 to reserve fund, the balance is £2 354. The directors propose to pay a final dividend of 6 per cent. on the ordinary shares, and carry forward £1 154. The ordinary share capital was increased from £10 000 to £20 000 by the capitalisation of £10 000 of the reserve fund. The traffic receipts were £34 393, against £29 878 in 1919, and traffic expenses advanced from £6 839 to £9 309; administration, management, legal, &c., expenses and income tax from £4 742 to £6 312, and cost of power also showed an advance of £600.

The report of Bullers, Ltd., for the year ended July 31 states that, after paying directors' fees and salaries, and providing for taxation, the profit was £23 353, which, with £846 brought forward, made a total of £24 199. Very ample allowance for depreciation has been made. Owing to the present financial stringency, and the necessity for conserving the resources of the Company, the directors propose to carry forward the whole of the balance (£8 949) after the payment of the 5 per cent. dividend on the ordinary shares in November last. The Milton Works, which are of the most up-to-date character, are now in operation, and will add considerably to the scope of the Company's business. The report refers with regret to the death of Mr. J. W. Harris, a managing director, and states that Mr. Gilbert H. Harris, manager of the Hanley Works, has been appointed a managing director.

Dr. J. A. Hosker, J.P., who presided over the recent meeting Bournemouth and Poole Electricity Supply Company, Ltd., stated that the receipts from the sale of current and meter rentals had increased by £26 512, or 31 per cent., and the total receipts showed an increase of £28 978. The working costs were £84 313, an increase of £23 792. Coal and other fuel increased by £13 801, salaries and wages by £4 200, repairs by £1 662, and rates, taxes and insurance by £2 912. The balance available was £22 549, compared with £20 641, and they were paying the same dividend as last year, namely, 6 per cent. New applications, representing 1 942 kW., had been obtained, compared with 1 695 kW. in 1919, and the units consumed amounted to 6 198 302, against 4 680 347. The trading department had again had a successful year and had earned a profit of £3 410. In conclusion he referred to the Electricity Supply Act. During the year a number of electricity districts had been delimited, but whether the result would be to get a cheap and abundant supply was open to question. They would like to be in a position to obtain bulk supply on terms cheaper than they could generate, but he saw little prospect of that.

Sir Henry Mance, C.I.E., who presided over the annual meeting of the Oxford Electric Company, Ltd., last week, stated that so far as general business in Oxford was concerned, 1920 was the first normal year they had had since the commencement of the war. The coal strike and the extension of summer time to October last were to some extent detrimental to the company, but, notwithstanding that, their output increased by 26 per cent. over that of 1919. The great advance in the rates of wages and the cost of coal and other commodities had necessitated an increase in the statutory charge, and that was now in operation. Up to the present the effect of electricity legislation had been beneficial to most supply companies. He thought it would be a long while before any material change could be made in the distribution of electric power throughout Oxfordshire or the neighbouring counties. A further measure would be under the consideration of Parliament this Session. It appeared to be an enabling Bill giving lending and borrowing powers to various authorities. What they really wanted was willingness on the part of the Government to guarantee interest on any money advanced with the latter's approval for the purpose of cheapening and extending the generation and distribution of electricity. If the Government would take that responsibility, which would cost them nothing, they would be rendering a real service to the industry throughout the country. Dividends of 5 per cent were declared on the preference and ordinary shares.

Presiding over the meeting of the Brompton and Kensington Electricity Supply Company, Ltd., last week, the chairman (Mr. H. R. Beeton) said the report and accounts for the past year recorded results which were eminently satisfactory. The growth of the business had proceeded along the lines which he had indicated at previous meetings. The conversion of the larger houses into flats and maisonnettes continued, and the demand for cooking and domestic accessories increased so that they had again not only connected more consumers and made more lamp connections, but they had also sold more current than in any previous twelve months Though they paid more for coal of a greatly inferior quality the improved working conditions resulted in a smaller coal consumption per unit generated. That economy in production, due to the progress of invention, would continue, and they were installing another large turbo-alternator of improved design. The gross receipts amounted to £102 372 against £74 045 in 1919, and the working expenses to £59 469 against £44 683, so that the net receipts were £42 902, an increase of £13 541, and they were paying the same dividend as last year, after making larger provision for depreciation and reserve. They had written down about £7 000 worth of machinery, which had become obsolete, and they had spent an additional £5 000 on the mains system. They had been called upon to make further advances to the Accessories Company, which were justified by the results of its working. Its assets continued to be worth their book value; it constituted one of their best customers, and its work contributed effectively to the business of supply in the area. The prospects of the company for the current year were satisfactory.

At the recent annual general meeting of the London Electric Wire Company & Smiths, Ltd., the chairman, Sir George H. Fisher-Smith, J.P., presided, and in moving the adoption of the report and accounts, he said that their total assets amounted to £1 500 000, or £386 852 higher than last year. The profit and loss account showed an increase of £20 000, but there was now a further £350 000 engaged in the business. The final dividend of 6¼ per cent. (making 7½ per cent. for the year) on the ordinary shares would leave £38 926 to be carried forward. The past year had been one of the mostdifficult ever known for commerce. At the moment the lack of business was due to the almost entire absence of purchasing power. There was plenty of work to be done, but there was not sufficient money to pay for it. The time had arrived when the cost of production would have to be seriously reconsidered, and capital and labour would have to work together to that end in their mutual interest if we were to retain our great manufacturing position. The present financial stringency was largely due to excessive taxation. In existing circumstances it was difficult to forecast the future, but he was under the impression that we were nearing the bottom of the reductions in the values of raw material, and if prices could be stabilised, buyers at home and abroad would have confidence in placing orders, and in consequence a revival in trade would surely take place. He believed that the electrical industry would be one of the first to revive, because a successful future would demand more and more the use of electricity. Their company was ready as regarded plant, machinery, materials and men to meet the expansion when it came.

At the recent meeting of the Mersey Railway Company, the chairman (Mr. James Falconer) said that the amount available for payment of interest on the debenture stocks was £48 815. The additional revenue required to pay interest in full on all their debenture stock was £4 867. The most important consideration was the amount of the working costs, which had now reached £199 750 a year, compared with £64 285 in 1913. In consequence of that large increase and of the exceptional position of the company, the board had applied to the Ministry of Transport for a revision of the fares. The position of the company was exceptional in many ways. The capital expenditure on the construction and equipment of the line had been £3 048 236, or £714 400 per mile, against £60 000 per mile, which was the average expenditure of all the railways in England and Wales. The working expenses were exceptionally heavy owing to the heavy gradients on either side of the river. The company was also different from other railway companies, as it did not carry goods and depended entirely on its passenger traffic, and when it adopted electric traction it inaugurated a scale of exceptionally low passenger fares. If their proposals were approved, their hope was that the company, by maintaining its frequent, rapid and efficient service, would resume the marked progress which it had continuously made from the date of the electrification in 1903 down to the commencement of the war in 1914. In those years the volume of traffic had grown from 6·85 millions of passengers carried in 1903 to 16·525 millions carried in 1913. They had decided after careful consideration to adopt the system of automatic signalling which was in operation successfully on all the underground railways in London. That would materially increase the capacity of the railway and enable the company to add to the convenience of passengers, especially during peak time.

New Companies.

The following list has been compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, Chancery-lane, London, W.C.2 :—

CONTRACTORS (STANNINGLY), LTD. (173 402).—Reg. Feb. 28, capital £1 000 in £1 shares, to carry on business of mechanical, electrical and general engineers. Directors: T. Croft, W. Summerscales and F. L. Bell. Reg. office: 23, Bradford-road, Stanningley, near Leeds.

DAY (BERNHARD), LTD. (173 427).—Reg. March 1, capital £5 000 in 4 500 £1 pref.-ord. and 10 000 1s. def. shares, to carry on business of builders merchants', mechanical and electrical engineers, &c. Directors: B. Day, 3, Cathcart-road, South Kensington, S.W.10, W. Matthews, Hoyles Farm, Bradfoeld, Yorks, and R. Watkin.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics": "German Aerial Developments"; "Airship Fabrics," by J. W. W. Dyer; "Soaring Flight."

"Cabinet Maker": Annual Spring Number: "The Effect of Taxation on Furnishing"; "Ancient Ideals and Modern Examples in Furniture," by Sir Charles Allom; "The Arts of Management," by Ernest J. P. Benn; and "Colour and Design in Furniture," by Percy Wells.

"Chemical Age": Special Spring Number: "Review of British Chemical Trade and Industry"; "Recent Progress in Rubber Chemistry and Technology," IV., by Dr. Philip Schidrowitz; "Distillation of Ammoniacal Liquor for the Manufacture of Liquor Ammonia," by Wilfrid Wyld, F.C.S.

"Farm and Home": "The World's Wheat Supply"; "Winding up the Ministry of Food"; and "Poultry Feeding," by Edward Brown, F.L.S.

"Fruit-Grower": "National Federation Conference at Hull"; "Trial of Mechanical Potato Lifters"; and "Commercial Nicotine."

"Gardening Illustrated": "Apple Bramley's Seedling" (illustrated); "Ferns for Rooms"; and "Rose Mrs. Chas. Lamplough" (illustrated).

"The Gas World": "An Extraordinary Proposal from German Fertilisers Manufacturers"; "The Composition of Town's Gas Supply"; and "Discussion on the Lighting and Heating of New Houses."

"Hardware Trade Journal": Annual Spring Issue: "Notions for the Spring Trade," and numerous special articles on the manufacture and sale of hardware.

Forty Years Ago.

(The Electrician, March 26, 1881.)

Electric Light for Windsor Castle.—It is reported that the interior of the castle is shortly to be illuminated by the electric light.

The Telephone and the House of Commons.—Efforts are being made to establish telephonic communications between the Houses of Parliament and the clubs and private houses of members. The cost, if carried out, will be £15 per annum for half a mile, £19 for a mile and £4 for each additional half-mile.

Patience off her Monument.—The Edinburgh correspondent of the *Gas Journal* wonders whether the Philosophical Society of Glasgow have become so enamoured of the electric light as to lose sight of the public duty which they have to perform, namely, of publishing the awards of the committees on the various articles shown at the exhibition of gas apparatus in October last.

Electric Light in the City.—At the last meeting of the City Commission of Sewers a petition was presented from the ratepayers and inhabitants of Leadenhall, Fenchurch and Billiter-streets, asking to have the electric light tried in those thoroughfares. The inhabitants of Newgate and Aldersgate-streets were said to be also anxious for a trial of the light there. At Ipswich a committee has been appointed to consider the desirability of using the light for public purposes.

Arrangements for the Week.

WEDNESDAY, March 30th.

Industrial League and Council.

7.30 p.m. At Caxton Hall, Caxton-street, London, S.W. Lecture on "Industry and its Relation to Finance," by Mr. H. G. Williams.

FRIDAY, April 1st.

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Pneumatic Conveyors," by Mr. M. Jennings.

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Notes.

Electrolytic Recovery of Zinc.

THE need for the more economical use of our raw materials is equally evident at the present time, whether we consider fuels or metals. It is not therefore surprising that researches are being made to discover whether much of the low grade ore which in times of affluence has been placed on the scrap heap cannot now be used for the economical production of zinc. An account of some very interesting laboratory and industrial experiments which have been undertaken under the direction of the British Metals Extraction Company on the electrolytic recovery of zinc were given in a Paper read before the Faraday Society recently by Mr. SAMUEL FIELD, and indicate something of what may be done in this direction. They are worthy of attention for two reasons. Zinc is a metal whose price has not only increased enormously since 1914, but for whose supply this country depends to a large extent on foreign markets. And while in 1913 of our total annual consumption of 220 000 tons of zinc only 60 000 tons was produced in this country and no less than 64 000 tons came from Germany, the output of home produced zinc at the present time does not exceed 20 000 tons.

The Need for New Methods.

THIS unfortunate state of affairs is mainly due to the gradual exhaustion of our supplies of high grade ores. And as such ores are the only ones that can be employed to produce the metal when the wasteful process known as distillation is used, it is obviously necessary in order to avoid a complete shut down of the industry to make a close study of methods for utilising the lower grade ores. Of these the electrolytic process seems the most promising, and it is therefore interesting to note that the necessity for developing this process is already recognised in America, Australia and Tasmania, in which countries, as we have already pointed out in THE ELECTRICIAN, a number of very successful recovery plants working on this system have been installed with outputs up to as much as 100 tons of metal per day. The commercial advantages of the electrolytic process, according to Mr. FIELD, are that it not only allows low grade zinc and complex ores to be treated, but that it gives a higher recovery of metal and allows other metals such as copper, cadmium, lead and sulphur, which in the distillation process are worse than valueless, to be recovered in their turn, and usefully employed. If all this can be substantiated such a process has much to recommend it, and we should therefore welcome some figures from America, where we have no doubt some interesting results have been obtained.

What the Electrolytic Process Does.

ELECTROLYTIC zinc also yields, it is stated, a very high grade product at the expense of little or no skilled labour, and should be especially useful in dealing with certain classes of home ore, which are not amenable to distillation. As described by Mr. FIELD, it consists essentially in calcining the sulphide ore, extracting the product with sulphuric acid in the form of sulphate, and electrolysing the result with insoluble anodes, metal zinc being deposited in an easily detachable form, whence it can be subsequently run down into ingots. This theoretically simple process is, however, complicated by the presence of disturbing impurities, and the main bulk of the research which has been undertaken has therefore been directed to the discovery of methods whereby these impurities can, in turn, be usefully recovered or at least their influence neutralised. Now, as this country is the largest consumer of zinc in the world, it will be agreed that its production by British interests is of considerable commercial importance, and we may be forgiven if we remark that its influence on the electricity supply industry is not among its least important factors. For such an industry would provide a load with load factor which any undertaking would be glad to have, and be a consumer of quite a generous amount of energy. For, according to Mr. FIELD, about 3 200 kW hours are required per ton of cathode zinc produced or, allowing for the power necessary for subsidiary mechanical operations, a total of about 4 000 kW hours per ton would be reached, thus giving a practically constant load of 160 kW per ton of zinc produced per day. From all points of view, then, the research, which the British Metals Extraction Company have enterprisingly undertaken is to be encouraged.

Some Fundamental Industrial Problems.

We suspect that Mr. E. C. de Segundo entitled the Paper which he read recently before the Royal Society of Arts "Some Problems of Unemployment" on the principle that in such a case an arrest of interest is better than accuracy. For the Paper deals with unemployment quite incidentally, being mainly concerned with a discussion of the fundamental relations between Capital and Labour so called. His most architectonic suggestion was, in fact, that not only unemployment, but many of our other industrial ills could be prevented by the formation of an industrial army, whose establishment should be the result of joint action between trade unions and an employers' organisation and which should be recruited only from those who have attained and maintain a certain standard of character, skill and efficiency in their work. As some recompense for obtaining the necessary qualifications, service in this army would be continuous, and admission would be confined to pure born British men and women.

A Revolution in Industry.

In the course of the discussion, this suggestion was rightly described by Mr. G. J. Wardle as a revolution in industry, and we may be forgiven for thinking that it was put forward because not only has the capitalist made rather a mess of industrial and social problems, but because there is no guarantee that if Labour took charge matters would be improved. We are rather afraid, however, that though the establishment of a working class bureaucracy, which is really what Mr. de Segundo's industrial army would mean, might prevent unemployment, it would give rise to a state of affairs that would be very much worse for industry and for everyone else. We would therefore prefer to pin our faith to his second solution of endeavouring by individual effort and active proganda to ameliorate the relations between employer and employed and to instruct both of them in the essentials of economics. For we feel certain that the present grave state of our industrial politics is not due entirely to the shortcomings of one or other of the parties concerned, but to the ignorances of both. On the one hand, the grave spectre of unemployment has led to a disastrous policy which has re-acted on those who adopted it, while, on the other hand, a neglect of the laws of the supply and demand have brought a slump in the midst of a world shortage of goods. Where both sides are to blame they cannot do better than come together, and discover a joint solution which will benefit them both.

The Failure of Absolutism.

Unfortunately this solution does not meet with approval, at least in the mining industry. Indeed, so difficult do both employers and employed find it to agree on a working policy which shall not only bring an adequate return to each, but ensure to the industry of the country a much needed supply of cheap fuel that we are at the moment faced with a situation that is neither a lock-out nor a strike, but whose harmful effects will be equal to those which arise from either. In such a case while nomenclature does not matter, a settlement most certainly does, for from such a state of things no one can gain anything, and the principal combatants will stand to lose much more than anyone else. It cannot be denied that both parties in the industry, assisted by the Government, are to blame for the present state of affairs, while the miners, or their leaders for them, are deserving of additional censure for making demands which have no economic justification. Further, having sought to enforce these demands by a strike which left them worse off than they were before, they now desire to bolster up a trade, which they have reduced to insolvency, by a subsidy, disregarding the essential facts that they can benefit from no wealth that they do not create and that there is no way of altering the inexorable law that wages are fixed by prices. But dark as the outlook is, even it has its bright side. The policy which the miners have followed, and the results which that policy has produced have raised a mightier and more unanswerable argument against the nationalisation of the coal industry than years of propaganda and statistics could have achieved. Indeed after many obscure journeyings we have reached the stage foreshadowed by Gladstone when he said that "All systems, whether religious or political, which rest on a principle of absolutism must, of necessity, be not indeed tyrannical but feeble and ineffective."

Dundee and Hydro-Electric Supply.

We are not surprised to learn that Dundee Corporation have abandoned the suggestion to develop the water power of Loch Ericht themselves, and that a modification of the scheme for an extension of the steam plant is to be adopted to tide over the next two or three years. It will be remembered that a little over a year ago a report on the water power project was obtained. Since then a sub-committee has made further investigations on the subject, and recently another report on a portion of the original scheme by Major Richardson, the City electrical engineer, and Prof. Gibson has been published. In view of the large capital expenditure that would be necessary, over £1 100 000, and in consequence of the existing financial and industrial position the Council are naturally anxious to avoid heavy capital commitments at present, and it is therefore probable that further negotiations will be continued with the promoters of the Grampians Electricity Bill.

The Grampians Scheme.

At any rate it is pretty certain that the Corporation will not now actually oppose the Grampians Bill, except for the purpose of obtaining the insertion of protective clauses. While if they can procure a supply of electricity in bulk from the company at a price not greater than that at which they can generate by steam themselves, combined with substantial guarantees that such a supply will be reliable, an agreement will probably be entered into with the company. As other Councils are also likely to require a bulk supply from the same source the chances of the Grampians Bill being passed are quite good, and as the demand from existing undertakings will be a substantial and a growing one, conditions should moreover ensure the company's scheme being a financial success. The only obstacle that we can see is the fact that the Water Power Resources Committee has not yet issued its promised report on water power development and it is not expected before the autumn. The Electricity Commissioners can, however, be trusted to see that the Grampians scheme is so developed that it will fit in with any national scheme which may be ultimately adopted.

Education in Industry.

In a recent issue of "The Times" attention was called to the necessity of placing many of our provincial universities on a sound financial basis in order that the educational facilities provided at these institutions should be within the reach of all. It is hardly necessary to say that we support this plea by every means in our power, not only on general grounds, but because the connection of many of the provincial universities with electrical engineering is particularly close. In no case is this truer than at Manchester, where the University forms a useful auxiliary to the work which is being done in training students and apprentices by electrical firms, and where on the other hand the works of these firms are useful as an auxiliary in applying a practical polish to the theoretical instruction which is being given in the various schools which the University controls. As an illustration of what we mean we may instance particularly the careful attention paid by the Metropolitan-Vickers Electrical Company to educational problems in a special training department which has been built up under the control of Mr. A. P. M. Fleming. A publication recently issued by the firm gives details of what is being done and a full account of the various courses which are open to the embryonic engineer. The scheme bears not only the mark of careful thought, but of the earnest desire that each apprentice of the firm may make the fullest use of his training.

The Recruiting of Trained Men.

For the better carrying out of this object a special works school has been established in co-operation with the local education authority, and scholarships have been endowed so that the youth unblessed with this world's goods may not be hampered in his desire to obtain a sound engineering training. In addition to the training which is available for the apprentice proper adequate provision is also being made for the practical training of university students, while a realisation of the need for a close connection between theory and practice is to be found in the establishment of research scholarships so that graduates in pure or applied science may have an opportunity of preparing for a honours or Master's degree, while carrying out research work at Trafford Park. It is therefore obvious that the Metropolitan-Vickers Electrical Company realises the fact, which should receive more general recognition than it has done up to the present, that to obtain a supply of adequately-trained young men for carrying on their work a firm must itself inaugurate schemes and supervise the necessary systems of training. In so doing they not only tend to increase their own prosperity by raising the standard of knowledge of those employed by them, but confer a benefit on the community. This being the case we should like to see all electrical and engineering manufacturers combining to improve our present engineering educational facilities and by the revival of such a body as the Engineering Training Organisation, now unfortunately in a state of suspended animation, to provide a means of recruiting trained men into the service of the industry.

German Telegraphs and Telephones.

Those who are interested in the present financial and engineering position of our telegraph and telephones may study with some advantage some figures given recently by Dr. Bredow before the German Technical Union. He pointed out that owing to the extraordinary rise in the cost of materials and labour, including an increase in the price of iron wire of 3 000 per cent., of copper wire of 1 200 per cent., of underground cable of 2 000 per cent., of internal cable 4 000 per cent., and of instruments of 3 000 per cent., there was a deficit on the service during 1920 of no less than 200 000 000 marks. At the same time, both the telegraph and the telephone systems were strained to their utmost capacity, and it was absolutely necessary for extensions to be put in hand at once. In considering these extensions, however, the question would have to be faced that the cost of installing a telephone line in Berlin had risen from 800 marks to 11 000 marks, while working and maintainance had increased ten-fold. The result was that though telephone charges had been increased about four times during the war, they still lagged behind expenditure and further drastic alterations would be necessary. These, it is interesting to note, or so Dr. Bredow proposes, include the abolition of the unlimited service rate, which some people seem to think is an ideal way of paying for telephones, and in its place the use of a tariff based on the number of calls made, which some people think is very unfair. But in Germany they would go farther in this matter than even our Post Office Administration propose doing, for they would increase the rate per call as the number of calls itself increased, thus extorting the uttermost farthing from an already overridden business community. But matters do not stop even there, and to provide capital for improving the system a compulsory loan is suggested. And the result of it all is to be that the financial situation will improve in time, though it will be many years before the service reaches its pre-war level of efficiency. But what will happen if the papers get hold of it and if there is a telephone strike, as has been suggested over here? We suppose, however, that they do not do that sort of thing in Germany!

Electric Propulsion.

It is in many ways extraordinary that the one direction in which the electric drive seems at present to be making little or no progress is in that of ship propulsion. We use that term to indicate the means of driving the propellors of the ship, and, moreover, confine the limit that has apparently been set to this form of electrical activity to the ascertainable conditions in this country. As will appear from the evidence that we publish below, progress has been very much more rapid in the United States, not only as regards the number and character of the ships equipped, but in the way of obtaining details of performance and information regarding the best design of equipment to employ. This progress has naturally brought with it corresponding benefit to the electrical industry and no disadvantage to the shipbuilding interests.

The reasons for this stagnation in electric propulsion on this side of the Atlantic are rather difficult to determine. Putting aside the innate conservatism of British shipowners, shipbuilders and marine engineers, and allowing full discount for the misdirected energy and almost the charlatanism of some of its exponents, the electric drive, in spite of its many advantages, seems hardly to have had a fair chance, and has certainly barely started its career so far as the marine industry of Britain is concerned. This remark applies, of course, only to the main propelling machinery. For, as far as auxiliaries are concerned, there is a very different tale to tell, so different as to make this lack of development in the field of propulsion even more inexplicable.

Reasons for the Stagnation.

Nor if American experience is anything to go by can this state of things be ascribed to any theoretical or practical shortcomings in the electrical equipment employed for driving ship propellors. For as Mr. Eskil Berg, who, as is well known, is an American engineer who has devoted a great deal of study to this question, recently showed, while the losses with the electric drive amount to 7·93 per cent., as against 7·26 per cent. with gearing on ships with propelling machinery of an output of some 3 000 h.p., this difference is so slight as to be negligible, especially when the somewhat rapid deterioration of the gearing and the other troubles such as those connected with lubrication, noise and wear to which the employment of this method of speed reduction gives rise are taken into account. The electric drive, on the other hand, undoubtedly possesses the advantages of greater inherent simplicity coupled with the elimination of shafting, relief from breakdown, and ease in repair. While such factors as the less space occupied, reduced weight, greater accessibility, economy at low speeds, interchangeability, ease of measurement, flexibility of location, and, above all, reduced overall costs, must also be taken into consideration. It also affords a means of reversal by a simple alteration of connections without changing the direction of the turbines, a point the importance of which can hardly be too highly stressed. For the propulsion of warships especially, it has, in fact, frequently shown itself equal, if not superior, to geared turbines and the older forms of drive on the two scores of reliability and overall efficiency.

Breakdown and Fire Dangers.

These points are important, for one of the chief talking points against the electric drive for this particular service has been its liability to complete breakdown from some trivial reason and the danger that is likely to arise in the circumscribed area in which the machinery necessarily works owing to the danger of fires of an electrical character breaking out. Experience shows, however, that even these bogies are largely imaginary and can be overcome to a great extent by employing induction motors of special design.

Drawing on American experience once again on this point, we find that this type of motor is specially suitable for marine work, owing to its small air gap and the rigidity which can easily be imparted to the stator frame. It has the added advantage in the same field that repairs can easily be effected by cutting out a faulty stator or rotor coil or even a complete circuit, thus permitting the ship to proceed at reduced speed, while even supposing the stator winding to be so badly damaged as to prevent such repairs being made, the stator leads can be disconnected and the burnt-out section short-circuited. The leads from the generator can then be connected to the rotor and provision made for the motor to be operated, inverted with both motor and generator running at 80 per cent. of their usual speed and at reduced voltage. Such a motor is smaller in diameter and longer in length than is usual in land practice, while greater care has naturally to be taken to insulate the windings against moisture and to ensure water-tightness. Special attention is also paid to the ventilating arrangements, to insulation and to details which ensure that there is ample lubrication when the ship is pitching or rolling. Motors of this design have been in use for some years in the United States Navy and mercantile marine, and have proved themselves as regards reliability, economy, ease of control and manœuvering under the most arduous conditions. Reliability is, of course, a most essential asset in work of this class, but in the present state of development in the design and manufacture of electrical machinery it should not be difficult to secure.

No Inherent Drawbacks.

American experiences and the apparatus which has successfully been produced as a result clearly indicate that there is nothing inherently absent in electrical generating or motor equipment which makes its application to ship propulsion impossible or so expensive as to be economically unsound. Even those who are most obstinate on this matter have long been convinced of the advantages of using the electric drive for the auxiliary machinery, so that the step to the operation of the main plant electrically is one of degree and not of kind. There is, therefore, every reason for exploring this new field for the employment of the electric drive with a view to scheduling its problems and discovering means whereby they can be overcome. In this matter we can, of course, learn from what has already been done and perhaps introduce some new and better means of attaining the desired end.

We have no doubt that if the problem is tackled it can be solved as successfully as many such more difficult problems have been solved before. There is the greater need for this in that electrical engineers have already entered this field once and cannot, therefore, afford to retire or at least cannot retire without loss of prestige. We, therefore, hope that the matter will be taken up seriously by the manufacturers of electrical machinery and a determined effort made to ensure some development in the directions we have indicated.

Cables, Voltages and Temperatures.

Research into the various phases of the behaviour of the cables now used in our electrical distribution systems is being conducted upon two convergent lines in this country and in the United States respectively. Within the last few months the Committee appointed by the Institution of Electrical Engineers to consider certain questions in connection with the heating of buried cables have issued a report which, whatever its shortcomings, at least indicates the necessity of a thorough and detailed investigation into the temperatures reached by cables operating under practical conditions, as to how those temperatures rise and fall with the load and especially as to how they affect the life of the cable employed.

The Lines of Future Investigation.

It will be remembered that the form this investigation took was to examine various commercial patterns of cable, buried in accordance with one or other of the methods now familiar in electrical practice and operating under normal conditions, to measure the resulting temperature rises and to some extent to explain the results as a basis for future action. As we pointed out at the time, however, the investigations so far are essentially of a preliminary character and must be both extended and modified so as to enable us to say not only what current a given cable will carry under given conditions but to allow us to determine and define those conditions, with the ultimate object of obtaining the highest financial return on the capital sunk in the buried portion of any electrical distribution system. Not perhaps a very high ideal, it is true, but quite essential all the same.

At the same time, on the purely technical side, rather more digestion of some of the results so far published by the Committee is required, so as to enable more definite information to be obtained on such points as the value of such constants as the safe working temperature of the dielectrics employed and the thermal resistivity of the different materials used in cable making, as well as such elusive factors as the effect of moisture content and ground temperature.

Another Method of Attack.

It is obvious, however, that the question could be tackled in another way by finding out not what temperatures are reached under certain conditions, but what is the maximum temperature the various kinds of insulation now employed can stand and how this maximum is effected by the methods of laying and the operating conditions under which the cable works. It is interesting, therefore, to find that these are the lines upon which investigators in the United States have been proceeding as is evident from the study of a group of Papers recently read before the American Institute of Electrical Engineers.

In considering these researches, we may first mention a Paper by Mr. PHILIP TORCHIO, in which he pointed out the inconsistency of allowing generating and converting machinery to operate at a fairly high temperature for long periods and at the same time designing cable networks so that the maximum temperature ever reached is a very much lower figure. This policy is the more inconsistent from the fact that cable is never likely to operate at that maximum temperature, whatever it may be, for more than a very short time, while machinery may operate at its maximum temperature for quite lengthy periods. These limitations on cable temperatures seem, in fact, to have been imposed by the fear that the compound may leak out of the paper, resulting in the latter becoming brittle and cracking inside the lead sheath, if it is ever necessary to move and reinstall it.

The results of a series of more or less involuntary tests on the system of the New York Edison Company, however, show that both these dangers are exaggerated, and that even after running at temperatures considerably higher than 100°C. for some hours the insulation was still in good electrical condition, though its mechanical properties had, it is true, been impaired. It therefore seems to follow that no danger will result from constantly operating a cable at least for short periods at a very much higher temperature than is now usually employed. As an aid to determining what the maximum temperature should be so that no harmful effects should occur, Mr. TORCHIO makes the interesting suggestion that the temperatures chosen should be a function of the load factor at which the cable is operating, falling from 105°C. with a load factor of 33 per cent. to 95 deg. with a load factor of 50 per cent. and to 90 deg. with a load factor of 66 per cent., these figures applying to low tension cables insulated with impregnated paper.

THE EFFECT OF HEAT ON IMPREGNATED PAPER.

Those who fear that the result of increasing the temperature of a network will have a harmful effect on the insulation and so lead to a string of practical difficulties may be reassured by a study of the Paper by Mr. WALLACE S. CLARKE, also read recently before the American Institute of Electrical Engineers, in which the effect of heat on impregnated paper used in cable is specifically dealt with. Mr. CLARKE shows that while the tensile strength of paper deteriorates less rapidly than its resistance to tearing, the deterioration in both qualities after prolonged exposure to temperatures of, say, 100°C. to 110°C. is not sufficiently marked to lead to any harm arising. In fact, he goes so far as to say that only if the temperature is kept constantly at 100 deg. for 90 days or at 110 deg. for 30 days is the deterioration so marked as to be dangerous from the operation point of view. It is therefore evident that a cable can be used for many years, with 110°C. as its peak temperature, before reaching that stage of deterioration which would be the result of a continuous 90 days test. The exact period at which it would reach this stage of deterioration is, in fact, very difficult to discover, because the rate of deterioration at lower temperatures is not accurately known. Mr. CLARKE, however, makes the important point that the temperature limit fixed for the operation of a low tension cable to avoid undue deterioration must take into consideration the length of time during which the temperature is maintained, and that the shorter time this maximum persists the longer the probable life of the cable.

THE ECONOMICS OF HIGHER VOLTAGES.

The question of the more economical use of our cables may, of course, be looked at from yet another point of view, that is, we may consider how far it is possible to employ this equipment to better advantage by increasing the voltage and thus reducing the heat losses which would otherwise occur. In this connection attention may be drawn to a Paper published in the United States by Messrs. DAVIS and SIMMONS, who undertook a research to discover whether the maximum stress on the insulation of present-day high voltage cables could not be increased to some figures nearer the dielectric strength of the insulating materials used. If such an increase was possible, consideration would naturally have to be given to the increased stress on the insulation caused by the stranding of the conductors, and special attention is paid by the authors to the determination of the maximum insulation stress in single and three-conductor cables in terms of their dimensions and of the minimum value of the maximum stress for a three-core cable of given outside diameter. As a result the conclusion is reached that this minimum value will be attained when the conductor diameter equals the core diameter divided by 5·94. It is also proposed that the maximum permissible stress should be raised to 25 kV per cm., or, in other words, that a maximum voltage of about 34 kV would then become possible when a cable with a core diameter of 3½ in. and a maximum insulation strength of 25 kV per cm. was used. This figure might be raised to 40 kV per cm. if a Hochstadter cable were employed.

INTERNATIONAL INTERCHANGE OF INFORMATION DESIRABLE.

The series of papers from which we have quoted sufficiently indicate that it would be desirable to inaugurate a useful international interchange of information on the important subject of most economical use of cable networks. We are the more convinced of this from evidence which has recently come to hand of the great interest that has been taken in the United States in the report of the Heating of Buried Cables Committee. There seems no reason, moreover, to doubt that the lines of research we have just outlined will arouse equal interest in this country and perhaps provide for that Committee a series of fresh thoughts on which to base new work. For even if there is nothing that is either new or strange in these American investigations, they certainly present the subject from rather a different point of view.

A NEW OUTLOOK.

They are, indeed, a striking indication of an interesting change of thought in electrical engineering practice, a change of thought which has been evidenced in several Papers read before the Institution of Electrical Engineers this session, notably that by Mr. G. A. JUHLIN, upon which we recently commented. For while in the past, when cost of materials and labour did not weigh anything like so heavily as they do at present in the balance sheet, we have always ensured ourselves against possible breakdown of electrical equipment by providing a margin of safety, in the present—whether it be in turbo-alternators or in cables—every effort must be made to employ to the utmost limit every cubic inch of material, and we must, therefore, be prepared to take risks in a way which would have been thought dangerous only a short while ago. In taking those risks there is no need to anticipate an increased number of breakdowns. Indeed, we think it very likely that experience will indicate that we have been too cautious in the past and that the data and new knowledge of the behaviour of the materials which we employ which will be available as the result of this braver policy will enable such results to be obtained and worked in a way that can only help to facilitate progress in both the economic and technical directions.

Behaviour of a Three-Electrode Vacuum Tube as an Oscillation Generator.

By EIJIRO TAKAGISHI
(The Electro-Technical Laboratory, Tokyo, Japan.)

(*Concluded from p.* 348.)

CONDENSER ACROSS THE INDUCTANCE.

It is often necessary to consider such a generating circuit as shown in Fig. 10, differing from the foregoing in introducing a condenser across the inductance in the grid circuit, in other words having two oscillatory circuits coupled with each other. Denoting the reciprocal of 2π times one of the two coupled frequencies by p', we obtain for the ratio of the plate and grid oscillating voltages

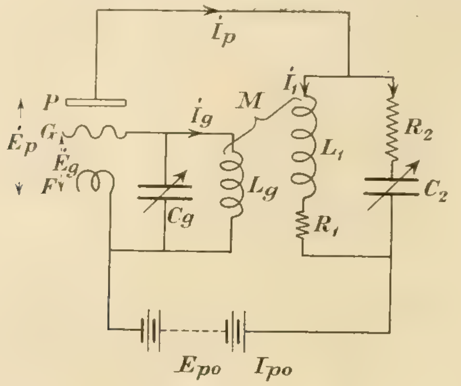

FIG. 10.

$$X = \frac{\dot{E}_p}{\dot{E}_g} = \frac{p' - p_g}{C_2 M}, \qquad (14)$$

$$= \frac{L_1}{M} \cdot f_x,$$

where

$$p_1 = C_2 L_1$$

$$p_g = C_g L_g$$

$$f_x = \left(\frac{p'}{p_1}\right) - \left(\frac{p_g}{p_1}\right). \qquad (15)$$

From the equation (14) it is deduced that

(1) With a positive coupling, the shorter wave oscillation only can occur, while

(2) with a negative coupling, the longer wave oscillation only can be established, both requiring the negative values of X.

The values of f_x vary with $\frac{p_g}{p_1}$ as shown by the curves in Figs. 11 (*A*) and 12 (*A*), which correspond to the longer and shorter wave oscillations respectively. Neglecting the power loss in the grid oscillation circuit compared with that in the main oscillatory circuit at the plate side, the following expression is obtained for the ratio of the plate current to the grid oscillating voltages :—

$$Y = \frac{\dot{I}_p}{\dot{E}_g} = \frac{C_2 R}{M} \cdot f_y, \qquad (16)$$

where

$$f_y = 1 - \frac{p_g}{p'_1} \cdot \frac{\left(\frac{p'}{p_1}\right) - \left(\frac{p_g}{p_1}\right)}{\left(\frac{p'}{p_1}\right)}, \qquad (17)$$

and for the main oscillatory current $\dot{I}_1$,

$$I_1 = -j \cdot \dot{E}_g \cdot \frac{\sqrt{C_2 L_1}}{M} \cdot f \qquad (18)$$

where

$$f = \frac{\left(\frac{p'}{p_1}\right) - \left(\frac{p_g}{p_1}\right)}{\sqrt{\left(\frac{p'}{p_1}\right)}}. \qquad (19)$$

The values of f_y and f are plotted in the curves (*B*) and (*C*) in Figs. 11 and 12. The equations (14), (16) and (18) are important for investigating the oscillating phenomena with the present circuitual arrangement. For the precise investigation of the individual effect of each constant of the circuit under consideration, it is necessary to rearrange these equations so as to have new coefficients; for example, in studying the effect of C_2 it is necessary to consider the coefficients

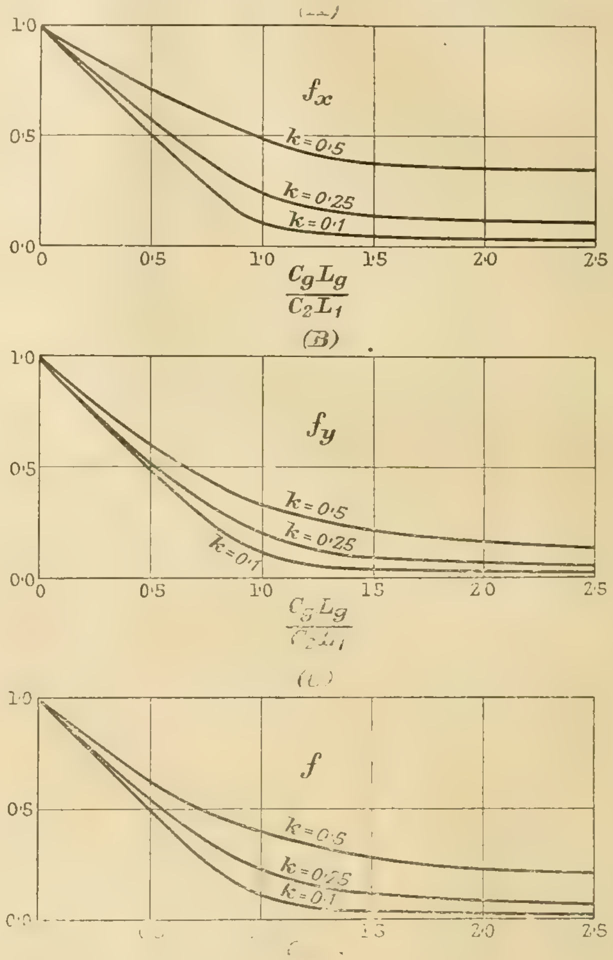

FIG. 11.—LONGER WAVE OR NEGATIVE COUPLING.

$$f_{xc_2} = \frac{f}{k} \qquad (20)$$

in the equation

$$X = f_{xc_2} \cdot \sqrt{\frac{L_1}{L_g}}, \qquad (21)$$

$$f_{yc_2} = \frac{f_y}{k} \cdot \frac{C_2 L_1}{C_g L_g}, \qquad (22)$$

in the equation

$$Y = f_{yc_2} \cdot \sqrt{\frac{L_g}{L_1}} \cdot \frac{C\,R}{L_1}, \qquad (23)$$

and

$$f_{c_2} = \frac{f}{k} \cdot \sqrt{\frac{C_2 L_1}{C_g L_g}} \qquad (24)$$

in the equation

$$I_2 = f_{c_2} \cdot \sqrt{\frac{C_g}{L_1}} \cdot E_g. \qquad (25)$$

Curves of these coefficients are shown in Figs. 11 and 12.

DETERMINATION OF COEFFICIENTS.

Other coefficients corresponding to any other constant can be easily obtained and the correctness of the result has been satisfactorily verified by experiments. For example, Fig. 13

and Fig. 14 represent the relation between the condenser degrees at which maximum oscillation currents have been obtained and those which have made the oscillations die away in reference to coupling distance, the values of the maximum oscillation current being plotted on the same sheets. The principal difference between these figures is seen to be that in case of longer waves (Fig. 13) condenser degrees, where the oscillation stops, lie above those at maximum oscillation current, while in case of shorter waves (Fig. 14) the reverse is true. This difference is clearly understood by comparing the curves of f_{xc_2} at their respective couplings. In this experiment it was observed that even with no external magnetic coupling there was established an oscillation current and with a certain degree of positive magnetic coupling there existed a range of no oscillations. These curious phenomena are due to the inherent capacity between the grid and plate electrodes in the tube.

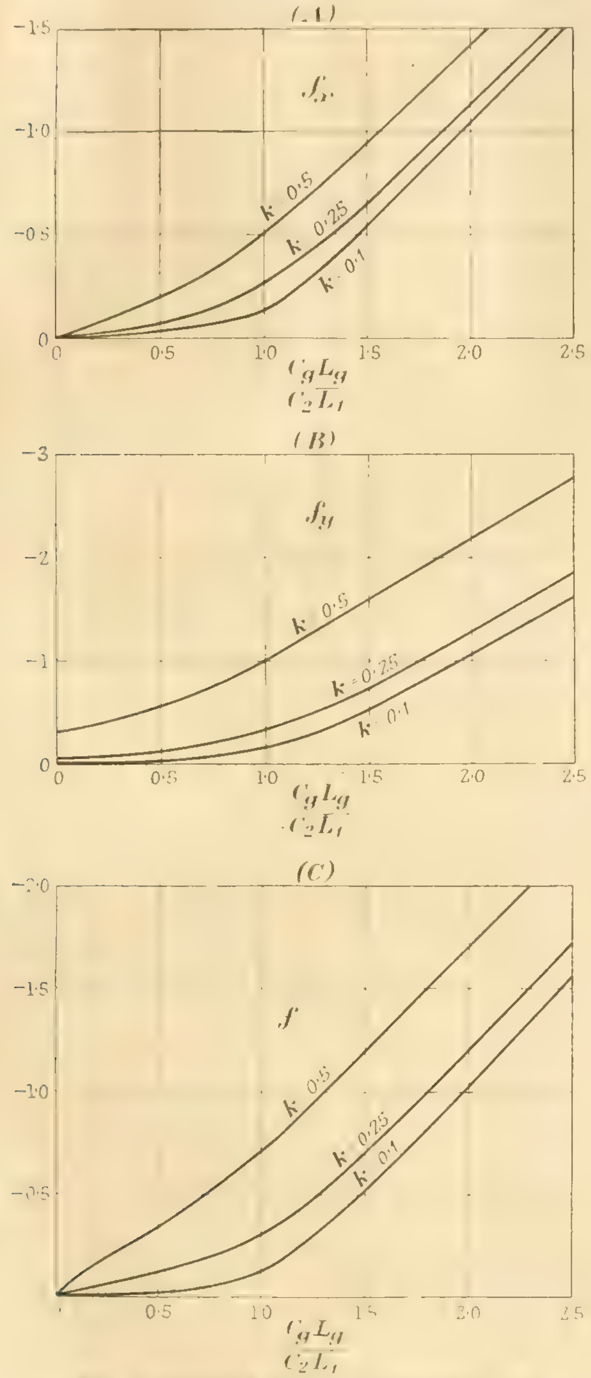

Fig. 12.—Shorter Wave or Positive Coupling.

As has already been explained the present method of analysis is applicable to any circuit having any form of coupling, say, either electromagnetic or electrostatic, if the quantities of the corresponding X and Y are obtainable.

While writing this Paper, the writer read a valuable article on "Determination of the Output Characteristics of Electron Tube Generators," by Lewis M. Hull, in Scientific Paper No. 355 of the "Bureau of Standards." He tried a similar method of attack to that writer's but limited the problem to a special case. There appeared also in May issue of the "Radio Review" an abstract of A. Blondel's Paper which seems to deal with a similar problem as the writer's taking the dynamic characteristics into consideration, but to my regret the particulars were unknown owing to the absence of the original Paper.

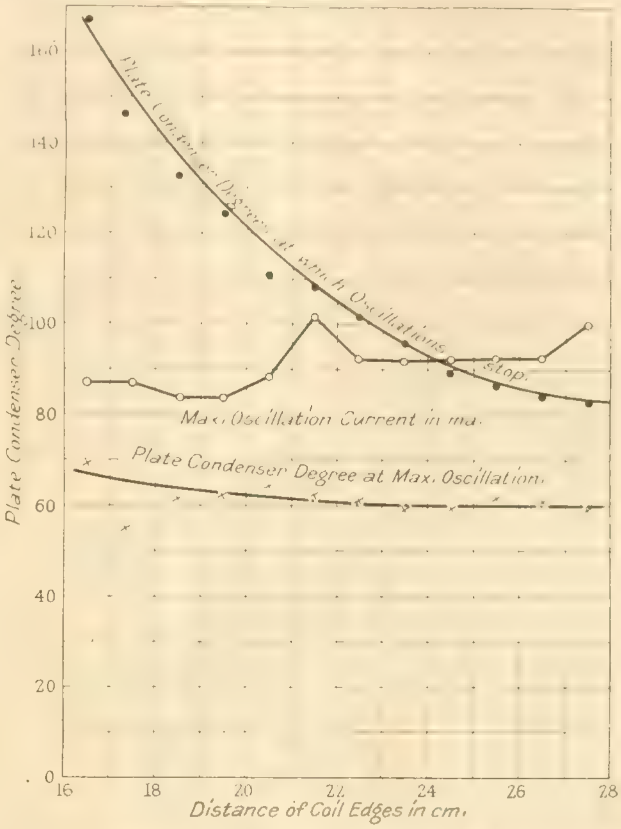

Fig. 13.—Negative Coupling or Longer Wave Grid Condenser Capacity = 0·00064 mfd.

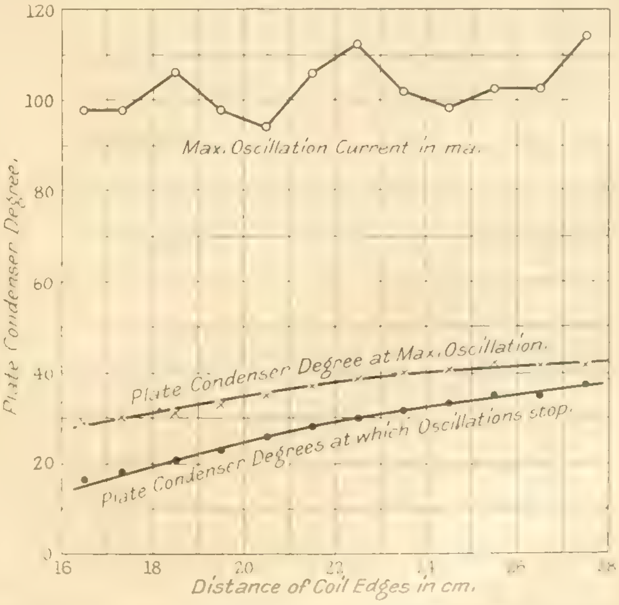

Fig. 14.—Positive Coupling or Shorter Wave Grid Condenser Capacity = 0·00064 mfd., Grid Being at −7·5 d.c.

In conclusion, the writer wishes to express his hearty thanks to Dr. W. Torikata, E. Yokoyama and M. Kitamura for his indebtedness to them for the completion of the present investigation.

The Long-Distance Telephone System of the United Kingdom.*

By SIR WILLIAM NOBLE.

(*Concluded from page* 352)

Artificial Balancing Lines.

The problem of constructing artificial balancing lines for telephone repeaters involves exhaustive study of the impedance characteristics of line circuits.

Sudden changes, due to unevenly spaced loading coils, the insertion of sections of line with different conductor resistance, electrostatic capacity, or insulation resistance per mile, introduce irregularities in the impedance frequency characteristics, making it practically impossible to obtain absolute balance. Freedom from such difficulties is obtained by so designing the circuit that the resistance, capacity, leakance and inductance are uniformly distributed. The circuit should also be practically "distortionless," *i.e.*, (*a*) transmit all the important speech waves with equal attenuation, (*b*) maintain the phase relationship between the various frequencies, and (*c*) possess constant impedance over the important frequency range. An artificial balancing line for such a cable would be a plain resistance whose value could be predetermined.

Hitherto these conditions have not been obtained in practice.

The author in the original Paper presents the results of measurements on a loop of 70-lb. conductors loaded with 135 mH coils at intervals of 2·6 miles. The mean curves for both the resistance and reactance components rise with frequency, owing to the loading coil nearest to the place of measurement being too near, and also to the effective resistance of the loading increasing appreciably with frequency.

One method of treating such a cable is to place a condenser in series with a resistance as a shunt across the line. This produces a modification in the mean curves, which become practically horizontal.

Methods of Overcoming Difficulties.

The difficulties in operating circuits using differential repeaters in tandem have induced investigations of other systems for obtaining 2-way facilities. One system involves an adaptation of the principle of the simplex telegraph repeater arranged for up and down working. The line is divided at the repeater station, and the up and down sides respectively are led through the tongues and spacing contacts of an electromagnetic switch to the input circuit of an amplifier. The output circuit of each amplifier is cross-connected to the marking contacts of the opposite electromagnetic switch. The electromagnetic switches correspond to the automatic switches of the telegraph repeater, and are similarly controlled by the amplified outgoing currents (*see* Fig. 5). This principle has also been applied to wireless telephony.

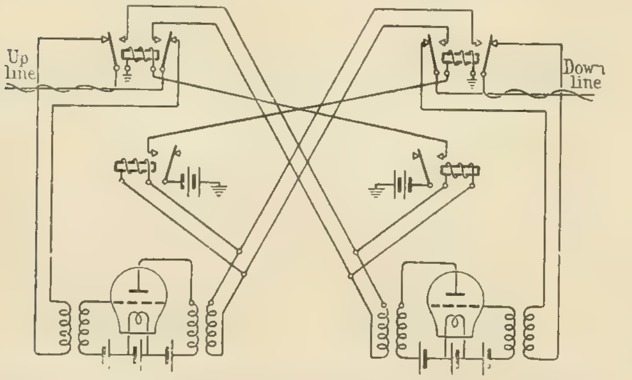

Fig. 5 (*a*).—Telephone Repeater with Switching Relays (Schematic).

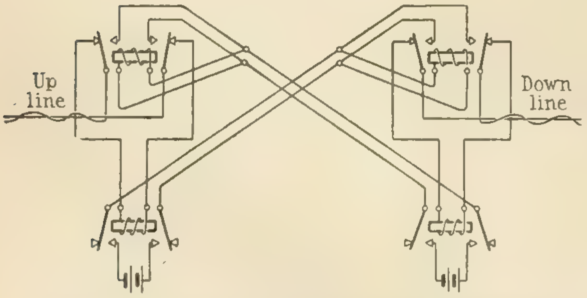

Fig. 5 (*b*).—Telegraph Repeater Simplex (Schematic).

A second system reverts to the original idea of using separate line circuits for transmitting in the up and down directions respectively. It is generally known as the 4-wire system (*see* Fig. 6). The speech currents circulate in only one direction round the circuit and are relayed by 1-way amplifiers in each side. The terminal telephones or extension lines are connected with the 4-wire circuit by means of differential transformers and are balanced by artificial lines. If those balances are accurate and the transformers are perfectly differential, then the whole of the incoming current from the last amplifier in either side will divide between the terminal 2-wire circuit and its corresponding balance, and no current will pass over to the other side of the 4-wire circuit. The repeaters could then be operated with an amplification limited only by the cross-talk between the two sides of the 4-wire circuit, and between adjacent circuits.

In practice the terminal balances can be made sufficiently accurate to enable the repeaters to be operated so as to give a transmission improvement equal to the suppression of an attenuation length not less than that of the total line circuit; *i.e.*, the over-all transmission equivalent of the circuit between terminals may be zero.

With modern balanced cables repeaters may be spaced up to 30 standard miles apart with a reasonable factor of safety; consequently very small conductors may be used. For long-distance cable circuits, beyond the economical range of the 2-wire circuit with differential repeaters, the 4-wire circuit offers important advantages and will be widely used.

Improvement of Trunk System.

Revision of the London-Liverpool scheme in 1918 with our later knowledge proceeded as follows:—

The trunk circuits were required to give a transmission efficiency of 12 miles of standard cable between testboards. This efficiency could be obtained with cable conductors weighing 200 lb. per mile of wire, loaded with 100 mH. per mile, and a cable of maximum diameter would provide 42 circuits including phantoms. Such provision would barely suffice for two years' development, and a second cable would have to be commenced immediately on completion of the first. After eight years several such cables would be needed.

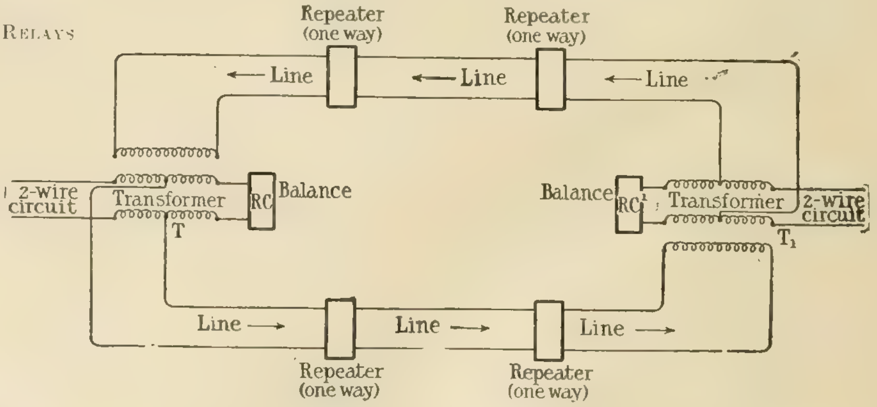

Fig. 6.—Four-Wire Repeater System.

Now, assuming the installation of a midway repeater giving a transmission improvement of 14 miles of standard cable; then for an equivalent of 12 standard miles between terminal testboards a cable containing 100-lb. conductors would be suitable. A cable of maximum diameter would provide 90 circuits including phantoms. The annual costs per circuit including repeaters would be approximately one half that of the previous scheme, and the provision of a second cable would be postponed for about three years.

Further, assuming the installation of two intermediate repeaters each giving a transmission improvement of 14 standard miles; then the required efficiency between terminal test-boards could be obtained with cable conductors weighing 40 lb. per mile of wire, and the cable would provide 240 circuits including phantoms. The total annual charges per circuit would be approximately one-third those of the first scheme.

It was decided to proceed with the London-Manchester development on these lines. The duct route between the terminal stations has been completed and the cable is well on the way. Duct space has been provided for the next 20 years. The duct route forks at Derby, one route going north to Leeds and the other north-west to Manchester (*see* Fig. 7). Repeater stations will ultimately be located at Northampton and Derby.

At the present time the construction of similar main cable rcutes from London to Southampton and Portsmouth and from London to Bristol and the west has been commenced. In due course the northern cable route will be extended beyond Leeds through Newcastle and Edinburgh to Glasgow, so that in the course of a few years all main telephone communications between the important commercial centres of this country will be underground, giving a quality and stability of service which will be equal to, if not better than, any in the world.

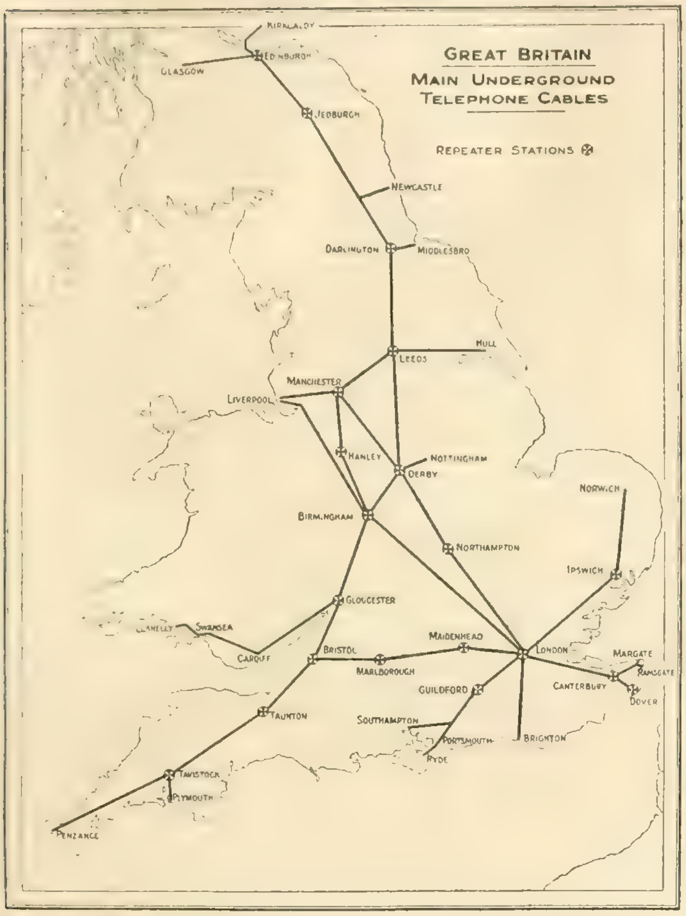

Fig. 7.—Main Underground Telephone Cables in Great Britain.

Submarine Cable Development.

Much work has been done on submarine cables. In 1914 it was pointed out that it was possible to obtain four circuits from a loaded 4-wire submarine cable if the circuits are isolated from the land lines at the ends of the cable by transformers, viz., the usual two side circuits and one loop phantom circuit, the fourth circuit being obtained by using the four wires of the cable in parallel with earth. The fourth circuit can be made successful in a continuously-loaded cable, but not yet in a coil-loaded cable.

In certain circumstances it might be desirable to lay single-wire loaded cables. The effective resistance of the conductor in such a cable would be materially greater than that of half the resistance of a loop circuit of the same gauge. The usual type of submarine cable contains four wires, but if a large number of circuits are carried across a wide river or estuary, a special continuously-loaded cable is needed. This cable will contain seven quads, and it is hoped that seven phantom circuits will be obtained in addition to the 14 side circuits. The introduction of telephone relays has made it possible frequently to use submarine cables of a less efficiency than the coil-loaded cables previously required, and thus to increase the use of continuously-loaded cables in which the difficulties of maintaining loading coils are entirely eliminated.

The tendency is to extend materially the use of submarine continuously-loaded cables.

High-frequency Telephony.

This Paper would be incomplete without some reference to high-frequency or so-called "wired wireless" telephony.

The principle of the system has been known to scientists for a decade, but the solution of the practical problems involved in adapting it to commercial use was delayed in this country by the war. These problems involve researches into the behaviour of aerial wires and underground cables over a range of frequencies hitherto practically unexplored. The most valuable feature of the high-frequency carrier-wave system is its adaptability to multiplex telephony, *i.e.*, the simultaneous operation of several communication channels over one wire circuit. The system is already in commercial service in Germany and in the United States on long aerial telephone circuits, but the conditions under which those services are possible are practically non-existent in this country. There are, however, a few cases where the system may be applied economically to aerial lines. Some of these are now being dealt with and will be brought into commercial service and linked up with the trunk system during the coming year.

Further statistical data are presented in a series of appendices to the original paper. Appendix I. gives detailed electrical characteristics of representative types of loaded underground cables. Appendix II. contains particulars of the P.O. thermionic valve. Appendix III. relates to submarine cables laid since 1916. Appendix IV. summarises the results of alternating-current tests on single submarine cables, and Appendix V. contains particulars of a test on an underground telephone cable.

DISCUSSION AT MANCHESTER.

The following is an account of the discussion which took place at Manchester on Sir William Noble's Paper on "The Long Distance Telephone System of the United Kingdom." An abstract of the first part of the Paper was given in our last number, and is concluded above.

Some incidental remarks by a speaker from Birmingham referring to the failure of the proposed Engineers' Club in that city, served to remind the members of the North Western Centre of the extent to which the amenities of the Engineers' Club, more inviting than the austere atmosphere of a university, are responsible for the success of their meetings. A crowded audience listened to the Paper, which was ably expounded in Sir William Noble's absence by Mr. A. B. **Hart**. The fluency of speech of many Post Office engineers was a feature of the discussion, ascribed privately by one of their number to the practice they have acquired in preparing official minutes, or is the real reason the necessity they have been under recently of explaining the shortcomings of the telephone sysem ?

Mr. W. J. **Medlyn** said that, in addition to affording improved speech transmission, lead-covered cables required less space, and were cheaper than those insulated with gutta-percha. He pointed out that in the year ending March 31, 1898, there were nearly 6 million trunk calls. Eight years later it had risen to 18 millions, and in 1913 to 36 millions. In March, 1915, it was over 40 millions. A network of cables already existed for providing intercommunication between the towns of South Lancashire and soon it would be possible to put through calls between South and Mid-Lancashire towns on demand. There were 132 lines between Manchester and Liverpool, and 160 new lines were being installed. When the underground trunk system was completed Manchester would be a repeater station, and a stable service would then be guaranteed under all weather conditions.

Mr. L. E. **Wilson** said that a solution of the properties of the telephone line was the most complicated problem in the electrical industry. The power engineer was inclined to regard milliamperes with contempt, but the 10 000 Ah batteries in repeater stations should produce a change in this attitude. Sir W. Noble's Paper was specially appropriate in view of the fact that Manchester was the first town to have a telephone exchange.

Mr. T. E. **Herbert** said that the range of the Paper was so great that detailed discussion would require a treatise. He thought the cable-balancing work of Martin and Tremain a remarkable achievement. The translation of "high-brow" laboratory work into everyday routine testing was a real romance of industry. The Paper demonstrated what had been done, and served to answer the dishonest and dishonourable campaign against the G.P.O. service. In 1896 there were 26 circuits between Liverpool and Manchester, and 18 had to be reconstructed before they gave satisfactory service. The present day number had been given, but the completion of work took time. The economics of telephone working were as remarkable as the scientific achievements. He suggested that it might be necessary to revive the old microphone receiver relay in trunk working.

Mr. G. S. Wallace said that cable manufacturers were concerned as much with mechanical strength and size as with electrical properties. Could cables be manufactured and balanced on more standard lines than hitherto? This would be cheaper, and deliveries would be shorter, two very desirable factors it must be agreed. Were British manufacturers alive to competition from German, American and French Makers of valves? Could a valve be evolved taking a smaller current than 1 A? Referring to repeater station layout, he suggested that existing testing stations might be utilised where possible.

Mr. T. Plummer asked whether Messrs. Martin and Tremain had worked with screened wires. To him the new system of fault localisation was sound, for it was possible to locate a fault within 100 yards in a 90-mile cable, which had, at the fault, an insulation resistance of 3 000 megohms per mile. Repeaters worked very well with very little attention. The Paper had not covered the repeating of ringing arrangements, which was more difficult than repeating speech. He inquired how far series working of valves was suitable for telephone work.

Mr. A. E. White asked whether there was any automatic arrangement to call the repeater station if a valve failed to act.

Mr. T. E. P. Stretche hoped that, if any portions of the Paper found their way to the daily press, residents in rural areas would not expect underground wiring.

Mr. J. S. Terras reminded the audience that the map of main underground cables did not represent all main line cables existing, but only those on the repeater system. He thought the attenuation constant of the London-Manchester cable under construction should be 0·01625, not 0·1625, as given in the appendix to the Paper.

Mr. A. E. Bankes said that the G.P.O. utilised all advances in science which could be applied to telephony. He asked for the value of the heating current and by what means this was prevented from exceeding a certain value.

Mr. H. Crane asked whether the circuit would be arranged so that valves were only in circuit when required?

Mr. E. P. Hill asked for information relating to interference between power lines and underground lines, and whether the amplifying valve would have any effect on interference.

Mr. A. B. Hart, in reply to part of the discussion, said that ringing arrangements were omitted on account of lack of space. These and many other matters were dealt with in the Professional Papers of the Institution of Post Office Electrical Engineers. In the tests by Messrs. Martin and Tremain, the London-Liverpool cable was unscreened. These workers dealt with screened conditions on other cables. Respecting accuracy in fault localisation, he recalled a story by Mr. Kempe to the effect that a fault was located in a cable between Marseilles and the African coast, and a grapnel was lowered and brought up the fault! It was possible to arrange valves for series working under telephone conditions, but the limit was in the cable. The mutual interference of strands in the cable was measurable and extra amplification resulted in undue interference. The maximum degree of amplification desirable did not require more than two valves in series. Repeaters on underground cables were about 60 miles apart. The actual current employed in the valve was 0 8 A and 4 W input gave an electronic emission of 10 mA. A valve taking a smaller current would be welcomed. The use of higher voltages and smaller currents resulted in a filament mechanically weaker and more inclined to sag at high temperatures. Low watt type valves had not proved entirely suitable for telephone repeaters. The grid voltage-plate current curve was required to be a straight line for telephone working. The microphonic repeater was dead, would remain so. It did not amplify small currents as well as the valve. With regard to interference, he thought that telephone and power engineers in conference could solve any trouble arising. No interference would arise if telephone and power circuits were balanced, and he thought power engineers might, with advantage study telephone practice respecting balancing.

DISCUSSION AT GLASGOW.

The following is an account of the discussion which took place at Glasgow on Sir William Noble's Paper.

Mr. J. R. M. Elliott referred to the complaints which had been made of the want of rigidity in thermionic valves of British manufacture, and to the opinions which had been expressed by certain people that the modern German-made valves were much superior in this respect. It would be interesting to know the experience of the Post Office in this connection.

Mr. W. Wood considered that the achievements of the Post Office Engineering Staff in overcoming the difficulties of keeping the telephone system going during the war had been nothing short of marvellous. He thought the question of inductive interference from power circuits called for special attention in view of the development of high-power overhead transmission in various parts of the country. He thought that rules should be laid down on the subject, and suggested that the problem should be tackled by the Post Office Research Department.

Mr. H. Hart, in replying to Mr. Elliott's point about the German valves, stated that, acting under instructions from Sir William Noble, he had brought samples of the valves over from Germany. Tests revealed that they were inferior in every way to the British article, with the exception of the glass blowing work, which was admirable.

Characteristics of the Multispeed Induction Motor.*

By F. CREEDY.

The desirability of adopting a uniform standard electric power system throughout the country has become apparent during the last few years. The system decided upon polyphase (usually three-phase) alternating system, has many advantages as compared with direct current, but has two defects:—(1) Wattless currents flow in the mains, reducing their effective capacity for transmitting energy, and (2) Variable speed motors for use on polyphase net works are at present scarcely obtainable. If and when these two defects can be overcome the polyphase net work will be in no respect inferior and will in very many respects be superior to direct current.

The factors on which the solution of the first problem depend are as follows:—(1) Large constant speed motors should be synchronous wherever possible. Progress has been made in designing self-starting and self-synchronising motors, but the number in actual service is still small. (2) Phase advancers of several distinct types are available, whereby induction motors may be made to give leading currents or unity power factors where synchronous machinery cannot be applied. (3) Electrostatic condensers of large size and thoroughly practical construction are available at fairly reasonable prices. Thus the general method of solution of the problem is well known and there is no technical reason why progress in detail should not be rapid.

Characteristics of Multispeed Motors.

With regard to the second problem, that of producing a variable speed polyphase motor, conditions are very different. The Paper will therefore be devoted to describing some of the essential characteristics of multispeed motors, to which little detailed study has been given. It is known that induction motors are sometimes built with two distinct stator windings for different pole numbers, but general knowledge on the subject hardly goes beyond this.

Naturally a multispeed motor depending on pole changing has only a finite number of distinct efficient speeds corresponding to the different pole numbers. With practicable arrangements of control gear the number of speeds available rarely exceed six, except perhaps in very large sizes. It is not so easy to arrange resistance control on a multispeed motor as it is on a single speed motor. To change the pole number of the rotor winding usually involves a considerable number of terminals and the number of terminals and slip rings that can be used with a revolving winding is very limited. Hence there is a strong incentive to the use of a machine with a short-circuited rotor wherever possible. It is comparatively easy, however, to arrange a multispeed motor to give resistance control on one speed only (preferably the top speed). The process of changing speed will then be as follows: If the motor is controlled by a "selective" type of controller (*e.g.*, a contactor panel in which it is possible to change from one speed to any other without passing through intermediate speeds), this can be done by a contactor panel, the master controller of which consists of a number of independent switches, one corresponding to each speed suitably interlocked so that not more than one switch can be closed at once The speed is regulated from the top speed downward by the resistance until a speed corresponding to a higher pole number is reached. The pole number can then be changed from that corresponding to top speed to the lower speed desired by an instantaneous operation on the contactor board, the resistance being automatically cut out of circuit at the same time by the interconnections of the rotor winding. This is accomplished by so arranging the secondary winding that points between which resistance is connected on the top speed become equi-potential points on the lower speed so that there is no tendency for currents to flow through the resistance. Such a type of control has a wide field of usefulness, but it does not entirely supersede the necessity for genuine resistance control on all the speeds.

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* Abstract of Paper read before the Institution of Mining Engineers.

The Functions of Resistance Control.

This control has two distinct functions :—(*a*) To permit starting and speed changing without a shock to the system caused by switching over suddenly from one speed to another. (*b*) To permit of the use of phase advancers on all speeds. This latter point is becoming of greater importance every year.

Large motors are more usually required to be of the multispeed type than small ones, since the large motor usually supersedes an individual steam engine which has excellent variable speed characteristics, while the small motor frequently replaces line shafting, necessarily operated at constant speed. Much, however, may be done with motors having purely short circuited secondaries, particularly if the step between speeds is not too great. Hydraulic and other clutches which permit of the starting and speed changing of motors on no load, and such devices may often form an efficient substitute for slip ring control.

Device for Checking Current Rushes.

The writer has carried out a careful series of experiments with regard to the rush of current which takes place on changing the speed of a 70 h.p. motor, with short circuited secondary, both on no load and full load, with a view to studying the kick of current when changing from one speed to the next both on full load and no load. A special device was fitted to the controller in order to diminish these current rushes. On the last step but one for instance the speed is changed from, say, 600 to 750 revs. per min , while simultaneously the voltage on the motor is reduced from line voltage to a considerably lower value. On the next step the voltage is restored to its normal value without any further change of speed. In this way it was believed that these current rushes could be reduced and a series of tests was taken on this point, with the result that the maximum current kick was reduced from about 2·4 times to 1·75 times full load current. However, the gain by this means was insufficient to justify the additional complication in the control gear. When changing speed on low load the current kicks are much less than those obtained on full load. The chief difficulty with the short circuited secondary type of single speed induction motor relates to the starting. This difficulty, however, is almost completely overcome with the multispeed motor having any considerable speed range, if we consider the air gap surface of a motor as arranged respectively for four poles and for two poles. In both cases the air gap density is the same, and therefore the magnetising current taken by the motor remains constant independent of the number of poles.

In the first case four conductors are connected in series each lying in the middle of the pole surface, in the second only two such conductors. If, therefore, we send the same current through the conductors, the densities of the fields in which they lie being the same in both cases, then in the four pole case we obtain twice as much torque as in the two pole case. Hence if we can arrange a motor so that it starts on four poles and runs on two poles it will require only half the starting current to obtain a given starting torque that it would require if it started with two poles. However, if a machine is arranged for two pole and four pole only the effect of such a method of starting will merely be to transfer the heavy rush of current characteristic of the starting of a short circuited secondary type of induction motor from the moment of starting to the moment of changing speed from four pole to two pole, so that the real benefit is not very great.

Intermediate Steps at Starting.

If, however, we introduce a number of intermediate steps between the starting pole number and the running pole number, this current rush at changing speed may be much reduced. For instance, if we start with 16 poles and instead of changing over directly to eight poles for running purposes we change from 16 to 14, 12, 10 and eight in succession, the current rush will be reduced to the very moderate proportions as indicated in the experiments referred to above. In fact the starting performance of a machine of this kind on the step corresponding to 16 poles was 0·775 times full load torque, with 1·88 full load current, whereas had it been started at the top or eight pole speed, it would have required at least four times full load current to give the same torque. Similarly a 15 h.p. three speed motor arranged for four, six and eight poles, will give, with the eight pole connection, 1·7 times full load torque with twice full-load current. With a six-pole connection it gives 2·3 times full-load torque with 3·5 times full-load current, with the four-pole connection it gives three times full-load torque and 8·6 times full-load current. Types of multispeed motor exist according as we arrange the field strength to be constant on all speeds, in which case we get a motor giving constant torque at all speeds, and therefore a horse-power proportional to the speed or a field strength inversely proportional to the speed as in the direct-current motor, in which case we get a similar rating namely constant horse-power at all speeds. For most applications the constant-torque motor presents a notable advantage as compared with the direct-current motor, which will give no more horse-power on the highest speed than at the lowest, yet almost every type of industrial apparatus requires greater horse-power at the higher speeds.

Efficiency and Power Factor.

As regards the question of efficiency, the variation in this, for machines of 20 h.p. and 70 h.p., on full load between top and bottom speed rarely exceeds 10 per cent., and is sometimes well below this figure. In the case of power factor the variation is considerably greater. In the constant-torque type, owing to the constancy of its field strength, the apparatus will absorb a constant magnetising current, whether running at high or at low speeds. By consideration of a series of circle diagrams for such a motor, operating on all polarities from six to 16, it can be shown that with constant power input the power factor will be approximately the same no matter what the number of poles. At low speed, of course, it is impossible to obtain a high power-factor, but this is due to the small horse-power output of the machines. A very great economy in starting current is obtained with the pole-changing motor. On 16 poles the motor absorbs but one-third of the starting current taken with the six-pole connection. On the higher speeds the power-factor is quite equal to that of the single-speed motors of the same rating, but it inevitably falls off considerably on the lower speeds, the range of power-factor from top to bottom speed being something of the order of 20 per cent. in a motor having a speed range of two to one or three to one. This dropping power-factor however is not greater than that usually found between full load and one-third load in many single-speed induction motors.

The Qualities of the Motor.

The qualities of the multispeed induction motor may briefly be summed up as follows : (1) While continuous speed variation is not possible, any number of distinct speeds can be obtained up to about six. On all these speeds which correspond to different pole numbers the efficiency will be approximately the same, declining no more than 10 per cent. between top speed and bottom speed in motors having a speed range of three to one. In large motors these variations will be very much less, say not more than 5 per cent. (2) The power-factor will decline not more than 20 per cent. between the highest and lowest speeds in a small motor having the same speed range. This is mainly due to the fact that the magnetising volt-amperes remain the same at all speeds while the true power input is reduced in proportion to the speed by the reduction of the horse-power output. Again in large motors the variation may not be more than 10 per cent. (3) The rush of current which occurs on changing speed may be minimised by having a sufficient number of speeds, and reduced to say twice full load current momentarily if the steps between adjacent speeds are sufficiently small. (4) The starting torque of a machine with short circuited secondary having a speed range between two to one and three to one will be very much more satisfactory than in a single-speed motor ; full load torque with twice full load current being readily attainable in a motor having a three to one speed range. (5) It is easy to arrange for the multispeed motors to start with resistance control on one of their speeds, switching over to the remaining speeds by means of a contactor panel, so as to entirely avoid any current rush on change in speed. (6) Methods exist whereby motors can be built having resistance control on all speeds. Such motors can be used with phase advancers as unity power-factor machines.

Electrical Advertising.

Ungrammatical and Illogical Copy.

By "ELECTROCYNIC."

To look through the advertising pages of many engineering journals is a sorrowful enterprise, not only for the "high-brow" and literary purist, but also for any man who cares for logical and grammatical phraseology. With certain honourable exceptions, the text of electrical advertising is beneath contempt. The writers seem to be ignorant of the most elementary and fundamental rules of English construction, and the awkward phrases and alarming solecisms which appear over the names of quite reputable firms are often such as would bring discredit upon a child of tender years.

Why is this? It is not always, or even usually, due to the money-saving instinct of the advertiser. Advertisements which are grammatically offensive sometimes cost quite a lot of money for space and preparation, especially the latter. Photography, blockmaking and drawing are expensive items, while in a great many cases one can trace in the lay-out and general appearance of the advertisement the creative genius of some well-known and highly-feed studio. But these carefully designed advertisements fail just as frequently as the most amateurish productions in the matter of text. Perhaps it is that the former are written by professional copy-writers who know nothing about electricity or mechanics, while the latter are the compositions of directors or managers who know nothing about the English language. In either case the result is disastrous.

An Important Superficiality.

Many advertisers will say: "What does it matter if the English isn't quite accurate? It conveys my message in a perfectly understandable fashion." Well, it does matter very considerably. Any statement which is not absolutely grammatical is less easy to understand than it would be if expressed in correct form. The degree of ambiguity or incomprehensibleness may be very slight, but, on analysis, it will be found that mistakes in the construction or punctuation of a sentence inevitably diminish its clearness.

Apart from this, it must be obvious that it is just as important to use good English in the wording of an advertisement as it is to give a good finish to the machine or accessory which is being advertised. Even if we admit (quite wrongly) that in both cases it is merely a matter of appearance, we must also admit that the sales influence of this superficial quality is never negligible, and is often predominant.

There is, of course, a place for the intentional inexactitude which is known as slang; but this is outside the present argument. For the moment I am only concerned with the English which is meant to be serious.

Irrelevant Grandiloquence.

It is, for obvious reasons, impossible to give actual examples of badly written advertisements, and I can therefore only refer in a general way to some of the more common blemishes which afflict electrical propaganda. One case I have in mind is concerned with a large advertiser who takes and misfills whole pages in the engineering press. The text of these advertisements is usually quite irrelevant to the goods advertised. The writer affects a grandiloquent phraseology, and discourses in a somewhat obscure fashion upon various politico-economic subjects. At the end, of course, there is always an attempt made to connect the general essay with the particular article.

Now I do not say that this style of copy-writing is necessarily bad. It is often quite appropriate. But it *is* essential that such copy should be well written. If one wishes to be impressive and rhetorical—to emulate the periods of Burke and Demosthenes—it is advisable to employ a writer who knows how to do this kind of thing in a neat and literate fashion. It is so very easy to lose one's way in a composition of this nature, wherein subject, verb and object are often widely separated by adjectival qualifications and dependent clauses.

Singular or Plural.

In the advertisements referred to, the copy-writer, by the time he has reached the verb, has always forgotten whether his subject is singular or plural. These parts of speech usually disagree in number, and invariably with the literary digestion of the reader.

Another fault was the misuse of long words. I am not one of those who object to long words. As a matter of fact, I always try to make use of a long word where a short one would do (which is not often), partly because I have a natural love for polysyllabic writing, and partly because the habit provides a basis for instructive and some times acrimonious discussions between compositor and proof-reader. Long words, however, usually have quite precise meanings, with which it is advisable to have at least a vague acquaintance before weaving such expressions into the delicate fabric of one's prose.

It is not easy to illustrate what I mean without putting perspicuous readers on the track of the offending advertiser. The most amusing instances can only be described by reference to the articles advertised. And that wouldn't do at all. These are the editorial pages!

Qualifying the Unqualifiable.

One advertiser is rather fond of the word "absolute" and its derivatives. It is a good word with an impressive sound; but, after all, it is not permissible to use words, as Swinburne sometimes did, merely because they look or sound well. Now absolute *means* absolute; but our friend always used the word when he really meant relative. At any rate, he would refer to his product as being "absolutely this or that" and then proceed to qualify the unqualifiable by saying "at the price." This reminds me of a recent advertisement of dances at the Queen's Hall. These were said to be the most "popular and exclusive" dances in London. I cannot imagine what the writer supposes these words to mean; but if the individual words mean anything at all, it is obvious that the phrase means nothing at all.

Another important electrical advertiser (a very enterprising one this, because he advertises in the general as well as the trade press, and his misconceived prose is read by millions of people) has become obsessed with the sales value of mythology.

Gods and the Goods.

Every recent advertisement issued by this company contains a picture and a short description of some mythological incident. A few sentences are devoted to the love affairs of ancient deities. These are quite well phrased, and appear to have been lifted from a book of reference. When, however, the copy-writer has to face, in the second half of his copy, the task of associating, so to speak, the goods with the gods, his prose style degenerates into a muddled illiteracy, which forms a most distressing anti-climax to the classical distinction of the opening sentences.

Reasoning from false premises, or drawing wrong conclusions from correct ones, are, of course, common errors in electrical as in other advertising. This may often be intentional policy, and perhaps hardly comes within the scope of these notes. However, on the more charitable assumption that such mistakes in logic are accidental, I will proceed to examine a single example.

An Absurd Claim.

There is a certain vacuum cleaner, which is advertised as possessing a low-speed, motor-driven brush and a high suction power. Having made these claims, which, so far as I am concerned, are quite indisputable, the advertisement goes on to say that the possession of these two features places the sweeper in a class by itself. If this means anything at all, it means that no other vacuum cleaner shares these characteristics. Surely such a conclusion is entirely wrong. Why is the claim made? No electrical reader (the advertisement appeared in an electrical paper) could for a moment believe a statement of this kind; and its inclusion in the copy only weakens the main argument. Presumably this copy was written by an advertising "expert" who knew nothing about the general mechanical principles of vacuum cleaners. Such a sweeping statement, even when made in respect of a sweeping device, should be checked by some competent person before it is published.

A Providential Sequence of Events.

And then there is the sort of copy which is simply idiotic. I was about to close this article when my eye was irresistibly drawn to an advertisement in an electrical journal which had just arrived. The boy had placed it on my desk, and the wind had fluttered the leaves so that an inside page was exposed to my wondering view. Without this providential sequence of events, I should have missed the gem of copy-writing ineptitude with which I now present my readers. The advertisement referred to an important piece of control apparatus. Many and complex are the qualities claimed for this appliance, but priority in the tabulated list of advantages was given to this meaningless absurdity: "First in Originality." Why not "Original in Firstness" or "First in Primariness"?

The Literary Technician.

The copy is the most important part of any technical advertisement and should be given a proportionate amount of consideration. Instead, those electrical advertisers who are willing to pay for skilled assistance, appear to be in the habit of dissipating their several allocations amongst that curious fraternity of artists and lay-out men which has succeeded in obscuring the essential purpose of publicity, and to have none to spare for the adequate remuneration of the expert copy-writer. It is quite a mistake to suppose that any director or manager can, by virtue of his position, write good copy. Neither can the non-technical copy-writer produce satisfactory copy on technical or semi-technical subjects. What is wanted is that super-copy-writer—the literary technician with a sense of advertising; and until the electrical industry has caught a sufficient number of these rare birds, electrical publicity will continue to suffer from illiteracy, technical ignorance, or both. I believe this *rara avis* is to be caught by the time-honoured method; but the salt must be applied generously and with proper regard for the dignity of the literary art.

Modern Marine Wireless Apparatus.

In the Kelvin lecture which he recently delivered before the Institution of Electrical Engineers, Dr. C. V. Drysdale gave some account of the work that is being done in increasing the safety of life at sea. It must, however, be realised that a great deal has already been done in this direction, mainly through the agency of wireless telegraph equipment whose installation has now been made compulsory on all British merchant ships. This requirement has resulted in the exercise of considerable ingenuity on the part of designers and we describe below the apparatus which Messrs. SIEMENS BROTHERS & COMPANY have found satisfactory for this purpose.

It may be broadly stated that the essential requirements for a ship station are ;—(1) compactness of the apparatus, (2) simplicity of operation, and (3) robustness, combined with sensitiveness while, apart from the question of safety mentioned above, the carrying of such apparatus facilitates position fixing, the calibration of chronometers and the transmission and reception of weather reports.

In the design of their apparatus, Messrs Siemens use a special spark-gap system in which it will be remembered only one wave is generated in the aerial, and the whole of the energy is utilised in this one active wave. A much higher efficiency is thus obtained than is possible with the older forms of spark gap, which produce two waves, only one of which is utilised. The frequency of the impulses producing the energy in the aerial being very high, viz., 1 000 per second, the same amount of energy can be produced in the aerial with very much lower electric potential in the transmitting apparatus, which therefore may be made smaller and more compact. The equipment further possesses the advantages of using compact transmitting apparatus and a small antenna. Owing to the fact that the distance between the plates of the spark gap is only about 0·2 mm. the spark gap works almost noiselessly and no special sound-proof cabin is therefore required. Another useful point is that long working range in relation to the size of the antenna and power consumed is obtainable, while there is great simplicity in operation and consequent freedom from breakdown. By using harmonically generated waves and a high note the signals can be the more easily distinguished from atmospheric discharges, which is naturally of great importance. Finally, Messrs. Siemens guarantee high efficiency of transmission, a figure of between 50 to 75 per cent., according to the size of the station, being obtainable.

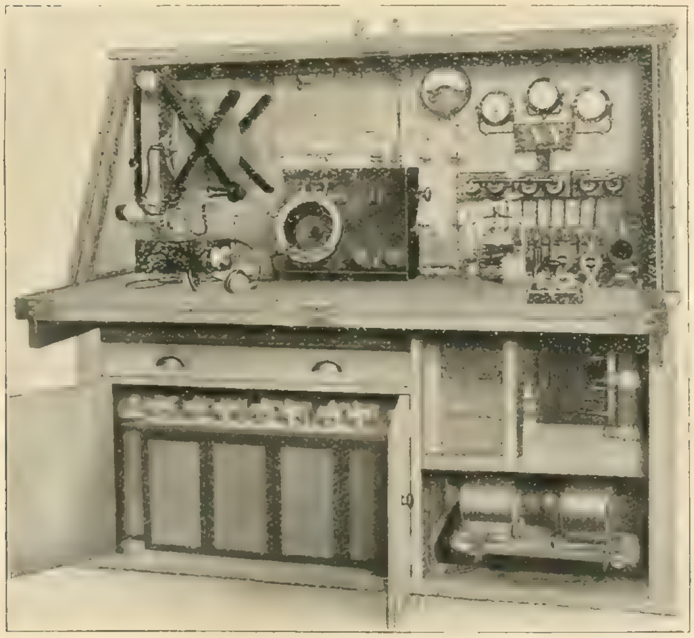

FIG. 1 —SIEMENS "A" STATION READY FOR USE.

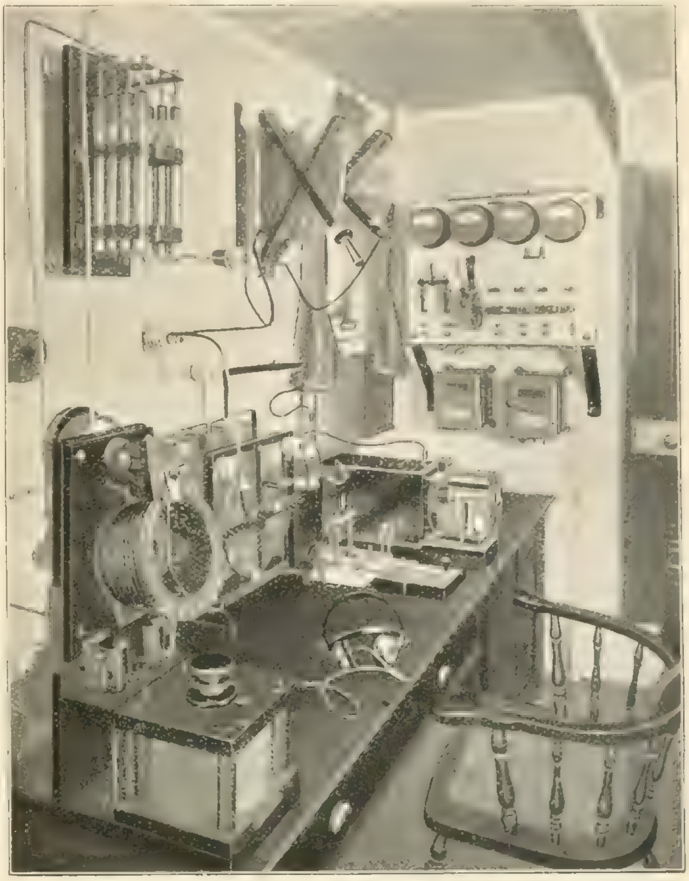

FIG. 2 —WIRELESS CABIN ON S.S. "MANDASOR."

The wireless sets designed by Messrs. Siemens Brothers & Company are made in three sizes. Fig. 1 illustrates a type A station, which is operated from a 50-V battery of accumulators which is stored in the bottom left-hand compartment of the cabinet. The motor-generator consists of a direct-current motor driving a 500 cycle $\frac{1}{4}$-kW generator. The excitation circuit consists of four specially insulated glass condensers, an inductance and quenched spark gap. An aerial lengthening variometer is included, enabling very accurate adjustment of the wave length emitted to be made.

An aural receiver with contact detector is employed. This receiver, which has a wave-range of from 200-2,000 metres, provides a wide range of variation of coupling, enabling very exact tuning to be obtained. A valve amplifier set can be fitted as an extra if required.

In the size B set, which is suitable for somewhat larger vessels, the excitation circuit consists of jar capacities, a 6-gap spark gap and a variable self-induction coil. The latter carried several plug sockets for various waves. The wave range of the station is normally from 300 to 900 metres, but this can be extended to 1,800 metres, by means of a fixed self-induction coil. An aural receiver with contact detector is employed, thus providing a wide range of variation of coupling, enabling very exact tuning to be obtained. This receiver has a wave range of from 200-2,000 metres.

In size D, which is suitable for passenger and merchant vessels, a variable speed generator is used for adjusting the pitch of the transmitted signals, while the spark frequency is regulated by means of the excitation of the generator. Sharpness of tuning is obtained by means of a primary coil in the low-tension circuit. The excitation circuit consists of jar capacities, an 8-gap spark gap and a variable self-induction coil. The wave range of the station is normally from 300 to 900 metres, but this can be extended to 1,800 metres by means of a fixed self-induction coil. Transmission is carried out by means of a key which operates a relay in the transformer primary circuit. This relay is of special construction in order to carry the large amount of current used for the station.

Emergency apparatus consisting of a battery and induction coil can be supplied with the two last sets we have described for use when the ship's dynamos are not running.

Fig. 2 shows a view in a modern wireless cabin equipped with Siemens apparatus.

A System of Railway Traffic Control by Telephone.*

By T. F. LEE.

Railway traffic consists roughly of two classes: The passenger service, run to a definite pre-arranged time-table, and the freight or goods service, run as required. With the former the control is simple, as passenger trains are timed for all points on the route, and travel repeatedly the same journey under similar conditions; but the freight service is irregular, as varying quantities and classes of goods arrive at all times all along the route, and the handling of these goods is a very different matter from loading and unloading passenger trains.

The quantity and class of goods, many of which are perishable and require immediate treatment, vary enormously from day to day, so that it is impossible to deal with goods traffic on a set time-table basis. The problem of using the available locomotives, wagons, shunting facilities, &c., to the best advantage, at the same time obtaining rapid service, is a very difficult one and of the greatest importance to railway companies.

This article deals with a system for controlling this goods traffic. It is not surprising that telegraph control was at one time almost universally employed in this work. It has, however, been steadily giving way to various control systems depending on telephones, and specially efficient instruments and various forms of signalling from one instrument to another have been developed. Generally this control is obtained by linking up the various points on the line by means of a single pair of wires, looping telephones across the wires at the required intervals, and arranging some form of call whereby one telephone can ring up another either by code or preferably by a selective system enabling one instrument to ring another without disturbing the remaining telephones.

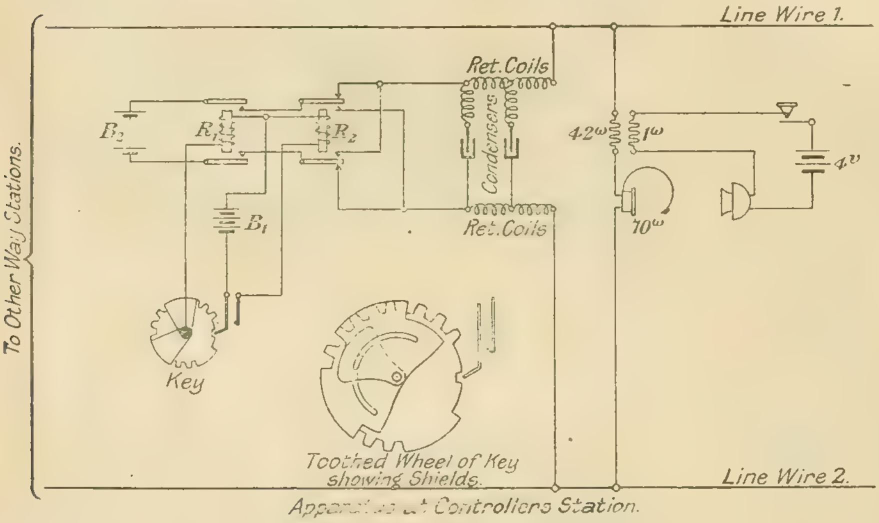

Fig. 1.—Circuit of Traffic Control System.

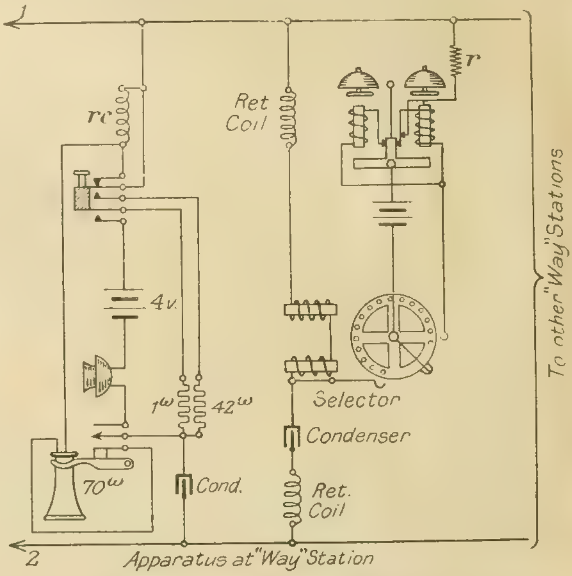

Fig. 2.—Mechanism of Selector Fitted at "Way" Stations.

There are in use several ingenious methods of effecting this selective call, the most obvious being by means of polarised relays or bells arranged, some across the line, and some between the wires and earth. This scheme has given good results, but is easily affected by line faults which are unavoidable in open line construction—such faults, for example, as intermittent and accidental "earths." Unfortunately these faults are very prevalent during bad weather, and it is just at these times that the control is most urgently wanted.

The system to be described was developed jointly by telephone and railway engineers to combine efficient apparatus with a practical scheme of control, and independent of "earth" connections. The actual method of handling traffic naturally varies with different railway companies, but the system in use with one of the largest English companies will serve to illustrate the general principle. The line is divided into sections and a controller appointed for each section. This controller has complete charge of the goods traffic on his section; no movement of trains, locomotives, wagons, &c., may be made without his knowledge, and in any case of doubt as to the best procedure his decision is final. In front of his desk is a large-scale map of the section mounted vertically on a board and showing the position and wagon capacity of all sidings, goods stations and so on. By means of clips, pin-flags or similar devices, representing trains, locomotives, &c., he can show the position of all the traffic on his section and can follow up the movements from time to time.

The telephone line on which his instrument is connected runs completely round the section, and at various signal-boxes, shunting-yards and such other points as are necessary, other telephones known as way-station telephones are located. The controller is always connected to the line by means of his head receiver and chest transmitter, and has before him a cabinet of keys, each key associated with a one-way station telephone. By giving any key a quarter of a turn and then releasing it the bell at the way station controlled by that key and no other bell rings. The way-station man need not ring up the controller, as he has only to listen to ascertain if the line is free, and then to speak to the controller.

In order to follow out the movements, imagine that a signalman has noted a goods train passing his box. He passes on the train, noting its number or other necessary details, removes his receiver, listens to ascertain that the line is free, and, if so, reports to the controller, who moves a flag on the map and logs the movement. Possibly further down the line there are trucks to be added to this train, and by operating one key the controller can advise the man in charge of the trucks that a train will be calling there at a certain time, while the operation of a second key will put him in communication with another point where the train guard can be advised of the number of trucks waiting for him to pick up. Thus, the controller literally controls his section. In order to make his authority complete no means of calling from one way station to another is provided, and way-station men are not allowed to use the line for intercommunication.

It is usually arranged that when the controller is away from his desk he removes his telephone, and the action of withdrawing his instrument plug throws into circuit a bell, lamp or loud-speaking receiver, so that a way-station man can give a visual or audible signal indicating that the controller is required.

Referring now to the actual apparatus and circuits by which these results are obtained, the controller's selector keys may first be considered. Each key consists essentially of a toothed wheel and two contact springs, one of which presses against the teeth so that as the wheel rotates contact between the two springs is made and broken. The rotation of the toothed wheel is controlled by a train of gear wheels, a clock spring and a small governor, and the "winding up" is effected by giving the handle a quarter turn. On being released the wheel rotates a full revolution at a constant speed, the contact springs controlling two circuits, one a local relay circuit, and the other a circuit formed by connecting a fairly high voltage battery across the line.

Fig. 1 shows that relay R_1 is operated for the whole revolution of the key, since the long spring is making contact with the body of the toothed wheel, either through the tops or roots of the teeth, except when the key comes to rest and the spring slips into the gap *a*. This relay places the battery B_2 across the line, through the contacts of R_2, the circuit of which is broken as the long and short springs on the key are brought together, or separated, by riding over the teeth. As the key rotates the polarity of the line wires is reversed as each tooth is passed. This reversal of polarity will be referred to as "sending positive and negative impulses to line."

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* Abstract of a Paper read before the Institution of Post Office Electrical Engineers.

In order to observe the effect produced at the way stations, consider first the action of the selector—that is, the apparatus which responds to the current impulses. Fig. 2 shows diagrammatically the essential working portion of this selector. The armature is polarised, but to simplify the diagram the polarising magnet is omitted. The driving pawl p_1 presses the toothed wheel forward, whether the armature is attracted to the right or left coil of the electro-magnet, driving pin d_1, actuating the pawl in the former case and driving pin d_2 in the latter. Pawl p_2 is only a holding pawl, resting under one of the teeth of the wheel, preventing it from returning once it has been advanced by p_1, and only leaving the wheel free when the armature is in its zero position, which is parallel to the magnet-pole faces. In this zero or normal position p_2 is held off the toothed wheel by d_4, but as soon as p_1 moves forward p_2 is freed, moves forward, and engages with the teeth of the wheel. When a positive current impulse is received on one line wire the armature will be attracted to the left-hand magnet coil, and the toothed wheel will be advanced one tooth, carrying with it ring R, which will advance one hole. The toothed wheel and ring R are rotated against the tension of the coil spring, which tends to return them to the zero position. The positive impulse will be followed by a negative impulse which will attract the armature to the right-hand coil, and during the reversal from the positive to the negative impulse the armature will pass its zero position, at which position p_1 and p_2 will release the toothed wheel, catching it again and advancing it another tooth as the negative impulse attracts the armature to the right-hand coil. The wheel will be released by p_2 for such a short period that it will not have time to fall back, as it would do under the action of the coil spring if free, but will be caught again by p_1. If the positive and negative impulses are continued, the wheel, and with it the ring R, can be rotated for a complete revolution, but if at any time the impulses are stopped, either by cutting off the battery, or by stopping the movement of the armature of relay R_2 (Fig. 1), the selector armature will remain in its zero position sufficiently long for the toothed wheel to be freed from the two pawls, and the coil spring will bring it back to zero unless it is stopped by some mechanical brake.

S_1, S_2 and S_3 are three pins in the ring R, and b is a broke spring pressing against d_3, and therefore moving backwards and forwards with the current impulses. It will be noted that S_1 is in the 5th hole, S_2 in the 5th+8th=13th hole, and S_3 in the 5th+8th+4th=17th hole in the ring. Pins S_1 and S_2 can be set in any holes, but S_3 is fixed.

Now if five impulses are sent out to line the ring R advances five holes, and if the impulses are then stopped the ring would return to zero, but as d_3 falls back, brake b also falls back and catches stop S_1, holding the ring and toothed wheel in place. If eight more impulses are sent out the same thing happens again and b catches S_2, and when four more impulses are sent brake b catches stop S_3, and at the same time contacts C_1 and C_2 come together and close a local bell circuit. One or two more impulses after the bell has rung long enough, will advance the ring again, and when the impulses cease, as there is no stop for the brake to catch, the ring will return to zero.

In order to control these impulses and send them out in the groups required, each selector key is fitted with narrow adjustable metal segments or shields, affixed to the side of the toothed wheel, and reaching to the circumference formed by the tops of the teeth, so that the spring, when passing over a shield, cannot ride up and down over the teeth, but keeps the contacts closed. During this closed contact period no impulses go to the line.

Fig. 3 shows the face of the toothed wheel of the key, and makes clear the action of the selection keys and selectors. When the key is operated the long spring first makes contact on leaving slot a, thereby completing the circuit through relay R_1, so placing the battery B_2 across the line, as already explained. The long spring then rides over the first group of teeth operating relay R_2 and sending alternately positive and negative impulses to the selectors, which all operate as already explained. The key springs then pass over the first shield, during which time no impulses are sent out, and the selectors return to zero, except the few that are caught by suitably arranged stops. The second group of impulses then passes out, and the selectors move forward again, some only to fall back to zero once more as the second shield is passed over. Finally the third group of impulses is sent, and by the time these are finished the selection of the instrument required will have completed its local bell circuit, and the bell will ring while the key springs pass over from C to D. After this, the impulses sent by the spring passing from D to slot a will release the chosen selector, and this will return to its normal position.

Batteries B_1 and B_2 both consist of dry cells, the voltage of B_1 being about 8 and that of B_2 varying from 100 to 200 according to the length of the line and number of stations fitted. The condensers in series with the selectors should next be mentioned. Their function is an important one, as it is the charging of these, first positively and then negatively, which gives the impulses of current operating the selectors. As current is only taken from B_2 at certain intervals while R_2 is operating, the actual amount of current used is very small, due to the stoppage of all direct current by the condensers, and the battery lasts for several months. The selectors have an ohmic resistance of about 15,000 ohms. The impedance of a selector and condenser at selective frequency, which is 3½ periods per second, is about 25,000 ohms, and at talking frequency over 1 megohm.

The arrangements shown in Figs. 1 and 2 are almost self-explanatory as regards the telephone circuit, the main feature of which is the provision of a separate speaking and listening circuit at the way stations. The controller's circuit is practically a regular local battery circuit. The way-station man presses the button on his telephone when speaking, and releases it when listening, but it will be seen that the retardation coil (*r.c.*) prevents an absolute break in the listening circuit, when the transmitter circuit is in use, and the user can just hear if the controller wishes to break in on his conversation.

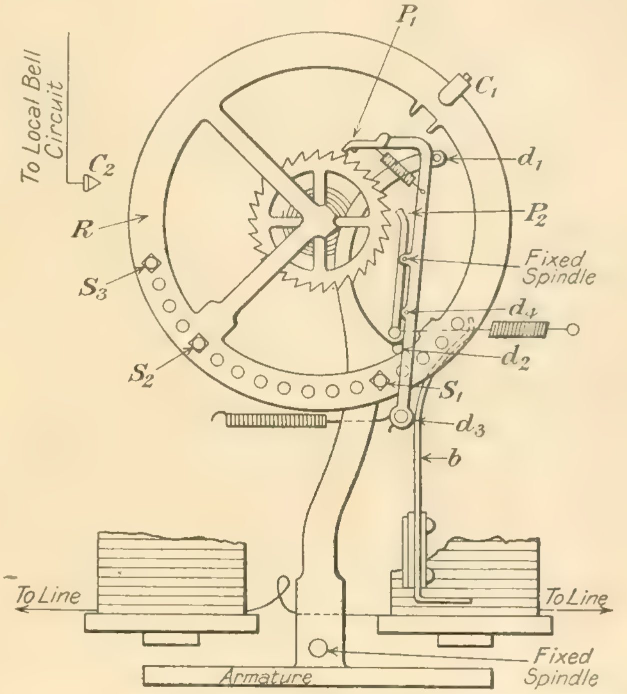


FIG. 3. ENLARGED SKETCH OF TEETH AND SHIELDS ON CONTROLLER'S SELECTOR KEY.

The telephone apparatus used, and the circuit described above, give exceedingly clear speaking with entire freedom from side noises, and the length of standard cable over which conversation can be carried on is rather longer than in the case of ordinary telephones.

One interesting feature is seen by referring to the resistance r in Fig. 2 in connection with the way-station bell. While the bell is ringing, there is a change in the potential of the line sufficient to cause a low buzzing in the controller's receiver, and by this means he can hear quite plainly when the bell of the selected station rings. In practice protectors are fitted at each telephone, a small circuit-breaker cuts off the main battery in case of a short circuit on the line, and double pole switches are so placed that any faulty way-station outfit can be cut out, leaving the line and the remaining telephones working.

The following brief facts will give an idea of the wide limits permissible and the flexibility of the system. Any selector can be set so as to be selected by any one of 78 groups of impulses when the ordinary standard selector and selector keys are used, and as in this country more than 35 way stations are seldom under the care of one controller, practical requirements are more than met. By a slight alteration to the selector and key, however, as many as 253 selectors are possible.

On a line of 150 lb. copper 80 miles long with a battery of 100 volts about 20 stations can be fitted, and if the voltage is raised to 200 volts 50 stations can be fitted.

On an average line, on which a 100-volt battery is suitable, from 10 to 20 stations can be equipped, and will be working under economical conditions.

The number can be reduced to 5, and still the operation will be quite satisfactory, although the voltage will be too high for economical working.

A controller, by means of a 17-impulse key, can call at all stations at once to give general instructions.

The quality of transmission with all stations on the line at one time will depend on the length of line and number of stations, but no difficulty has been experienced in using this service on the English railways, where the number of stations seldom exceeds 35 and the length of line (open wire) does not exceed 100 loop miles.

Reviews.

The Theory of Electric Cables and Networks. By Alexander Russell, M.A., D.Sc. Second Edition. (London: Constable & Co.) Pp. x.+348. 24s. net.

When this work was first published about 11 years ago, the chief criticism of it was that, on account of its somewhat heterogeneous character, it was more in the nature of a collation of valuable—but hitherto scattered—information upon a large number of branches of the subject, than a systematic treatise. While this was true in detail, the reviewer has always regarded the work as an excellent example of one of those more or less slender bridges across the gulf which divides purely scientific from technological work, and which slowly, but surely will exert a beneficial influence on all branches of industry.

Regarded from this point of view, the value of the work is on a very high plane, because in the first place each phase or section of it is dealt with in the lucid and comprehensive manner with which one associates the author of "The Theory of Alternating Currents," and secondly, because the gathering together of the best theoretical work bearing on the broad subject indicated by the title, forms a key to the literature of the subject for those who may desire to pursue its numerous ramifications. Its value from this latter point of view is enhanced because of the great, and it may be said characteristic, care bestowed by the author on bibliography and references.

The production of this second edition has entailed an appreciable amount of supplementary work. Besides two additional chapters—on "Alternating Currents" and "Systems of Supply" respectively— a large number of additions and alterations have been made in order to keep various parts of the work abreast of the developments of recent years.

These modifications tend to counter the criticism above referred to. A little more attention might, however, with advantage, have been paid to those parts of the work which occasionally refer to technical or manufacturing points; for example, on pages 32 and 74 the old erroneous idea is perpetuated that the tinning of copper wires for use in vulcanised rubber cables is performed for the purpose of preventing attack of free sulphur on the copper conductor, whereas the real reason is to prevent the catalytic oxidation of the rubber by the copper. Although one would not use this book as a guide to manufacture, such a statement as this should not have appeared in a modern work. Generally, the occasional references to manufacturing points are open to improvement.

The modifications to the first two chapters (on "Fundamental Principles" and "Conductivity" respectively) chiefly relate to the recently revised data of the B.E.S.A. (revised July 1919) on insulated annealed copper conductors. A new short section on "Computing Resistances at Various Temperatures" is also embodied. In Chap. 3, on "Insulativity" new paragraphs on the effect of humidity, dielectric absorption, surface leakage and on chemical changes due to exposure to light are added to the existing information regarding insulation resistance and the bearing thereon of the design of insulating coverings (as regards thickness) and methods of testing. On page 69, line 3, in connection with the I.E.E. Rules regarding permissible dielectric temperatures, there is an obvious slip. ("The maximum permissible *rise of* temperature for rubber is 130°F. . . . " should read "The maximum permissible temperature . . . ").

The new chapter on "Alternating Currents," chapter 4, is rather condensed, but fairly adequate for the purpose in view. The succeeding chapter (also a new one) on "Systems of Supply" is quite elementary, but more or less leads up to the next chapter on "Distributing Networks," is handled in the author's characteristic style and to it has been added general theorems and some numerical examples. The following three chapters on "Insulation Resistance of House Wiring," "Networks" and "Faults in Networks," remain as before, except that the first mentioned has been brought up to date by reference to the I.E.E. Wiring Rules of 1918.

The next three Chapters, X., XI. and XII., are perhaps the most important in the book. They deal with dielectric strength, grading and the heating of cables; and here the author is at his best, for no one has done more than he to elucidate these fundamental factors in cable design. In Chapter X. paragraphs have been deleted which dealt with the dielectric strength of liquids and of isotropic and æolotropic solids. The reason for this is not apparent. Data has been added on the dielectric strength of air and on sparking voltages between spheres of various sizes, the latter being based on the author's own work and on his analysis of the results of Heydweiller and those published in the American Standardisation Rules of 1918.

Under "grading" a criticism of Jona's well-known method regarding the constancy of the dielectric coefficients of the layers of various insulating materials over a period of years is followed by other new matter dealing with the conducting layer method of grading, to which considerable prominence was given in an I.E.E. Paper by the reviewer in 1914. The author deals with the proportioning of such cables, the potential of the conducting layers, and the condenser or charging currents therein, and gives numerical examples. The particular value of this method of grading for high tension direct currents is also referred to. Some extra notes have been embodied under "The Heating of cables," viz., on the fusing current of a wire, variable resistivity, and on the heating of insulated wire. In connection with the latter, the apparently paradoxical effect of cooling a wire under certain conditions of size and thermal conductivity by covering it with insulating material is noted, but no mention is made of the fact that this was originally predicted by Lord Kelvin and later experimentally proved by Prof. Porter.

The concluding chapters on "Electric Safety Valves" and "Lightning Conductors" remain as in the first edition. While of considerable interest, they seem to be somewhat out of focus with the rest of the work. The book is, however, one of such character, interest and value that it should find a place in the library of every electrical engineer and student of electrical engineering, especially in view of the "key" character of its contents, already referred to.

C. J. Beaver.

Electric Switch and Controlling Gear. By Dr. C. C. Garrard. (London: Benn Brothers, Ltd.) 2nd edition. Pp. xxii.+654. 25s.

The second edition of Dr. Garrard's book is a worthy successor to the first. The author states in his note to the former that "it has not been found necessary to make any considerable alterations," but the reader will find that many additions have been made, bringing the book up to date by describing various new appliances and the results of standardisation, &c.

Four years have elapsed since the issue of the first edition, and this period, more than any other of equal length, has forced home the importance of the electrical industry in the economic life of the nations, with the result that the tendency now is to construct electrical power stations of much greater capacity and higher voltages than hitherto. The design and application of switching and control apparatus have therefore become problems of great importance, and it is imperative that the manufacturers of this country prepare to meet the competition of other countries, whose engineers have had more opportunities of obtaining the necessary experience in E.H.T. and large capacity stations than the engineers of this country. On this account we should have welcomed in a second edition of Dr. Garrard's book more information on the design of high-breaking capacity oil switches, E.H.T. transmission and outdoor switching apparatus. The importance of the work covered by these sections is apparent to all interested in the industry, and we can only assume that lack of space prevented Dr. Garrard from dealing with them more fully.

The volume contains 120 illustrations and diagrams more than the original one, and these largely indicate the numerous additions made. The standardisation of switchgear and control apparatus by the British Electrical Standards Association has made considerable progress, and the findings of this association as covered by the printed specifications have been included where desirable. An appendix giving a list of the published specifications is also a useful addition. The use of automatic field switches in connection with the protection of alternators, also the Beard patents of compensated pilots for Merz-Price balanced voltage and the self-balancing protective systems are added and fully described in Chapter III.

In Chapter V., dealing with starting and controlling apparatus, many additions are made describing various devices for inching starters, step-by-step devices, creeping speeds; also a new section on contactor gear. Chapters VI., VII. and VIII., descriptions of large battery switches, outdoor type sub-stations of very small capacity, modern types of lightning arresters, and the special products of the Railway & Industrial Engineering Company, U.S.A., have been included.

The field indicated by the title of this book is an extremely large one, and it is only pssoible in one of this size to treat the principles of design in a very limited way, but sufficiently to make the book extremely useful to manufacturers as well as purchasers and users. There are very few books which deal with the design of switchgear and controlling apparatus, and Dr. Garrard is to be congratulated on producing one which covers so wide a field, and is capable of use by so many interested in the subject.

F. F. Evans.

"The Elements of Electro Technics." By A. P. Young, O.B.E., M.I.E.E. (London: Sir Isaac Pitman & Sons, Ltd.) Pp. viii + 348. 7s. 6d. net.

The amount of "information" contained in Mr. Young's book is amazingly large and varied. According to the description of the cover-sheet this book "explains in simple language the fundamental principles of the electrical industry and abounds with practical illustrations." But, so far from "explaining," the book flings "information" at us, as from a machine gun. We are told that electrical power is EI; we are given details of standard calls; the copper and aluminium output of different countries are hurled at us all ready made, followed by details of submarine cables; expressions for eddy current and hysteresis losses rapidly give place to an expression for the damping force of an eddy current brake; the E.M.F. of self-induction is introduced to us as $= -L\left(\frac{di}{dt}\right)$; graphic methods of finding accelerations and curves showing displacement velocity and accelerations switch us off to electric traction—and we turn back to read the title of the book and the description on the cover-sheet.

An electrical pocket-book is not intended as a text-book, nor does it profess to "explain"; it is only intended for the use of those to whom "the fundamental principles of the electrical industry" are already well known. Mr. Young's book would not be any more helpful as an explanatory treatise of the elements of electro-technics than the average pocket book. And the average pocket book is more convenient.

J. Paley Yorke.

Controllers for Electric Motors. By H. D. James. (London: Crosby, Lockwood & Son.) Pp. xiv. + 354. 21s. net.

The sub-title of this American book, "A Treatise on the Modern Industrial Controller, together with Typical Applications to the Industries," explains pretty well its contents. The greater part of the subject matter appeared in the "Electric Journal" in 1917 and 1918 in the form of a series of articles, and this statement probably gives a fairly good idea of class and quality of the work. There are 26 chapters in all; the early ones deal chiefly with principles and the remainder with applications. Numerous types of controllers are described and illustrated by photographs of the actual apparatus.

Thus there are separate chapters on mine hoists, hydraulic pumps, machine tools, printing presses, mills, cranes, bridges, elevators, &c. The treatment throughout is descriptive—the author very rarely touches upon the analytical side, nor does he concern himself with the actual calculation of resistances. While it would be going too far to describe the book as a textbook on switchgear, there is much more information in it than would be found in most trade publications. Also, from time to time, the author puts forward good suggestions, as, for example, when he advocates simplicity in control gear, and gives useful information, as when he discusses the number of steps in a starter. The chapter on "how to read controller diagrams" should prove very helpful. The book will doubtless be consulted by many who are interested in switchgear, and their main grievance will probably be that the author has not gone far enough to satisfy their needs.

Stanley Parker Smith.

Shorter Notices.

Experimental Science. Section V.: Light. By S. E. Brown. (Cambridge University Press.) Pp. vi.+151. 6s. net.

Any book that is produced by the Cambridge University Press is worthy of close attention. The particular book under notice forms Section V. of the Experimental Science series, which has been written by Mr. S. E. Brown. It is intended to form a laboratory course in the subject of optics for pupils preparing for the school certificate or matriculation examination. The book is well and clearly written and illustrated. The experiments seem to be of a practical and informative nature, and each chapter is completed by a series of questions which have mainly been already asked in examinations. But considering the number of similar text-books already on the market we wonder whether the production of yet another is really worth while.

The Motor Cyclists' A.B.C. Edited by Horace Wyatt. (London: George Newnes, Ltd.) Pp. 164. 2s. net.

In the few months that followed the Armistice the number of motor cyclists on the road increased, and the number of people driving motor cycles who had never driven such equipment before increased in an even greater proportion. It is for the instruction of such people that the Motor Cyclists' A.B.C., edited by Mr. Horace Wyatt, is produced. After three short chapters dealing with principles generally the remainder of the book is arranged on what we believe is called the child's guide to knowledge principles. The work is well done.

Correspondence.

FIBRES IN OILS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In connection with the article on "The Deleterious Effect of Fibres on the Electric Insulating Power of Oils," in The Electrician for March 18th, it may be of interest to record that the phenomena investigated by Prof. McLaughlin have been under observation in our laboratories for some months past, and that our deductions coincide very closely with those of the author.

In addition to examining the effect on dielectric resistance we have carried the matter further in connection with the actual breakdown strength of the oil. Instead, however, of using a microscope, which would be impossible when using high pressures, because of the personal risk and the disturbance of the field under examination, we project an enlarged image of the oil gap on to a screen, and are thus able to watch the fibres assemble on the application of the stress until the rope-like path formed between the electrodes is broken down and scattered by the discharge.

There can be no doubt that some of the curious effects which investigators on liquid dielectrics have attributed to absorption, temperature change, &c., have been largely due to the presence of more or less damp microscopic fibres, either left in the oil by refiners—possibly from the papers of the filter presses—or detached from rags used in cleaning the testing apparatus.—I am, &c.,

P. DUNSHEATH.

Research Dept., W. T. Henley's Telegraph Co.,
March 21st, 1921.

SYNCHRONOUS INDUCTION MOTORS AND POWER FACTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the "Electrical World" for November 20th, 1920, a very interesting series of tests, carried out at the Yale University, U.S.A., on an ordinary induction motor, supplied with continuous current to the slip rings, was published. Messrs. Warner and Knowlton, who carried out these tests, are to be congratulated on the intelligent way in which they have appreciated the difficulties which prevent supply engineers from doing anything on a large scale to improve the power factor of their stations, and on the manner in which they have in their Paper expressed these difficulties; but, unfortunately, there is still a lot of valuable information which they have not given, and possibly cannot give.

Surely, Sir, here is an opportunity where some of our many British university and other laboratories might do something to help the supply engineers of our own country. For instance:—

(1) The tests were only carried out on a 10-H.P. motor; how would they show up on a 100-H.P. motor, and with what result if the rotor were delta-wound?

(2) The constant excitation at which the tests were carried out, using only two limbs of the star, appears to have been fixed too low, apparently with the object either of improving the overall efficiency or of reducing the leading current at the lightest loads; but it is not made clear what is the exact load at which the motors become unstable, in regular running, with this particular current and with the *rotor* used as field.

(3) Similar information is wanted with respect to the load limits at synchronising; in other words, how much extra exciting current is required for additional load during this operation.

(4) What are the absolute limits to the exciting current which are fixed by the heating of the rotor windings?

It would surely well repay our universities, &c., to ascertain further particulars regarding these, and many other, points of interest to supply engineers, and to publish them.—I am, &c.,

Birmingham, March 22nd. A. M. TAYLOR,
Hon. Major.

New Premises of the General Electric Company.

We are informed that the GENERAL ELECTRIC COMPANY will move their head offices, sales department and stores to Magnet House, Kingsway, London, W.C.2, on and after Monday next, April 4. Those interested are cordially invited to visit Magnet House at their earliest convenience. The main entrance to the premises is in Kingsway, with a goods entrance in Keeley-street. The telephone number is Regent 7050 (50 lines) and the telegraphic address is Electricity, Westcent, London. Until further notice the showrooms of the Company will remain at 67, Queen Victoria-street, London, E.C.4.

Electrically-Driven Gramophones.

The latest development in the electric drive comes, as might be expected, from America, where we understand a large business is being done in operating gramophones by this means. The motors used can be fitted to any sort of gramophone and are provided with an automatic stopping switch, so that not only is the apparatus safeguarded, but the cost of operation is reduced to about ½ per cent. per hour. Considering the large number of expensive gramophones which are being now sold in this country, to be used in almost every conceivable circumstance, this seems a possible outlet for the fractional horse-power motor makers of which will please note.

Dundee's Electricity Undertaking.

The future extension of the electricity undertaking was discussed at some length by Dundee Corporation last week. In the course of a long and lucid explanation, the convener of the Electricity Committee (Mr. Hynd) pointed out that during the past winter the plant, with its nominal capacity of 10 000 kW, had had several times to carry a load of 11 200 kW, and if trade had remained normal the output for the current year would have approximated 28 million units. The overload had been carried at a considerable risk of breakdown, and had entailed a great deal of careful supervision and management on the part of the engineer and his staff. Before next winter the capacity of the plant would have increased to 15 000 kW, and the possible output to 39½ or 40 million units. They had in sight a load of 3 000 kW and demands for 1 000 to 2 000 kW were under consideration, besides the natural increase on existing installations. Under normal conditions they reckoned on the new plant being equal to the load of 1922-23. The plant would probably be taxed to its uttermost, as it was last winter, but he thought the Council would be justified in risking a few months' delay in order to see how the demand actually developed, and to see if they could get better terms both as regards price and delivery.

SUGGESTED WATER-POWER SCHEME.

Mr. Hynd reminded the Council that a little over a year ago he submitted a report as to water-power being utilised, and a sub-committee had been authorised to continue the investigations. The electricity department had at no time propounded any water-power scheme, nor had anybody connected with it; but they were now in a position to make a definite recommendation. Two alternatives were open for consideration—first, development by the city; second, purchase from another source. As regarded development by the city, the cheapest available water-power was the Loch Ericht scheme, and that might be ready in time to take up the 1925 load of 50 million units. The bare cost of the current would be 0·5d. per unit; but there would be no load for the steam plant, so that 0·18d. would require to be added as the cost of leaving that idle. The cost of supply for 1925 would, therefore, be 0·68d., compared with 0·63d. if generated by steam. By 1930 the demand might overtake the capacity of both steam and water plants, say, 100 million units, and the cost would be 0·61d., compared with 0·72d. if generated by steam alone. In the six years 1925–30, the result would be: In the first three years, a loss as compared with steam generation; in the last three, a saving, so that in respect of those six years the consumer would have gained little or nothing; but the city would have laid out £1 760 000 instead of £1 060 000. At the end of six years they would have effected a saving of 0·11d. per unit if the price of coal remained as at present, and the constructional cost of the water scheme were as estimated. A drop of 10s. in the price of coal would wipe out the saving of 0·11d., and if they had to pay 7 per cent. instead of 6 per cent. for capital, that would wipe out half of it, and an error of 10 per cent. in the estimated cost of the water scheme would wipe out the other half. Including distribution costs (which remained the same for water or steam), the average cost of current at present was 1·6d. per unit. It was obvious that they could not strain the credit of the city to the extent of three-quarters of a million, and to take all the risks involved in order to secure after 1930 that very problematical reduction from 1·6d. to 1·5d. per unit.

BULK SUPPLY FROM THE GRAMPIANS COMPANY.

As to the possibility of purchasing in bulk from another source, Mr. Hynd said that the Grampians Company had suggested that they might be in a position to meet the city's wants. If the city could buy in bulk from the company at a price not greater than the cost of generation by steam, under varying conditions, on terms which would protect the Council against any possible variations, with suitable guarantees as to permanency and reliability of supply, and at the same time evading the necessity of incurring capital expenditure on extensions, that would appear to be the better course to take.

After discussion, it was therefore decided, having regard to the risks involved, to postpone the order for new plant, and the engineer was instructed to submit to the December meeting a report on the position and prospects of the requirements as they then appeared. Major Richardson was also instructed to confer further with the Grampians Company with a view to securing a favourable offer.

The Aylesbury Electrical Exhibition.

Mr. W. A. TURNBULL, borough electrical engineer, and his assistants achieved a very notable success with the local electricity exhibition which was held at Aylesbury from Monday to Thursday last week. As our readers probably know, Aylesbury is an ancient town with a number of historic buildings, but being situated in an agricultural district, it has not so far made much of a mark in the electrical world. While, however, the plant is at present small, it is very modern and works very efficiently. The rates charged are 10½d. for lighting and 2d. for heating and cooking.

On the occasion of the exhibition the Town Hall was filled with a very representative display of electrical apparatus and the interest taken by the local population shows here is one example worthy of flattery and imitation.

Britannia Electric Fires.

Most electrical suppliers are now interested in the sale of electric fires and the demand from the consumer is steadily increasing, especially in good residential areas. In fact electric fires have so many advantages to recommend them that they must appeal to every user of electricity. Always ready for use, portable, cleanly, they may be said to be almost essential to the equipment of every house which is connected to the electricity supply. In order to give a continuous demonstration of electric fires at their own rating is, however, an expensive item, and dealers should therefore appreciate the showcard novelty just issued by Messrs. ENGLISH ELECTRIC & SIEMENS SUPPLIES, Ltd., Brook House, 191-192, Tottenham Court-road, London, W. 1. Britannia electric fires may be constantly displayed to the public by means of this showcard for the small cost of current consumed by a 30 W metal filament lamp. An actual model of the 1 kW Britannia fire is mounted on the front of the showcard and transparencies arranged on a background, shewing the constructional detail of the fire, effectively reproduce the glowing element when illuminated by an ordinary 30 W metal filament lamp. The lamp is carried in a box fixed on to the back and a thermo-electric flasher may be connected in circuit if the exhibitor desires to obtain an intermittent effect on the lines of a flashing sign. The device is executed in an attractive colour scheme and folds flat to facilitate despatch. Contractors interested in the sale of electric fires should apply for one of these showcards which provides an efficient and economical method of advertising.

THE "BRITANNIA" ELECTRIC FIRES.

Scottish Electricians' Strike.

At a meeting of the ELECTRICAL CONTRACTORS' ASSOCIATION of Scotland, held at Edinburgh last week, the progress of this strike was considered. Of the entire Scottish membership only two firms in Edinburgh were reported as not having given notice of the reduction in wages. Their action, while affecting but a very small number of employees, was strongly condemned as tending to prolong the strike, and to reduce employment by maintaining the existing impossible cost of work. It was resolved to bring the names of the two firms before the Central Board of the Association for consideration.

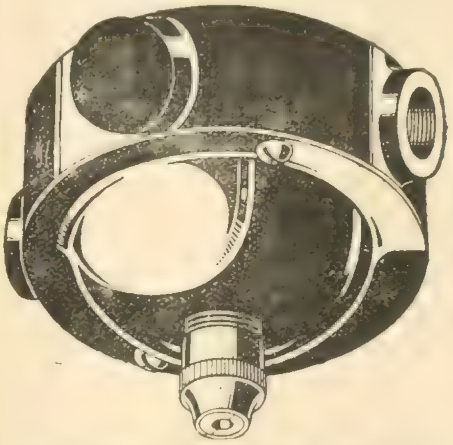
When the strike took place, a certain number of both Union and non-union men did not go out, and continued to work at the new reduced rate. There are signs that men are beginning to come in and ask for work at the new rate. It was noted that some effort had been made by the E.T.U. to call out selected men from firms affiliated to the Engineering Federation. In view of the fact that the standard rate of wage paid by that Federation is less than the rate offered by the Contractors' Association, the employers' representatives at the meeting were of opinion that further immediate steps should be taken towards the equalisation of all wage rates of electricians in Scotland, and the introduction of one flat rate.

Station Finders for Travellers.

In our issue of December 26, 1919, we gave an account of an indicator for railway and tramway systems which had been designed by Messrs. INDICATORS, LTD. This apparatus, it will be remembered, not only indicated the next station at which the train was to call, but showed what stations were to be missed. We understand that one of these indicators has now been fitted to a train on the Great Northern & City section of the Metropolitan Railway with complete success.

"Metallic" Cord Grip Pendant Box.

We have received from the METALLIC ELECTRICAL ENGINEERING COMPANY, of Birmingham, some particulars of their latest pattern of cord grip pendant box. This, as will be seen from our illustration, retains the ordinary pattern box for incoming wires, which is malleable iron and tapped four ways; but the novelty lies in the added refinement of a steel bronze dome cover of a very neat and unobtrusive appearance, which obviates the need of a ceiling rose. It is therefore likely to be popular in cases where economy in wiring costs and neatness of appearance are required. The complete box, which is of War Office pattern, is adapted for use in ships, schools, churches, public buildings, &c., and, being strongly made and easy to fix, should appeal to a large number of electrical contractors.



THE "METALLIC" CORD GRIP PENDANT BOX.

Parliamentary Intelligence.

ST. HELEN'S CORPORATION BILL.

This Bill, which was considered by the Local Legislation Committee of the House of Commons last week, sought (inter alia) power to increase the maximum charges for electricity.

In the report of the Ministry of Transport it was pointed out that the undertaking had hitherto been profit-bearing, and they could not see any adequate reason for the proposed increases.

Mr. B. T. HAWKINS, borough electrical engineer, said it was true they had had a successful career as an electrical undertaking, but all the profits had hitherto gone into the undertaking, and none had gone to the relief of the rates. They had a nominal profit of £10 000 last year, but that was all wiped out by the increased charges for coal and wages which had to be met. In view of those charges there would be a deficit for the current year, increased by the fact that there was a new liability on new capital outlay on an extension of the works which had been contracted for but not yet carried out. They were at present charging their maximum charges. The Temporary Increase of Charges Act would expire in 1923, and therefore, they wanted the power beyond that period on account of their capital commitments. It did not follow they would impose the proposed maxima as they did not make profit for the sake of making one. The charge to powers users was about 1·2d. per unit, and about 94 per cent. of the total output was supplied to power users.

The Committee decided they could not grant the power asked for, but substituted a clause sanctioning "such increases as the Minister of Transport may agree to."

Legal Intelligence.

Damages Against a Tramway Company.

At Leeds Assizes last week, Mrs. B. Riley recovered £750 damages from the Yorkshire (West Riding) Electric Tramways Company for the death of her husband, which was alleged to have been caused by the negligence of the Company. Negligence was admitted, and £500 was paid into Court. Riley, who was a goods guard in the employ of the Lancashire and Yorkshire Railway Company at Wakefield, was killed on January 29 last year by coming into contact with telegraph and telephone wires that had fallen on to the tramway trolley wires.

Oldham Tramway Arbitration.

The Court of Appeal (Lords Justices Bankes, Warrington and Atkin) has dismissed the appeal of the Oldham, Ashton and Hyde Electric Tramway, Ltd., from the judgment of Mr. Justice Rowlatt on the appeal from the award of the arbitrator as to the purchase price to be paid to the company by the Ashton and Hyde Corporations and the Audenshaw and Denton Urban Councils. The arbitrator awarded the company £142 000 and the case was that Mr. Justice Rowlatt ought not (1) to have depreciated the claim as to engineering fees, (2) to have allowed nothing for the item as to the cost of raising capital; (3) should not have remitted to the Arbitrator for reconsideration the item as to interest on capital during construction and (4) that the Judge should not have disallowed wholly the item with regard to the expenditure the company incurred in respect to alterations to the Guide Bridge.

Commercial Topics.

Trade Catalogues for Roumania.

H.M. Consul at Czernowitz (Mr. J. A. Cameron) is fitting up a room in the Consulate as a waiting, reading and information-room for business men, and would be glad to receive catalogues (illustrated, if possible), directories, trade journals and other literature. The commercial language in the province being German, catalogues and other literature printed in that language would be most useful.

* * * * *

British Cable Manufacturers and the Export Trade.

The British cable manufacturers are probably the best organised and most progressive branch of the electrical industry. Notwithstanding the various difficulties and anxieties of the past year both the British Insulated & Helsby Cables and W. T. Henley's Telegraph Works Company show better results than in 1919, and the ordinary dividend is maintained at 15 per cent. The net profit of the British Insulated Company was £340 700, an increase of £12 024 over 1919, while that of W. T. Henley's Company was £193 000, compared with £168 000 in the previous year. Both companies report increased sales and a larger turnover, but serious complaints are made of the difficulty in meeting foreign competition in the export trade owing to the high wages and the high manufacturing costs. In view of the importance of the subject and of the eminently practical and sensible nature of the speeches of the chairmen of the companies, we give below a few extracts from them.

WAGES AND FOREIGN COMPETITION.

Mr. James Taylor, chairman of the British Insulated & Helsby Cables, referred to the "ca' canny" policy adopted by some men in the wire-drawing department in order to defeat the bonus system, which had been in operation for many years, and to substitute a flat rate wage as high as the bonus system. The company refused the demand, and about 70 expert wire drawers, who declined to continue on the old system, had to leave the company's service. Though some time was required to train fresh hands, the difficulty was overcome and the new men were doing as much per week as the old and more experienced men. The "ca' canny" methods injuriously affected workers in other departments and resulted in the company being unable to turn out the usual and proper quantity of cable per week. The present high costs of manufacture and inability to give certain delivery, owing to labour unrest, were preventing the company from taking orders, which were now being placed abroad. Foreign trade could only be retained by a reduction in the cost of production, and although a decrease in the present high rate of wages would have a most beneficial effect, another and very important element had to be considered—namely, increased efficiency in the mechanical means of production. The company, therefore, had carried out a re-organisation of the works. They had built what were practically three new factories, fitted with all the latest and most improved appliances, and had enlarged the power plant. They had also greatly improved and increased the facilities for handling raw material and finished products, besides making improvements in other departments, which should largely tend to cheapen production. The company had been working under the improved conditions and additional facilities for the past two or three months, and while they were feeling the beneficial results of the changes generally, it was noteworthy that they could now turn out all the latest types of special high-tension cables of very long lengths.

EXPORTS AND EMPLOYMENT.

Mr. Geo. Sutton, chairman of W. T. Henley's Company, was able to announce that the sale of their products and spheres of influence—their overseas developments—continued to expand. They had done much work in telephone trunk cables at home and abroad, including a new continuously loaded cable which was to be laid across the Straits of Georgia. They had nearly completed a contract for the city of Birmingham for the construction and laying of the largest order yet placed for super tension cable, to work at a pressure of 33 000 V. Their general trade had gone into countries where hitherto no cable trade was to be done. Jerusalem had become a buyer of Henley's cables, and their products were not unknown in Baghdad and Mesopotamia. They could possibly have a prosperous dividend-paying concern by home trading only, but their desire had been and was to give as much employment as they could by the extension of their overseas trade. A large export trade was essential to our nation, and they had to bear their part by extending their overseas business, and keeping their factories as fully employed as they could. Before the war British cable makers held their own in foreign trade, their reputation for quality and reliability was unimpaired, but the red danger light was now showing very clearly. The orders from foreign countries (excluding British Overseas Dominions) had fallen off very seriously during the past six months; countries which bought from them in considerable quantities had nearly ceased to buy. There were several causes for that, but an important one was that they were unable to compete in price with foreign countries. How could they compete in price with German factories, for instance, with their rates of wages three or four times higher than those current in German cable factories? They did not like reducing wages, and no doubt they could earn dividends without doing so, but they could not maintain or increase the employment in their factories unless they were able in competition to secure foreign business. He firmly believed that at the present time lower rates of wages were necessary, and a good standard of living must be secured by working more hours in a week. Or, to put it another way, they must have a larger output for their wages bill if they were to keep their foreign trade. There was no question of pre-war rates of wages—the standard of living must, and would be higher than it was before the war, but it must be obtained by mechanical and human devices to improve the output per worker employed.

Electricity Supply.

HASTINGS Corporation has decided to carry out extensions of the electricity undertaking at an estimated cost of about £50 000.

The Lighting Committee of GIRVAN Town Council is collecting information as to the possibility of introducing electricity supply in the district.

OSWALDTWISTLE Urban Council has secured a special order for the supply of electricity, and negotiations are proceeding with Accrington and Blackburn Corporations for a bulk supply.

BELFAST Electricity Committee recommends the appropriation of an additional sum of £14 000 for installing the second 6 000-kW generating set at the auxiliary power station at Musgrave Channel-road and providing converting plant at the East Bridge station.

Notice has been given by the OLDHAM and BLACKPOOL Corporations electricity departments that, for the present, new supplies of electricity can only be given along the routes of existing mains, owing to the prohibitive cost of new mains.

ABERDEEN CORPORATION has approved of the scheme prepared by the city electrical engineer (Mr. J. A. Bell), for providing additional generating and converting plant at the Ferryhill electricity works, at an estimated cost of £210 540.

The Electricity Commissioners have again extended the time until the 30th July next for submitting schemes or making representations as to the organisation of electricity supply in the NORTH WEST MIDLANDS ELECTRICITY District.

Some opposition is being manifested at BLACKPOOL regarding the Corporation Staff Salaries Sub-committee's recommendation to increase the salary of Mr. Charles Furness, the borough tramways manager and electrical engineer, from £1 250 to £1 500 per annum.

STOKE-ON-TRENT Corporation has decided to purchase a site for a sub-station in March-street, Hanley, and application has been made to the Electricity Commissioners for sanction to borrow this sum and for holding more than five acres for electricity purposes.

Instead of putting down additional generating plant, BO'NESS Town Council will take a bulk supply of electricity from the Scottish Central Electric Supply Company, and application has been made for sanction to borrow £20 000 for transforming plant, &c.

We congratulate the consumers of electricity in KINGSTON upon their victory on the question of the back-dating of the increase in prices. The Council recently received the sanction of the Ministry of Transport to increase the price of current and to back-date it for three months. At the time we challenged the legality of this procedure, and at last week's meeting of the Council the opinion of counsel was read expressing doubt as to the legality of the suggested action, and the subject was referred back to the Lighting Committee, it being understood that the proposal would be abandoned.

CHICHESTER Corporation is negotiating for the purchase of the undertaking of the local electric light company. On the recommendation of a committee, an offer has been made to purchase the undertaking as a going concern, including stocks and stores, for £12 500, subject to outstanding claims being discharged by the company, and to authority being obtained for borrowing the purchase money. If the purchase be effected, application will also be made for sanction to borrow £2 000 for repairs.

NEWARK Town Council has adopted Mr. C. H. Wordingham's scheme for the erection of electric supply works, and is applying for a special order. The estimated cost of the generating plant and distributing network is put at £100 000, and provision is made for extensions as they are required. Supply will be given in Newark and the rural district, and, if the East Midland areas is unable to supply Southwell and Farnsfield, the undertaking may also include these places. The plant will be of 3 000 kW, and the average cost per unit is put at 2·29d., and one firm will take energy to the value of £7 500 a year.

An alternative scheme for the supply of electricity to TORQUAY has been submitted to the Electricity Committee by Mr. H. J. Wilson, managing director of the Wilson Syndicate, which was formed for the purpose of developing the lignite in the Bovey basin, near Newton Abbot. Before the war some Germans carried out some experimental work in the district, chiefly for the purpose of obtaining oil, and it is understood the work will be continued by the Syndicate. It is proposed to erect works at Heathfield. Mr Wilson thinks he can supply electricity at a cheaper price than it can be generated at Torquay. The cost of a cable from Heathfield is put at £50 000 to £70 000. Mr. Wilson is to submit details to the borough engineer (Mr. Woods) and the chairman of the committee (Mr. J. Taylor), and a report will be submitted later to the committee.

A deputation from the GLASGOW Lighting Committee recently visited London for the purpose of inspecting the public lighting arrangements in the metropolis. The deputation, which consisted of Bailies J. Stewart (convener) and J. Mitchell (vice-convener), Mr. S. B. Langlands, public lighting inspector, and Mr. R. Richmond, were entertained to dinner by the Streets Committee of the Corporation of the City of London; and in addition to members of the Committee, the city engineer (Mr. E. E. Finch), the inspector of public lighting (Mr. W. J. Liberty), Mr. Frank Bailey (City of London Electric Lighting Company), and Mr. F. W. Goodenough were also present. Subsequently the lighting of the principal thoroughfares in the city was inspected, and in their tour they were accompanied by Mr. H. G. Stanham, of the Streets Committee, and by Mr. Finch and Mr. Liberty, who gave an explanation of the arrangements made, costs and other particulars were supplied.

Electric Traction.

The work of converting the Dudley-road tramway route, Wolverhampton, from the Lorain surface contact to the overhead system has been completed, and this will enable a through service from Wolverhampton to Dudley to be run.

In the report of the Inspector of the Ministry of Transport on the Bradford tramway accident on February 23 last, when about 40 persons were injured as the result of a tramcar overturning after jumping the points, it is stated that the speed of the car was about 15 miles an hour, which was too great. The provision of special light signals at tram junctions is recommended.

The London County Council is recommended to enter into an agreement for taking over and working the Leyton tramway undertaking on a co-partnership basis for 10 years. There have been losses on the Leyton system for some time, but it is considered that with a through service, bringing Londoners right into the lower parts of Epping Forest, there would be increased traffic.

At the Ministry of Transport on the 23rd ult. Sir Wm. Marwood, Director-General of Public Safety and General Purposes, heard an application to confirm the Dearne and District Light Railways Order. The scheme is promoted by the Urban Councils of Wombwell, Wath-upon-Dearne, Bolton-upon-Dearne and Thurnscoe, and provides for the construction of about 15 miles of light railways between Barnsley, Thurnscoe and Swinton. It was provisionally sanctioned in 1913, but owing to the war the work of construction was postponed. In 1920 the promoters applied to the Light Railway Commissioners for an amended Order, and after an inquiry the Light Railway Commissioners granted the application.

Opposition was now offered by the Great Central, the Midland and the Hull and Barnsley Railway Companies, and by the Motor Legislation Committee. For the railway companies it was contended that the scheme would entail a charge on the rates. Sir William Marwood said he would give careful consideration to the representations that had been made, and he would give his decision later.

The increasingly important part which electrically-driven vehicles are playing in house-to-house refuse collection is emphasised in a report just issued by the Salvage Department of the Birmingham Corporation. The department has 32 electric vehicles at work. The average weight of refuse collected per house per visit was 0·3628 cwt. by electric vehicle and 0·4982 cwt. by horse wagons. Each electric vehicle, working in the outer portions of the area and travelling double the mileage of the horse wagons per day, visited as many houses per week as approximately 2½ horse wagons visited in their restricted area near the depot. The cost per house per visit was as follows :—

Horse wagons, continuous system, inner area, 3·22d. per house per week; electric vehicles, continuous system, outer area, 2·94d., showing a saving in favour of the electric vehicle of 0·28d., or £125 per annum for each electric vehicle. The saving was actually much greater than this, because if the horses had to travel to the areas now served by electric vehicles they would not visit nearly as many houses as they did in the inner area, and the superintendent estimates the saving effected by transferring two horses from the long-distance work into the inner areas, or short-distance work, was at least £125 per annum, so that each electric vehicle directly or indirectly resulted in a reduction of the working costs of not less than £250 per annum.

The report of the Inspector of the Ministry of Transport (Major A. Mount, R.E.) on the collision between two electric trains, which occurred on the 25th January, at James-street Station on the Liverpool Overhead Railway, has been issued. After describing the accident the report states that it arose from a simple but serious case of misunderstanding and slack working under normal conditions. The signals and block instruments concerned were in working order. The accident is one which would not have happened had the new system of signalling, now in course of introduction on the line, been in operation. The work is in hand, but there is delay in the supply of certain material. When the system is brought into use, the block instruments will be abolished. In the meantime the practice of hand-signalling all non-stop trains through stations is misleading, and Major Mount suggests that it be discontinued. Hand-signals will then only be displayed in exceptional circumstances, and drivers will then stop at fixed signals in the danger position until permitted, if the signal has failed, to proceed under a clear hand-signal. The cut-out switches in cabs will be dispensed with under the new system of train-stops, but it would make for safer working, in spite, perhaps, of minor delays, if they were now taken out of all trains. The practice of using the block instrument bells for calling attention in urgent cases to speak on the telephone must be stopped, and if necessary, louder telephone bells should be installed.

Bankruptcies.

Claims against Edwd. Stirling Elam & John Walton, trading as Elam, Walton & Company, electricians, 63, King Edward-street, Hull, are to be sent by April 13 to Mr. G. Hamilton, York City Bank-chambers, Lowgate, Hull.

Leslie Philip Howse and Geo. Harry Bertram Snell, trading as Howse & Snell, electrical engineers, 6 and 8, Duke-street, Margate, have been adjudicated bankrupt.

Chas. Thos. Stanton, trading as the Southern Electric Engineering Company, 25, Beckenham-road, Penge, has been adjudicated bankrupt. The first meeting of creditors will take place on April 4 at 132, Westminster Bridge-road, S.E.1., and the public examination on April 21, at the County Court, Scarsbrook-road, Croydon.

Institution Notes.

The Manchester and District Local Advisory Committee of the Electrical Trades Benevolent Institution is holding a smoking concert to-day at the Albion Hotel, Manchester.

At the recent meeting of the Leeds and District Amateur Wireless Society, Mr. J. E. Tindall, a vice-president, gave a brief address, and the hon. secretary (Mr. H. Soyer) reported on the progress made. They had about 50 members, of whom quite a number had installations and were more or less experienced. The society would cater for both experienced men and absolute beginners.

On Wednesday next a joint meeting of the Iron and Steel Institute, the Institution of Mechanical Engineers, the Faraday Society and the Institute of Metals will be held at the Institution of Mechanical Engineers to discuss the " Failure of Metals." There will be three sessions, beginning at 3 p.m., 5 p.m., and 8 p.m. respectively, with intervals for tea and dinner.

The fifth Swiss Trade Exhibition will be held in Basle from April 16 to the 26th. Its promoters are confident that it will give an excellent opportunity to visitors and traders of becoming acquainted with Swiss manufacture and genuine Swiss goods. A special section will be devoted to the electrical industry, while other sections will deal with house fittings, lighting, advertising and small machinery and tools. The managing director is Dr. W. Myler, 30, Gerbergasse, Basle.

The annual report of the Western Centre of the Institution of Electrical Engineers states that it was hoped during the past session to have had a meeting at Plymouth in addition to those already arranged at Cardiff, Bristol and Swansea. Unfortunately, the response was not sufficient to justify the expense, though it is hoped that this lethargy is only temporary. That the centre is increasing in usefulness is obvious from the fact that its membership rose from 222 in 1913 to 415 in 1920, the increase being progressive, though the slope of the curve has been steepening during the past two years. In drawing attention to the success of the summer meeting of the Institution which was held in the Western Area, the report makes a fitting tribute to the work of the hon. secretaries, Mr. C. T. Allan and Mr. A. J. Osler, whose wonderful efforts were in a large part contributory to this satisfactory result.

The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers on May 5 and 6, beginning each day at 10 a.m. The annual general meeting will be held on the morning of May 5 and the annual dinner in the evening. A number of interesting Papers are down to be read, including one by Mr. W. E. Hughes on " Slip Lines and Twinning in Electro-deposited Iron," one by Mr. H. R. Ringrose on " Scientific Control of Combustion," and one by Mr. A. Westgren on " Roentgen Spectographic Investigations of Iron and Steel."

The autumn meeting of the Institute will be held in Paris early in September by invitation of the Comité des Forges de France. After the meeting the members will have the opportunity of visiting works in Lorraine, Creusot and Normandy, and of inspecting the battlefields and cemeteries in France and Flanders.

The Annual General Meeting of the Batti-Wallahs Society was held at the Holborn Restaurant on Monday, the 21st inst., following the luncheon that this lively association holds monthly. Among the guests was Mr. Beresford (" Tendency Beresford "), President of the American Institute of Electrical Engineers, and complimentary reference to his presence brought from him a capital little speech in reply.

The retiring President, Mr. W. Wyld, was in the chair until such time as he handed it over to the newly-elected president, Mr. W. E. Ireland.

The hon. secretary, Mr. F. Pooley, reported sound progress in 1920, both in numbers and in finance, and the meeting registered a resolve to make the Society still more comprehensive in 1921. Mr. Greenly remains the whimsical and enterprising entertainment secretary, and the intentions (if any) of Mr. Pooley to retire from his duties of secretary and treasurer were forestalled by the presentation of a most handsome silver bowl which was inscribed as a small tribute of esteem and gratitude for his long and splendid services to the Society.

Obituary.

We regret to record the death of Mr. Fredk. Jas. Marchment, a director of the British Electric Transformer Company, Ltd., who died very suddenly on the 22nd ult. in his 65th year.

We also regret to record the death of Dr. W. Bruce, radiologist at Charing-cross Hospital. Dr. Bruce, who was only 44 years of age, was a skilful worker with X-rays, and he has fallen a victim to the effect of frequent exposure to the gamma rays emitted by X-ray tubes. He warmly welcomed the newer tubes of higher penetrating power, believing that the improvements which had been effected would lead to a wider usefulness. His researches had already shown most important results, and his untimely death is a heavy loss to his profession.

The death is announced of Mr. Marchand B. Kenworthy, engineer at the English Electric Company's works at Stafford. Deceased, who was 41 years of age, was a native of Saddleworth, Lancs., and was educated at Huddersfield Grammar School. He entered the service of Messrs. Siemens Bros. Dynamo Works about 17 years ago, and he has since remained with the company and its successors. He was also instructor in machine construction and drawing at the Stafford Municipal Technical School.

Imperial and Foreign Notes.

H.M. Senior Trade Commissioner in Canada has received a request from a Montreal firm to be put in touch with British manufacturers of small electric motors. The type required is a universal motor, of about [illegible] H.P., 115 V, 25 to 60 cycles, approximately 3 600 r.p.m., with rheostat for controlling speed. About 900 per month would be required for a small portable motion-picture machine, for which a sewing-machine motor is at present being utilised. The name and address may be obtained from the Department of Overseas Trade.

H.M. Trade Commissioner at Winnipeg (Mr. L. B. Beale) reports that a Western Canadian University is planning to build a new chemistry building next year, and proposes to replace the gas lighting plant by a coal gas plant capable of supplying about 1 000 burners. It is also proposed to install a new direct-current electric generator and gas engine. Firms interested may obtain particulars from the superintendent of the university buildings, whose address will be supplied by the Department of Overseas Trade.

The new radio-telegraph station at Sandham (Finland) has recently been in experimental communication with the wireless station at Poldhu, a distance of about 2 300 kilometres. The station was equipped by the Poulsen Company, of London, and is estimated to have a range of action of about 3 000 kilometres.

What is stated to be the world's long-distance wireless record was achieved by the U.S.A. Navy on March 8 by sending messages within three minutes from Gavite, Philippine Islands, to Washington, a distance of about 10 000 miles. It is claimed that the new system of automatic control, which was used in making the record, eliminates all handling of messages between originating and receiving points.

H.M. Consul at Pondicherry, French India (Captain H. G. Tranchell) has informed the Department of Overseas Trade that 65 000 Rupees have been voted by the Conseil-General of the town for repairs and new machinery in the municipal electric light works. Most of the equipment will probably be obtained from Madras or Bombay.

The Argentine Government has granted a concession to the General Wireless Telegraph Company of Paris to erect a Radio-Telegraph Station in the Argentine for the purpose of communicating with France and other European countries. The concession is for a period of 30 years, and power is also given to establish wireless telephone communication.

The Committee appointed by the Finnish Government has reported in favour of a vote of credit of 10·5 millions of marks for developing State waterfalls and the purchase of other falls. It is proposed to begin at Imatra and Linnankoski, which are to be joined, and power generated from one station. During this year certain expropriations are to be made for Linnankoski and a temporary power station erected at Imatra.

The "Nieuwe Rotterdamsche Courant" states that, in accordance with the conditions of the contract for the supply of electricity to Stolwijk, Bergambacht and Ammerstol (Holland) by the municipality of Gouda, the latter has been requested to replace by underground cables the aerial network at present in use. The cost is estimated at 83 000 gulden, to which 7 000 gulden are to be added for a telephone cable of 14 kilometres.

According to the Finnish Press, arrangements are being made to send 10 young Finnish engineering students, who have completed their course in the Helsingfors Technical High School, to Germany, in order to study the latest developments in the big industrial establishments of that country. Each student is to stay about a year in Germany and the firms of Siemen & Halske and Voigt's Turbine Factory are mentioned as those to which the students will be attached. A sum of 100 000 marks is provided in the Budget for the initial expenses of the scheme.

The German Reparation (Recovery) Act comes into force to-day (Friday). Under Sec. 5 of the Act the Board of Trade may by order take certain steps, including the following:—

Under Sec. 1 of the Act, importers of German goods are to pay to the Customs a prescribed proportion of their value, not exceeding 50 per cent. The Board of Trade may reduce the proportion as respects articles of any class, make or description, or may exempt them altogether. Sec. 2 excludes from the provisions of the Act goods partially manufactured or produced in Germany which are not first consigned from that country and in which 25 per cent. or more of their value is attributable to processes of manufacture undergone since they last left Germany. The Board may vary this percentage. The Act does not apply to goods imported before April 15 if they are imported in pursuance of a contract entered into before March 8, but the Board may substitute some later date for April 15. Sec. 4. provides that where any person is liable, under a contract entered into before March 8, to accept bills of exchange or make advances in connection with the importation of any goods, he may apply to the High Court to suspend or annul, or, with the consent of the parties, amend the contract, or stay any proceedings for the enforcement of the contract. The Board of Trade may extend the classes of contract to which the section relates.

The Board are not, however, to make any order under the above provisions except on the recommendation of a committee, and the following have, therefore, been appointed by the Board of Trade:—Mr. H. A. Trotter (Chairman), Mr. H. B. Betterton, M.P., C.B.E., Mr. F. R. Davenport, Mr. Stanley Machin and Mr. D. Withers, with Captain G. W. Duncan as Secretary. Applications should be addressed to the Secretary, Board of Trade, Great George-street, S.W.1.

Miscellaneous.

Mr. Chas. Kernot has been appointed construction engineer for the Victorian Government's Morwell electricity scheme.

A petition for winding up the Bastian Electric Company, Ltd., has been presented by Mr. W. F. N. May and Mr. A. E. Wall, and will be heard in the Royal Courts of Justice, London, on April 12.

The inauguration of the new wing of the physics department of University College, Nottingham, took place last week. The wing is built in three storeys and consists of an elementary room, an optical room, and an electrical room.

We have received from the Walsall Hardware Mfg. Co. a copy of the "Grip" for March, 1921, which puts forward in a succinct and forcible fashion the various advantages that are to be gained by using Walsall conduits and fittings in electrical work.

By means of Wireless Telephone apparatus on the Bar Lightship which is anchored 12 miles out at sea, the crew can now speak with the offices of the Mersey Docks and Harbour Board. The power of the wireless set is 100 W, and, under ordinary conditions, its range is 35 miles.

We have received from the Metropolitan-Vickers Electrical Company a well-illustrated pamphlet entitled "Education in Industry," which deals exhaustively with the various courses which are now available at Trafford Park to the young man anxious to enter the electrical engineering profession. We refer more particularly to certain questions to which the pamphlet gives rise in our Editorial Notes.

According to statistics given in a recent issue of the "Iron Age" (New York), there are 961 Electric Steel Furnaces throughout the world, of which 308 are of the Herault type. The United States possess 356 furnaces, of which 159 are Herault, 52 Snyder, and 23 Greaves-Etchells. In the remainder of the world there are said to be 131 Herault, 85, Rennerfelt, 65, Greaves-Etchells, 7 Snyder, and 6 von Baur, a total of 294 installations, but there are estimated to be 268 furnaces of other types, making a total of 562. The United Kingdom is credited with 53 Herault, 7 Rennerfelt, 38 Greaves-Etchells and 3 Snyder furnaces, plus 49 of various other types, a total of 150. Germany has a total of 100 electric furnaces, France 69, Italy 59 and Sweden 50; and in Canada there is a total of 43, including 18 Herault furnaces.

The Committee formed in 1911 by the late Prof. MacGregor to promote a memorial to Prof. Tait in the form of a second chair of Natural Philosophy in Edinburgh University report that the "Tait" Chair will shortly be established. The funds collected before the war have been substantially augmented by funds from other sources, and the University Court have found it possible to arrange for the foundation of the Tait Chair not later than the year 1925, by which date certain funds set aside by the University Court towards the endowment of this Chair will have matured. The Committee state that additional contributions to the fund will make it possible to inaugurate the Tait Chair of Natural Philosophy before 1925. Dr. C. G. Knott, University of Edinburgh, is secretary of the Committee.

Interesting evidence of the re-entry into the political arena of the old constitutional type of trade unionist is given in an article on Works Committees in the current issue of the "Industrial League Journal." The author is Mr. S. Ratcliffe, who is chairman of the Works Committee of the Metropolitan-Vickers Electrical Company. While, on the one hand, the leaders of the Labour Party shortly expect a political landslide in their favour, on the other hand, there is increasing discontent among the rank and file at the way in which their affairs are being managed. This attitude is likely to be encouraged by the activities of these Committees which will equip workmen with knowledge and experience to enable them to adopt a more beneficial influence on the industry, help to remove the idea that managers are their enemies and encourage frank discussions on all points of view, so operating to their mutual benefit.

The Government Committee of Inquiry into the High Cost of Building Working Class Dwellings in Scotland held a series of meetings in Edinburgh last week, and among the witnesses examined was Mr. Lyall, of the Electrical Contractors' Association. Mr. Lyall said that the electrical work in connection with housing represented only about 1·5 per cent. of the total cost. Contractors had very little difficulty in obtaining raw material. The wages of electricians had increased 200 per cent. over pre-war rates. The Ministry of Health's specification for electrical work was simple, but he thought that it would be better to allow electrical contractors a freer hand. Insufficient care was taken by the authorities to ensure co-ordination amongst the various trades, and that affected electrical work, particularly as in some cases electrical contractors, in order to proceed with the fitting of lights, had to undo work which had already been done by other trades.

We are pleased to learn that the Atlanta Company, Ltd., which was formed for the purpose of giving employment to women engineers, has succeeded in raising the necessary capital. The formation of the company was suggested by members of the Women's Engineering Society, primarily to utilise the services of women engaged in engineering during the war. The scheme has been financed almost entirely by women, only five out of the 50 shareholders being men. The directors include Lady Parsons, Lady Shelley-Rolls, Miss Caroline Haslett (secretary, Women's Engineering Society), and Mr. Schofield, head of the Loughborough Technical College. The works are at Loughborough, where the girls attend the technical college for further instruction. The company is doing sub-contracting work, and there is said to be plenty of orders. At present the women are engaged on a new invention, a type of atomizers used for oil mining, and they are also working on bottling machinery. It is hoped to run the concern on a co-partnership basis.

Business Items, &c.

On and after the 4th inst. the head office, sales department and stores of the General Electric Company, Ltd., will be at Magnet House, Kingsway, London, W.C.2. The new telephone number will be: Regent 7050 (50 lines).

Our contemporary "Electrical Industries," which has been published weekly since 1901, by the Electrical Press, Ltd., desires it to be known that it has no connection with a company entitled Electrical Industries, Ltd., a trading concern, which was registered in May, 1920, and is now in liquidation.

Messrs. Jones & Pordes ask us to state that Mr. D. J. Esterson, of Glasgow, has ceased to represent them, and that they have appointed Messrs. Macdonald & Shaw, 116, Hope-street, Glasgow; and Mr. Mason Alcock, Windsor-buildings, North-street, Belfast, and 33, Harcourt-street, Dublin, to be their selling agents for Scotland and Ireland respectively.

Messrs. H. W. Smith & Co., Ltd., have appointed Mr. C. H. Spafford, of 20, Falmouth-road, Bishopston, Bristol, as their representative for the West of England. Telephone: Bristol 5373. For a long time Mr. Spafford was with Messrs. Simplex Conduits, Ltd. The firm have also appointed Mr. W. J. Davies, Dydraw, Porthcawl, as their representative for South Wales. Telephone, 65 Porthcawl.

Messrs. Alfred Herbert, Ltd., Coventry, have acquired the sole manufacturing rights for the small ball hardness testing machine covered by the Craig, Moore & Mather's patents. This machine is a development of the Brinell method of determining hardness, the difference being, not in principle, but in the use of very small balls with correspondingly small loads. With the machine thin-walled tubes and other hollow forms may be tested without internal support, and during the war it was used at Woolwich Arsenal for testing cartridge cases. A batch of 50 of these machines has been put in hand and delivery will be made in about three months' time.

Catalogues, Price Lists, &c.

Messrs. Jones & Pordes, 8, Crawford-passage, Farringdon-road, E.C.1, are circulating a leaflet describing their "Elba" electrical specialities, dry cells, accumulators, bell sets and portable lamps. Dealers can have a supply without the firm's name.

A new list (A 102) of Hydraulic Baling and Packing Presses has been issued by Messrs. Hollings & Guest, Ltd., Thimble Mill-lane, Birmingham. Prices of various sizes of press, together with illustrations of some standard types are given. Another list (No. A 107) contains similar particulars of Guests' all-metal bundling press.

A large poster and a folder for the purpose of popularising "Universal" Electric Labour Savers, for spring cleaning, are being circulated by Messrs. L. G. Hawkins & Company, 116, Charing Cross-road, W.C. 2. The firm, who supply vacuum cleaners, electric irons, toasters, coffee pots and other cooking and heating appliances, are making a special effort to develop the use of electric appliances for domestic use, but especially for spring cleaning. They are offering a set of four pieces at a definite figure, so that buyers may have a definite idea of the inclusive cost.

An illustrated pamphlet of eight pages (H. 41 5) on Oil Switches and Switch Pillars for mining and industrial purposes has been issued by the Electrical Apparatus Company, Ltd., S. Lambeth-road, S.W. 8. The range of switches has been increased, and a number of recent designs are included. General specifications, dimensions, prices and technical details are given, so that the new publication, copies of which will be sent on request, should be of considerable assistance to users.

The recent trade literature of the Metropolitan-Vickers Electrical Company, Ltd., include two illustrated descriptive leaflets (379/1-1 and 379/1-3) on three-phase transformers for rotary converters, and one (711/1A) on transformers for use in collieries. The former gives a description of the design and construction of the machine, together with some excellent illustrations, and the latter contains an illustrated description of a new transformer, which has been developed by the company for underground working.

The General Electric Company, Ltd., 67, Queen Victoria-street, E.C.4, have issued the section of their catalogue relating to G.E.C. "Witton" Alternating-current Generators. Commencing with a general and technical description, there are specifications of engine-driven and turbo-generators, and these are followed by details of the company's two and three-phase and single-phase generators. The catalogue, which is well illustrated and shows some examples of plant supplied by the company for various purposes, may be obtained by those interested.

The 1921 catalogue of the Hart Accumulator Company, Ltd., of Stratford, is a nicely printed, well-illustrated publication with a foredge index which facilitates the work of reference. The company manufacture storage batteries for all purposes—for lighting, power, traction, ignition, telegraph and telephone work, testing, &c., and ample technical particulars) capacity, charge and discharge rates, dimensions, &c.), with prices, are given of the various types of cell supplied. A section of the catalogue is devoted to stands for cells, acids, spare parts, switchboards, instruments and accessories.

Messrs. Thos. Firth & Sons, Ltd., of Sheffield, have issued their price list of "Die Hard" Alloy Steel Hacksaw Blades. This well-known firm are specialists in the production of high-grade steel for the manufacture of hacksaw blades, and the list contains particulars and prices of various types of blade for hand and light power and heavy power work. These hacksaws are made of a special quality of tungsten steel, and they are extensively used in engineering work. Copies of the catalogue, which contains some useful hints for users, can be obtained on application.

Tenders Invited and Accepted.

Manchester Electricity Committee require tenders by April 6 for consumers' substation switchgear (3-phase 6 600 V. Specification from Mr. F. E. Hughes, Town Hall.

The municipality of Pretoria invite tenders for the supply and erection of switchgear. Tenders to Deputy Town Clerk, Municipal Offices, Pretoria, by 4.30 p.m., May 10.

Worksop Urban Council want tenders by April 6 for e.h.t. and l.t. cables, switchgear transformers, and 500 kW rotary or motor converter. Specifications from the Manager and Engineer of the Electricity Dept.

London County Council requires tenders by April 18 for about 5 500 tons of standard steel girder tram rails, lipless track rails and guard rails, &c. Form of tender from the Chief Engineer, County Hall, Spring Gardens, S.W.1.

New Zealand Public Works Department invite tenders (by April 19) for 6 000 pin insulators for a 66 000 V transmission line. Tenders to the Secretary, Public Works Tenders' Board, Wellington. Specifications at the Department of Overseas Trade, 35, Old Queen-street, S.W. 1.

The Commissioners of H.M. Works, &c., invite tenders by April 12 for the supply of electrical engineering labour in day-work in the Leeds district. Forms of tender and particulars from the Director of Contracts, Storey's Gate, Westminster, London, S.W.1.

The Welsh National Memorial Association, Westgate-street, Cardiff, require tenders by April 11 for the supply and erection at Glan Ely Sanatorium, Cardiff, of two 20 kW internal combustion engine-driven generator sets, battery-charging booster, switchboard and battery. Specifications from the Secretary.

Belfast Corporation invite tenders for the manufacture and erection at the new Harbour power station of extra-high pressure and low pressure switchgear. Specifications from the consulting engineers, Messrs. Preece, Cardew & Rider, 8, Queen Anne's Gate, Westminster, S.W.1., or the city electrical engineer, Mr. T. W. Bloxam. Tenders to the Town Clerk's Office, City Hall, Belfast, by April 25.

Sheffield Corporation has placed an order for the supply of 1 000 tons of tram rails with the Leeds Steel Works at £24 per ton.

Wolverhampton Electricity Committee has accepted the tender of Callender's Cable and Construction Company for twelve months' supply of e.h.t. and l.t. cable.

The Metropolitan Asylums Board has accepted the tender of the Chloride Electrical Storage Company at £468 10s. 0d. for two Exide Ironclad traction batteries for electric vehicles at Queen Mary's Hospital.

Sunderland Corporation has accepted the following tenders:—Enfield Ediswan Cable Works, Ltd., house service cables; W. T. Henley's Telegraph Works Company, section pillars; Ferguson, Pailin, Ltd., e.h.t. switchgear; and W. G. Farrow, joint boxes.

Portrush Urban Council has been authorised by the Electricity Commissioners to accept the tender of Messrs. Curran for the supply of electric generating plant, electric cables, &c., at £13 957 15s. The tender of Cochrane & Elliott at £1 652 11s. for erecting the power station has also been accepted.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

138 914 Automatic Telephone Mfg. Co. [illegible] systems. (12/2/19.)
140 [illegible] Automatic Telephone Mfg. Co. [illegible] systems. (10/3/19.)
141 [illegible]74 Automatic Telephone Mfg. Co. [illegible]
142 836 Soncini. Electric crucible furnaces. (25/4/19.)
143 190 Blondy. Electric pocket lamps. (20/2/19.)
146 082 Automatic Telephone Mfg. Co. Automatic telephone systems. (30/6/19.)
157 051 Soc. Metallurgique du Frayol. Electric furnaces. (7/1/20.)
158 060 Frecheville. Electrically-operated horns for motor vehicles. (23/10/19.)
158 067 B.T.-H. Co. (G.E. Co.) Controllers for electric motors. (24/10/19.)
158 070 King. Electric torches. (25/10/19.)
158 073 Joseph. Electrically-heated cooking utensils. (25/10/19.)
158 076 Balbi. Form of thermo-electric measuring instrument. (27/10/19.)
158 081 Baumann & Metropolitan-Vickers Electrical Co. Ventilation and cooling of electrical or other machines. (27/10/19.)
158 082 Jelley & Metropolitan-Vickers Electrical Co. Ventilation and cooling of electrical or other machines. (27/10/19.)
158 085 Sykes Interlocking Signal Co. & Tarrant. Means for controlling the transmission of electrical impulses. (27/10/19. Cognate application, 8,897/20.)
158 090 Davies, Bean, Bean & Bean. Means for applying electricity to the soil for agricultural purposes. (28/10/19.)
158 141 Automatic Telephone Mfg. Co. & Flynn. Telephone systems. (29/11/19.)
158 148 Levin. Electrolytic gas generators. (31/12/19.)
158 150 Caparn. Limit switches for controlling electric motors. (7/1/20.)
158 284 Jeance. Electro-magnetic wave navigational systems. (12/4/19.)

A pair of aerial coils arranged at an angle, preferably a right angle to one another, and movable about a vertical axis are each connected with a receiving device through connections including a reversing switch, one of which switch connections is further adapted to cut its coil completely out of circuit so that a coil can be placed in a position adjacent to the minimum position, and then the effect of the other coil added thereto or subtracted therefrom by the operation of a second reversing switch, so that during the operation of this latter switch consecutive signals of substantially equal strength are heard without passing through a position in which a third signal is heard which would affect the physiological sense of the operator in comparing the two signals.

158 291 Round & Ditcham. Wireless telegraph transmitters. (19/8/19.)
158 328 Rohman. Installations for electrically lighting, heating and ventilating railway carriages and other vehicles. (29/10/19.) (Addition to 145,120).
158 334 B.T.-H. Co. (G.E. Co.) Controllers for electric motors. (30/10/19.)

158 353 Moore, St. George & Whitmore. Means for supporting antennæ used in wireless telegraphy. (3/11/19.)
158 357 Joice. System of distant control without additional line wires for electric supply systems. (4/11/19.)
158 361 Russell. Electric power-generating units. (4/11/19.)
158 363 B.T.-H. Co. (G.E. Co.) Electric resistance units. (4/11/19.)
158 373 Ayres & Metropolitan-Vickers Electrical Co., Ltd. Alternating current electric motors. (5/11/19.)
158 377 Baker & Parsons. Electric switches. (6/11/19.)
158 380 Burdon. (Siemens-Schuckertwerke Ges.) Electric arc lamps or projectors and carbons or electrodes therefor. (6/11/19.)

APPLICATIONS FOR PATENTS

August 9, 1920.

23 282 Jamie. Switches.
23 288 Irvine. Electric door-bells.
23 308 C.L.I Mfg. Co. & Watson. Electric lighting systems.
23 309 Donovan. Trolley-heads.
23 319 Alexander. (Newspaper Corporation). Printing telegraph receivers.
23 329 Clark's Neo-Electric Devices, Ltd. Electrical resistances.
23 333 M.L. Magneto Synd. & Watson. Magnetos.
23 338 Richardson Electric bulbs for headlights. (28/8/19, U.S.)
23 347 Bardeloni. Receiving methods for radio telegraph and telephone signals (10/1/18, Italy.)
23 368 Slee. Means for interrupting electric currents.
23 373 Oldham. Gas exits for galvanic batteries.
23 374 Oldham. Miners' safety, &c., electric lamps.
23 375 Wade. (Mills). Electric motor for driving phonographs, &c.

August 10, 1920.

23 391 Radio Communication Co. & Scott-Taggart. Modulation systems, &c., in radio communication.
23 427 Silbermann. Electric luminous writing machines.
23 442 Western Electric Co. Telephone systems.
23 450 Lee. Electric couplings.
23 461 Kühner. Electrostatic igniter.

August 11, 1920.

23 470 Byrne. Electric apparatus.
23 479 Angold & Railing. Arc lamps.
23 480 Angold & Railing. Means for charging accumulators.
23 529 Klotzli & Sohn. Prevention of overheating of electric irons.
23 535 Wright. Electric converter or generator.
23 537 Barfield & Wild. Electric furnaces.
23 540 B.T.-H. Co, & Martin. Electric ship propulsion.
23 541 B.T.-H. Co. (G.E. Co.) Electric resistance devices.
23 544 Lawton. Drums for automatically coiling electric cables.
23 565 Morris-Airey & Macrorie. Transmitting and receiving circuits for wireless telegraphy.

August 12, 1920.

23 603 Highfield & Calverley. Electric machines.
23 610 B.T.-H. Co., Trincham & Wallace. Protection of electrical apparatus and distribution systems.
23 645 Sterling Telephone & electric Co., Bell-Davey. Electric bells.
23 650 Glaser, Ltd. Current-regulating devices.
23 651 Harrison. Renewal of thermionic valves or amplifiers.

August 13, 1920.

23 664 Howarth. Apparatus for measuring maximum demand.
23 693 Payne. Alternating current electromagnetic engine.
23 696 Siemens-Schuckert Ges. Cooling arrangements for electric machinery. (8/10/19 Germany).
23 727 Western Electric Co. Determining transmission equivalent of an electric circuit.
23 740 Hopper & Woods. Brush holders for electric machines.

August 14, 1920.

23 761 Banks. Armatures for dynamo-electric machines, &c.
23 794 Carey-Gavey Synd. Alternating-current motors, &c.
23 798 Soc. Anon pour l'Exploitation des procedes, M. Leblanc-Vickers. Electric machines. (18/9/19, France).

August 16, 1920.

23 860 B. T.-H. Co. Frequency filters.
23 861 B. T.-H. Co. (G. E. Co.) Radio receiving systems.
23 863 Sullivan & Joseph. Variable electric condensers
23 899 Western Electric Co. Telephones.
23 904 Petra Akt.-Ges. fur Elektromechanik. Kinematograph projection apparatus (19/1/20, Germany.)
23 906 Pickie. Permanent magnets. (16/8/19, Germany.)
23 909 Bosch (R.) Akt.-Ges. Reversing direction of rotation of direct-current machines (16/8/19, Germany.)

August 17, 1920.

23 961 Crowther & Makower. Thermionic valves, &c.
23 964 B. T.-H. Co. (G. E. Co.) Radio receiving systems.
23 965 B. T.-H. Co. (G. E. Co.) Switches.
23 977 Prentice. Ceiling roses, cut-outs, connectors, &c.
23 978 Prentice. Switches.
23 979 Prentice. Distribution or fuse boards.

August 18, 1920.

24 011 Taylor. Transmission systems.
24 018 France. Filament lamps
24 042 Selective Signal Co. & Lyons. Electric oscillatory circuits.
24 054 Western Electric Co. Signalling systems. (31/10/19, U.S.)
24 058 Angus. Devices for supplying, &c., electricity.
24 059 Warner. Electric generators.
24 064 B. T.-H. Co. (G. E. Co.) Machines for making lamp bulbs, &c.

August 19, 1920.

24 162 Taddei. Electrically heated air waving appliances.
24 166 McClintoch & McKinnon. Electrolytic rectifiers.
24 198 Mauri. Three-phase electric furnaces.

August 20, 1920.

24 210 Morris. Electrolysis of acetone solutions.
24 241 Brader. Switches.
24 253 Ensign & Wadsworth. Circuit breakers.
24 262 B. T.-H. Co. (G. E. Co.) Motor control.
24 275 Akt.-Ges. Brown, Boveri & Co. Regulating resistances. (26/8/19, Switzerland.)
24 278 British Electric Transformer Co. & Roothaan. Transformers.
24 296 Lipke. Electric heater.
24 311 Zuckschwerdt. Switches.
24 314 Oldham. Galvanic batteries.
24 356 Elliston. Electric service lifts.

August 21, 1920.

24 320 Brown. Batteries.
24 328 Miller & Sanders. Fuse holders for car lighting systems.
24 329 Automatic Telephone Manufacturing Co. & Mercer. Circuit arrangements for controlling automatic selector switches
24 360 Andrews & Brough. Electric cut-out and theft-preventing devices for motor vehicles.

Companies' Reports, &c.

The directors of the Metropolitan-Vickers Electrical Company, Ltd., recommend the payment of a dividend on the ordinary shares of 12½ per cent. for the year ended Dec. 31 last.

The directors of Sir W. G. Armstrong, Whitworth & Company, Ltd., have declared a dividend of 5 per cent. on the ordinary shares, making 10 per cent. for 1920, against 12½ per cent. for 1919.

The directors of Hadfields, Ltd., recommend in addition to the interim of 6d. per share paid in July last, a further dividend on the ordinary shares of 6d. per share, making 5 per cent. (tax free) for the year.

Resolutions have been passed by the Shanghai Electric Construction Company, Ltd., for increasing the capital by £80 000 to £400 000 and for capitalising £80 000 by paying up in full 8 000 new shares of £10 each by way of capitalisation of profits.

The total receipts of the Isle of Thanet Electric Tramways and Lighting Company, Ltd., for the past year were £97 244. The balance at credit of revenue account is £24 797. A sum of £2 500 is placed to reserve, £10 000 to permanent-way reserve, and £4 284 carried forward.

The directors of the Electrical and Industrial Investment Company, Ltd., recommend the dividend of 6 per cent., less tax, on the preferred ordinary shares for the past year. A sum of £21 028 is being carried forward, subject to corporation profits tax.

The profit of the Electro-Bleach and By-Products, Ltd., for 1920, after deducting repairs, standing charges, depreciation, income-tax, debenture interest, &c., and making provision for taxation, was £51 643. With £4 277 brought forward the total was £55 920. The directors recommend a dividend of 25 per cent. on the ordinary shares, carrying forward £5 920.

The accounts of the British Aluminium Company, Ltd., for 1920 show a profit (including amount brought forward), after making provision for taxation, and charging amounts required for service of prior lien debentures and debenture stock, depreciation reserve of £137 612. A sum of £50 000 has been set aside for depreciation and £50 000 to reserve, and the director recommend a final dividend at rate of 12 per cent. on the ordinary shares, making 10 per cent. for year, carrying forward £19 534.

The notice relating to the payment of the half-yearly dividends on the preferred stock and preference shares of Vickers, Ltd., states that while the books of the company for 1920 are practically complete as far as ordinary transactions are concerned, there are still outstanding questions with Government departments of such importance that it is not yet possible to present final accounts for the year.

The directors of Stewarts & Lloyds, Ltd., recommend, after setting aside £70,000 for depreciation and after making provision for estimated liability for taxation, a dividend on the deferred shares of 2s. and a bonus of 1s. per share for the past year; on the deferred (10s. paid) 6d. and bonus of 3d.; and on deferred issued in exchange for shares in Alfred Hickman 1s. and bonus of 6d. per share, all free of tax; placing £150 000 to reserve, £10 000 to employees' benefit reserve, carrying forward £110 000.

During the past year the Newmarket Electric Light Company, Ltd., connected the equivalent of 3 241 33-W lamps to the mains, making the total 38 933 lamps. The gross profit for the year was £2 952 18s., compared with £2 351 5s. in the previous year, which, after providing for debenture interest (£710) and adding £303 brought forward, leaves £2 546. The directors recommend that a dividend of £3 per cent. be declared, that £1 500 be carried to reserve for renewal of plant, and that the balance of £249 be carried forward.

The report of Browett, Lindley & Company, Ltd., for 1920 states that, after deducting £2 399 for debenture and bank interest, writing off £4 292 for depreciation, and making provision for income tax, the net profit is £8 694, which, with £9 484 brought forward, makes £18 178. The year's dividend on the six per cent. preference, and a further dividend of 6 per cent. on preference on account of arrears absorbed £6 000. A dividend of 8 per cent. on the ordinary shares (against 12 per cent. in previous year) required £3 000, leaving £9 172 to carry forward.

The profit earned by the Waste Heat & Gas Electrical Generating Stations, Ltd., in the year ended Jan. 31, after deducting administration expenses, was £34 439 (against £39 626 in previous year). The directors have transferred to reserve £14 000 (£1 3500), and after adding amount brought forward (£1 764) the amount available is £38 203 (£43 464). The directors recommend that a dividend be declared at the rate of 8 per cent. for the year (£25 600), of which 2½ per cent. was paid in August last, leaving £12 603 to be carried forward.

The following companies will be Struck off the Register of Joint Stock Companies unless cause to the contrary is shown before May 22: Bourne End Electric Installation Co., Cold Light (Dussaud Processes), Goddard, Massey & Warner, Indian Railless Traction, International Electric Railways & Water Power Syndicate, Kamm's Zerograph Syndicate (1905), Northern Power Syndicate, Page's Engineering Weekly, P-a-y-e (London) Syndicate, Premier Electric & Hardware Company, Radium-Uranium Syndicate, Railway & Tramway Advertising Concessions, Richardson's Turbine Company.

At the recent meeting of the Hastings & District Electric Tramways Company, Mr. George Kitchin stated there was an increase of £20 786 over the previous year in the traffic receipts, mainly due to the rise in fares, as they carried 1 304 630 fewer passengers than in 1919. The extra expenses amounted to £15 538, power expenses showing an increase of £6 192 and traffic expenses of £5 830. After allowing for payment of interest on debenture stock and loans, &c., the available balance was £10 000. They proposed to place £3 000 to depreciation account, to pay the preference shareholders the full dividend of 6 per cent. for 1920, and 1½ per cent. on account of the arrears for 1919 and to carry forward the balance of £999 17s. 9d.

Mr. Chas. Ker, who presided over the annual meeting of the Clyde Valley Electric Power Company last week, referred to the effect on the company's business of the high price of coal, which accounted for over 60 per cent. of the total cost of production. That did not affect the company directly so seriously as it might appear, as, owing to their sliding scale of charges, they were enabled to pass on a certain proportion of the increase to the customers, but the effect of the high price of coal on industry generally tended to restrict the output of electricity. In his opinion, there could be no real prosperity in industry until the price of coal became more normal. He also referred to the heavy burden of taxation. In view of the high cost of production, the profit for the year was most satisfactory, and the contracts for supply showed an increase during the year of 11 307 h.p. and connections to mains an increase of 8 954 h.p.

The directors of the International Automatic Telephone Company, Ltd., report that for the ten months ended Dec. 31, 1920, the profit was £11 778, and after paying directors' fees and the dividend on the preference shares (£11 144), the balance £634 is to be carried forward. The activities of the allied company (the Automatic Telephone Mfg. Company) during the past year have been largely devoted to the reorganisation of their works and personnel, necessary to attain quantity production of automatic telephone apparatus to cope with the large foreign orders received under the manufacturing contract entered into on the formation of the International Company in March last. Consequently, the actual output of completed work was restricted, although a large amount of work has been done towards the fulfilment of the orders on hand.

The profit of the Automatic Telephone Company, Ltd., for the year 1920 was £15 370, plus £9 341 brought in, making £24 711. Deducting directors' fees (£2 850), depreciation on patents, goodwill, plant, &c. (£3 000), dividend on preference shares (£12 000), there is a balance to carry forward of £6 861. Activities during the year have been chiefly devoted to special measures necessary to give effect to the agreement with the International Automatic Telephone Company for promotion of overseas sales of Strowger automatic telephone apparatus. Orders of considerable value have resulted from the alliance, and, to cope with these, extensive additions to personnel have been necessitated. Much productive work had been accomplished against automatic telephone contracts, but manufacturing period was too limited to enable any appreciable volume of this work to be converted into sales. For this reason, coupled with heavy development expenses, the profits will not allow of a dividend on the ordinary shares.

The chairman of the Liverpool District Lighting Company, Ltd. (Mr. Chas. McLaren) stated that last year's turnover profits and the output of electricity had established records. The turnover had advanced from £15 734 in 1919 to £21 406, an increase of 36 per cent., owing to the large amount of new business obtained during the past year. The profits increased from £5 983 in 1919 to £7 221 in 1920, or 20 per cent., and the units sold had advanced from 596 631 to 720 171, or 20 per cent. The working costs had increased by ⅛d. per unit, due to increased price of coal. The gross profit was £6 640. Deducting depreciation (£1 252) and interest on special account (£427) there was a balance of £4 960, out of which the directors recommended a dividend at the rate of 5 per cent. per annum, £2 000 being added to reserve. A large number of new houses were being built in the neighbourhood of Blundellsands and Crosby, all of which required electricity for lighting, heating and other purposes. In order to supply those a considerable quantity of new cable would have to be laid, and their engineer reported that extra plant would be needed in the generating station at Waterloo.

The chairman of the Para Electric Railways & Lighting Company, Ltd. (Mr. Follett Holt) explained at the recent meeting of shareholders that owing to the fall in exchange the directors had decided to reduce the dividend from 8 per cent. to 6 per cent. for the past year. They had carried £10 000 to the general and contingencies reserves and a further £10 000 to depreciation reserve. The reserves (over £200 000) had been used for the development of the company's property on capital account, and the shareholders had not been asked to provide any additional capital for a great number of years. Last year the capital expenditure was £10 212, and was employed in extensions of the lighting system, including part of the cost of building the transmission line to the village of Pinheiro. The local gross receipts were slightly less than those of the year before, chiefly owing to certain concessions made both for public and private lighting. During the latter part of the year traffic returns were less satisfactory, due to the unfortunate state of the rubber market, on which the prosperity of the City of Para was largely dependent. The condition of the rubber market, chiefly governed by the Eastern plantation rubber, was critical, and there was little doubt that the year 1921 would put the commercial endurance of the Amazon Valley to a severe test.

The gross receipts for year ended Nov. 30, 1920, decreased from £299 282 to £296 897; operating expenses increased from £152 779 to £175 032; net revenue earned in Para, after allowing for loss on exchange, was £112 124, against £129 383. Adding interest, transfer fees, &c. (£53 46), and deducting provision for income tax and other charges and London office expenses (£19 845), debenture interest and sinking fund (£38 500), there remains £59 125 (against £79 206), plus £21 931 brought in. After making provision for depreciation and renewals, &c., a final dividend of 3 per cent. (less tax) on the ordinary shares (making 6 per cent. for the year) was declared, carrying forward £18 157.

In moving the adoption of the report and accounts at the annual meeting of Pinchin, Johnson & Company, Ltd., last week, the chairman (Mr. Edward Robson) referred to the very satisfactory results obtained from the past year's trading, in spite of the difficult trading conditions that had developed in the latter months of the year. The net result, after providing for all expenses, depreciation and taxation, showed a net profit of £72 282, which, added to £4 642 brought forward, gave an available balance of £76 924. After paying 15 per cent. on the ordinary shares (less tax) there remained £29 088, which the chairman recommended be disposed of by the allocation of £10 000 to reserve, £8 500 to be written off preliminary expenses of the new capital issue, and to carry forward £10 588. Doing a very extensive business, such as they were, it was necessary to carry extensive stocks, and although on some commitments there had been fairly substantial depreciation in the latter months of the year, the directors had adopted the sound course of writing down the trading stocks to current market prices, which placed their business in a very strong position to withstand what remained of the present trade depression. During the year the company had extended its operations in every market of the world, and in output, volume of sales and net profits the results constituted a record. Arrangements have been completed for substantially increasing the production at their several factories, and they were now in a position to deal very efficiently with a much greater volume of business than ever before. Their sales organisation had also been consolidated and extended in every direction, and they were now in an excellent position to give a service for their extensive variety of products that could be equalled by few companies in Europe.

Mr. J. H. Armstrong presided over the annual meeting of the Newcastle-upon-Tyne Electric Supply Company, Ltd., last week, and moved the adoption of the annual report and accounts. He announced that he proposed to retire, and Mr. R. P. Sloan, C.B.E., would succeed him as chairman and managing director.

Mr. Sloan explained the financial position, and stated that the year under review had been one of considerable progress, but it had also been one of anxiety and difficulty. In the early part of the year the trade of the district was much affected by the moulders' strike, and in October business was seriously handicapped by the miners' strike. They were disappointed in their anticipation that during the latter part of the year they would get some revenue benefits from the new generating plant at the new station on the River Tees and at Dunston power station. Further sections of plant at both stations would, however, be brought into operation shortly, so that before long the cause of anxiety should be removed. During the year the connections to their system amounted to 25 203 h.p., and with the connections made in the Cleveland area, an additional 16 846 h.p., the total was 42 049 h.p. They had thus created a record—the previous maximum being in 1913, when the total was 39 920 h.p. The year's profit was £392 643, or £144 449 in excess of that for 1919 (a very disappointing year), and an excess of £50 249 over 1918. The additional capital expenditure (£475 459) had been incurred largely on power station buildings, machinery and electrical instruments, &c. The programme of extensions at Carville power station, which had been in hand for many years, had been completed. That power station had a capacity of over 130 000 h.p., and was the largest generating station in operation in the United Kingdom. During the current year they would reap considerable benefit from the operation of the new generating plant in the Tees and Dunston stations. They had on hand at present additional applications for connection to their system, representing over 70 000 h.p., and although, nowadays, there was a considerable lapse of time between a request for supply and the revenue earning stage, they hoped to get some benefit during the current year as a result of their large order-book.

New Companies.

The following list is compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, Chancery-lane, London, W.C. 2:—

C. F. ELWELL, LTD. (173,566.)—Reg. March 6, capital £50 000 in 40 000 A ordinary and 10 000 B ordinary £1 shares, to acquire benefit of inventions connected with radio telegraphy and telephony and develop and work same. Directors: J. H. Scrutton (chairman), B. Binjon, C. J. Elwell, and B. C. Mittell. Private company. Reg. office: 12, Craven House, Kingsway, W.C. 2.

FOGDEN'S ELECTRIC COMPANY, LTD. (173 508.)—Reg. March 4, capital £2 000 in £1 shares, to carry on business of electricians, electrical, mechanical, sanitary, gas and water engineers. Directors: Bertha Fogden, Blanche Fogden and A. F. Wilson. Reg. office: 23, The Broadway, Leigh-on-Sea, Essex.

HENRY ROGERS ENGINEERING COMPANY, LTD. (173 531.)—Reg. March 5, capital £30 000 in £1 shares, to carry on business of marine, aviation, electrical, motor and general engineers. Directors: L. H. Twentyman, H. E. Twentyman and A. H. Twentyman. Regd. office: Union-street, Wolverhampton.

MACQUEEN'S STANDARDISED ALUMINIUM ALLOYS, LTD. (173 553.)—Reg. March 7, capital £100 in £1 shares, to acquire the sole manufacturing, utilising and selling rights of a perfected process of standardising the alloys of aluminium. Directors: L. E. MacQueen and L. A. MacQueen. Reg. office: 267, High Holborn, W.C. 1.

WYE LIGHTING, HEATING & POWER COMPANY, LTD. (173 525.)—Reg. March 4, capital £5 000 in £5 shares, to light with gas, electricity, oil or other illuminating means, the roads and houses in Wye, Kent. Directors: J. P. Sharples, J. Long and S. D. F. Harwood. Reg. office: 7, Bank-street, Ashford, Kent.

The Electrical Trades' Directory.

The Thirty-ninth Edition of The Electrician Electrical Trades Directory and Handbook, commonly known as the "Big Blue Book," is now available, and its contents have undergone careful revision. The Handbook Section contains much useful technical, commercial, legal and other information, including a number of electrotechnical tables and data, particulars of resistance materials, electricity supply cables, wire gauges, aluminium data, notes on illumination, periods allowed for repayment of municipal loans for electricity supply, interest and sinking fund tables, &c. Particulars are given of the work of the British Engineering Standards Association, the International Electrical Commission, the list of International Symbols, the Imperial Ohm, Ampere and Volt, the Standardisation Rules of the British Electrical and Allied Manufacturers' Association, details of the Import Duties leviable on electrical machinery in the British Dominions and Colonies and in foreign countries, lists of trade commissioners and commercial correspondents abroad, &c.

The telegraphs and telephones section contains the International Telegraph Convention, particulars of the work of the International Telegraph Bureau, the International Service Regulations, statistics of the submarine cables and landlines of the world, means of telegraph communication between Great Britain and other parts of the world, telegraph tariffs, the world's cable-laying fleet, the International Radio-Telegraph Convention, British Wireless Telegraph Regulations, wireless telegraphy on ships, international call signals and the law relating to telegraphs and telephones. Particulars are also given of British, Colonial and Foreign Electrical Engineering and Scientific Societies, the names of the professors and teachers of engineering and scientific subjects in the universities, university colleges and technical schools, the chief officials of the engineering and technical sections of British, Colonial and Foreign Government Departments, the Rules of the Institution of Electrical Engineers relating to electric wiring and the electrical equipment of ships. A special feature of the Handbook Section is a full digest of the law of electricity supply and electric traction, and the new issue of the book incorporates the numerous changes made by the Electricity Supply Act of 1919. It also gives the latest forms of the regulations and orders of the Ministry of Transport and the Electricity Commissioners relating to electricity supply.

In the British Alphabetical Division of the Directory are included the names, descriptions and addresses of everyone engaged in or connected with the electrical and allied trades, while the Classified Section contains full lists of the firms and persons engaged in the manufacture or supply of electrical plant and apparatus. The Colonial, European, Asiatic and African, Central and South American and United States Divisions are arranged in a similar manner, and there is also a useful list of telegraphic addresses of firms in the British Division. The published price is 25s. net, and copies may be obtained from Messrs. Benn Bros., Ltd., 6 and 8, Bouverie-street, Fleet-street, E.C.4.

Prices of Metals, Chemicals, &c.

Tuesday, March 29.

		Price.	Inc.	Dec..
Copper—				
Best selected............	per ton	£70 10 0	£2 0 0	—
Electro Wirebars ...	,,	£73 0 0	£1 10 0	—
H.C. wire, basis	per lb.	0s. 11⅜d.	0s. 0⅛d.	—
Sheet	,,	1s. 0½d.		—
Phosphor Bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. 3⅜d.	0s. 0⅛d.	—
Brass 60/40				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1½d.	—	—
Wire, basis	,,	1s. 1½d.	—	—
Pig Iron—				
Cleveland Warrants .	per ton	£7 15 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£29 0 0	—	—
Lead Pig—				
English	,,	£21 10 0	£1 10 0	—
Foreign or Colonial ...	,,	£20 5 0	£1 5 0	
Tin—				
Ingot	,,	£165 15 0	£9 5 0	—
Wire, basis	per lb.	2s. 3½d.	0s. 1¼d.	—

Salammoniac.—Per cwt. 100s.-95s.

Sulphur (Flowers).—Ton £14 10s.

,, (Roll-Brimstone).—Per ton £14 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £32 10s.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 10d.

Sodium Chlorate.—Per lb. 5d.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

The Editorial, Advertisement and Publishing Offices of "The Electrician" *are at* 8, *Bouverie Street, London, E.C.* 4. *Telegrams: Benbrotic, Fleet, London. Telephone: City* 9852 (5 *lines*).

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Forty Years Ago.

(The Electrician, April 2, 1881.)

The City and Guilds Technical College.—Prince Leopold has consented to lay the foundation stone of the City and Guilds of London Technical College, in Finsbury.

The Society of Arts.—Mr. W. H. Preece read a Paper before the members of this Society on Wednesday, on "Recent Advances in Electric Lighting." We hope to find room for this lecture in an early number.

The Society of Telegraph Engineers and of Electricians.—At the next meeting of this Society, which is fixed for the 14th inst., a Paper will be read by Mr. St. George Lane Fox on the subject of "Electric Lighting."

To Our Friends Abroad.—The enlargement of this journal, which commences with the present number, seems a suitable occasion for again inviting our readers at foreign stations to favour us with any pieces of intelligence that may be of interest to readers stationed elsewhere. The Electrician circulates in every quarter of the globe, and we desire not only to publish the best home news relating to the progress of electrical science, but also such general news as may have a special interest for cable companies' clerks wherever they may be situated. From gentlemen in charge of technical departments we shall always be glad to receive contributions. The opportunities for observation of electrical phenomena at foreign stations are quite exceptional, and the results would often be esteemed of great value here. No more suitable medium for publicity exists in this country than the pages of The Electrician.

Benn Brothers Journals.

Some Features of the Current Issues.

"The Cabinet Maker": "The Wholesale Furniture Exhibition"; "Ireland and the Furnishing Trade"; and "Practical Polishing."

"Chemical Age": "Materials of Construction used in a Chemical Works" (1), by Geo. B. Jones, A.M.Inst.C.E.; A.I.C., and "The World's Petroleum Supplies."

"Farm and Home": "Hedge-Clearing and Stump Extraction"; "An Easter Opportunity"; and "How I secured a Holding," by Ex-Service Man.

"Fruit-Grower": "Control of the Carrot Fly"; "The National Fruit Show"; and "Echo of the Hull Conference," by F. R. Ridley.

"Hardware Trade Journal": "The Electro-plate Department"; "The Cost of Light Castings"; and "Gunmetal and Its Capabilities."

"Gardening Illustrated": "Hardy Spring Treatment of Ferns"; "Rotation of Vegetable Crops"; and "Watercress for Small Gardens."

Arrangements for the Week.

FRIDAY, April 1st (to-day.)

Junior Institution of Engineers.

7.30 p.m. At 39, Victoria-street, London, S.W. Lecturette on "Pneumatic Conveyors," by Mr. M. Jennings.

SATURDAY, April 2nd.

Midland Institute of Mining, Civil and Mechanical Engineers.

2.15 p.m. At the Danum Hotel, Doncaster. Paper on "Electric Haulage and the Elimination of Pit Ponies," by Mr. S. Diggle; "Firedamp Explosions," by Prof. R. V. Wheeler; Abstract of the No. 1 Memo. of the Miners' Lamp Committee, by Prof. F. E. Armstrong; and "Metering of Compressed Air," by Mr. J. L. Hodgson.

MONDAY, April 4th.

Institution of Electrical Engineers—Western Centre.

6 p.m. At the Public Library, Alexandra-road, Swansea. Lecture on "The Commercial Application of Variable Speed Motors," by Dr. S. P. Smith.

TUESDAY, April 5th.

Institution of Civil Engineers.

5.30 p.m. At Great George-street, London, S.W. Paper on "Airship Sheds and their Erection," by Mr. L. H. Larmuth.

WEDNESDAY, April 6th.

Iron and Steel Institute.

3 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. General discussion on "Failure of Metals."

Institution of Electrical Engineers—North-Western Centre.

7.30 p.m. At the Municipal College of Technology, Manchester. Popular lecture on "Developments in Wireless Telegraphy and Telephony," by Prof. E. W. Marchant.

THURSDAY, April 7th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Some Recent Developments in Steam Turbine Practice," by Mr. K. Baumann.

FRIDAY, April 8th.

Physical Society.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers on "A New Registering Microphotometer," by Dr. W. J. H. Moll; "The Examination of the Structure of Crystals in the form of Powder by Means of the Ionisation Spectrometer," by Sir William Bragg, K.B.E., F.R.S.; and "A Balance Method of Using the Quadrant Electrometer for the Measurement of Power," by Mr. H. Parry.

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Notes.

The Institution and its Council.

On another page of this issue will be found the names of the official nominees for those vacancies on the Council of the Institution of Electrical Engineers which will occur on September 30th next. Mr. J. S. Highfield is put forward for the office of president and Prof. E. W. Marchant and Mr. C. C. Paterson for the two vacancies in the ranks of the vice-presidents, Mr. A. A. Campbell Swinton being, of course, left to work out the rest of Mr. S. L. Pearce's term. Six nominees are suggested for the four vacancies among ordinary members of Council and two for the two vacancies in the associates section. The influence, therefore, which the ordinary member can exert on the constitution of the Council, an influence which we are told is the best way in which the wishes of the profession and industry can make themselves felt, is both relatively small and rather less than usual, unless, of course, opposing nominees are put forward under the authority of Article 50 of the Articles of Association.

The New President and the Vice-President Question.

The election of a president with such a wide knowledge of the intricacies of electricity supply as Mr. Highfield will be welcomed at this juncture. His experience in this field should be of the greatest value to the Institution, and we look forward to his having a very successful year of office. The nomination of Prof. E. W. Marchant and Mr. C. C. Paterson raises once again the question to which we referred last year of the recruitment of vice-presidents. Both these gentlemen are at present serving on the Council as ordinary members, so that their promotion enables their experience and advice to be retained for a further period. This is one side of the picture. On the other hand, when their term of office as vice-president expires they must either proceed to a still more exalted position, as Mr. Highfield has done, or, as is more probable, since only one vacancy for president occurs each year, they must join that ever increasing band of vice-presidents who have suffered partial eclipse. This is not a good arrangement for the Institution, and, as we have pointed out before, it would be better for the selection of names, which must of necessity occur, to be made from members of Council and not from the vice-presidents. We should like to see the status of the vice-presidency raised to a higher level, and to be a direct stepping-stone to the presidential chair. Again, a period of years should elapse between one term of service on the Council and the next. Only in this way can representation be spread over as large a number of members as possible. These criticisms are, we hasten to add, put forward in no personal spirit, and we quite unreservedly congratulate Prof. Marchant and Mr. Paterson on their well-deserved promotion, a promotion which is not only an honour to themselves, but a reflected glory to the Institution.

A Bolder Policy.

We are glad to see among the nominees for vacancies for ordinary members of the Council a number of fresh names. We hope that this is an indication of the adoption of that bolder policy which we have often advocated of infusing new blood into the governing body. Among these new names are Col. H. E. O'Brien, Mr. A. Page, Mr. T. Roles and Capt. H.

J. Round, though Mr. Roles has already served on the Council as the chairman of a local section. They represent a variety of interests which is all to the good, but what will happen if the Council (including Mr. Page) falls out with the Electricity Commissioners (including Mr. Page)? Of the other two members nominated for these vacancies, Mr. S. Evershed will generally be welcomed, as an elder, if not an older, brother, while Mr. A. L. C. Fell will not unlikely secure election, not only on personal grounds, but as a representative of a section of the industry which is now passing through a very anxious and trying time. But a more important matter than the names and qualifications of the nominees for the Council is the interest, or lack of interest, which the members take in the election. It is encouraging to find that this interest is increasing year by year, but it is still small compared with what it should be. We hope that on this occasion a very much larger percentage of the members than heretofore will take the trouble to send in their ballot papers. One other little matter: Is it really necessary to send out the nomination paper at the latest possible legal moment? It creates an appearance of evil which is unwise in these democratic days.

"A Plague on Both Your Houses."

The general public is inclined to the view that it ought not to have happened and to exclaim with Mercutio "A plague on both your houses." "It," of course, is the situation in the coal industry, describe it how we may, whereby our vitally necessary supplies of fuel have been cut off in order, if we understand Mr. Hodges aright, to ensure a supply of cheap coal without reducing present wages. For ourselves, and we are sure we speak for the electrical industry, we should like to see this paradox translated into hard fact. Unfortunately, hard facts do not square with rhetoric, whether Mr. Hodges' or anybody else's; and we are, therefore, certain that, whatever the outcome of the miners' present policy is, it will not reflect much of that altruism towards the public which has recently become a part of the labour leader's stock-in-trade. It is evident, without discussing the rights and wrongs of the dispute, that this cessation from work by those engaged in the coal industry is yet another of those blows in the back which have made our trade recovery so slow. The effect of that blow cannot but be felt for a long time not only by the industry, but by Labour generally and not least by the miners themselves. It is indeed a sorry comment on the intellect of those who would be our rulers, that not only does this cessation of work receive no condemnation from other industrial organisations, but there are even to be found those who would support it by doing likewise.

The Demands in Essence.

The miners demand in essence, though not in presentation, is that they should be subsidised by the other industries. Being refused this somewhat ingenuous request they have withdrawn their labour, though it is open to them to take wages on a lower scale than those which they are at present receiving, and so play their part in once more placing the industry on a sound foundation. A grave fault is, therefore, theirs. On the other hand, the employers' operations have been shrouded in a secrecy which a few days' strike is only beginning to relieve and have been marked by an absence of tact which is equally deplorable. Both the miners and the public should be told more and in a clearer fashion about the extent of the proposed reductions in wages rates and how far these are only basic. They should also be told how far each grade is effected and how far each man has it in his power to increase the basic amount he will receive by his own output. Unfortunately, however, we have not yet got to that stage when discussion of details can be profitably undertaken. For the miners' demands for consideration of the wages question on a national basis and that any deficit should be met by a pooling of profits or by a Government subsidy has ruled out any calm consideration of the questions at issue.

X-Ray Dangers.

The recent deplorable succession of deaths of eminent radiologists in this country and abroad has arrested the public attention. Our knowledge of the precautions necessary for the safety of the X-ray worker has been bought dearly. It is now realised that while such precautions are successful in safeguarding the patient, those precautions are not always adequate for protecting the radiologist, who is continually employing the rays. The dangers arising out of the use of X-rays are probably not yet fully known, but within our experience the mischief may take two forms: The long-waved (or soft) rays may occasion dermatitis or even cancerous growths; the short-waved (or hard) rays may damage the deeper, including the blood-forming organs. Casualties of the first type are now prevented by the protection (sheet-lead, lead-glass, and the like) which forms part of all X-ray installations.

The Short Wave Problem.

But as his technique has developed, more especially in deep therapy, the radiologist has demanded shorter and shorter wave-lengths, and the exciting voltages (whether with the Coolidge or gas tube) have crept up from the neighbourhood of 100 000 to the region of 250 000 V. It is not for us to say whether such high potentials are essential to the radiotherapist, but it would certainly seem from recent unfortunate happenings that the protective measures have not kept pace in most institutions with the enhanced penetrability of the rays. The conditions were doubtless aggravated during the war, when radiologists were grossly overworked.

The Necessity for Expert Advice.

Nevertheless the work of radiotherapy must not be arrested in the smallest degree; the results already obtained are too valuable and encouraging for that. We would, however, suggest that most hospitals and private practitioners would do well to have their X-ray protective measures reported on by some independent authority of standing, for example, the National Physical Laboratory. Not only protection, but the ventilation of operating and dark rooms should be gone into. Very high voltages bring coronal discharges in their wake, and the air is being continually fouled with nitrous fumes. The difficulties of providing efficient safeguards for the health of the operator may be considerable, but there is little doubt they are surmountable. For the rest, we would give our whole-hearted support to the scheme which has been launched for founding an X-Ray Institute in London, where the many problems of radiology could be thrashed out for the benefit of all concerned.

The Key Industries Bill.

Both those whose political bias is in favour of a tariff and those who prefer Free Trade will view the two financial resolutions which are to be proposed in the House of Commons as a preliminary to legislation for safeguarding British industries from foreign competition with some suspicion. These resolutions will, if passed, be given effect to in this year's Finance Act. The first provides for the levying for a period of five years of a $33\frac{1}{3}$ per cent. *ad valorem* duty on certain commodities whatever the country of their origin. Among the articles scheduled are scientific instruments and glassware, magnets, magnetos, arc-lamp carbons, wireless valves, rectifiers, vacuum tubes and tungsten products. Whether the list is sufficiently comprehensive is open to doubt, but presumably opportunity will be given to discuss the matter and omitted articles, such as electric lamp bulbs, added if the manufacturers make out, as we believe they can, a good case for their inclusion. As these articles come chiefly from Germany they are already subject to a 50 per cent. tax under the Reparations Recovery Act. The second resolution is designed to protect manufacturers against "dumping" either of the ordinary kind or due to the rates of exchange enabling goods to be sold in this country at prices below those at which we can profitably manufacture them. This is to be effected by a Customs duty of $33\frac{1}{3}$ per cent. on the value of any article which has been scheduled by the Board of Trade under the provisions of the Act. Thus German magnetos, for instance, might, under the joint operation of the Reparations Act and these resolutions, be subjected to a tax of $116\frac{2}{3}$ per cent.

The Drawbacks of the Scheme.

But, in our opinion, any advantage, real or presumed, that would be likely to accrue from the protection thus provided would be more than counteracted by the fact that selection of the amount of the duty and of the articles on which it is to be imposed will be vested in the Board of Trade. We are informed that the resolutions are framed in general terms and provide wider powers than would be sought for in the Bill itself. But they are, in fact, so wide and so arbitrary that they are likely to defeat the good purpose which they are designed to attain and to be open to the suspicion that they are only in thin disguise the beginning of another attempt to increase the power of our bureaucrats. The duty of the bureaucrat, whose numbers should be strictly limited, is to administer and not to govern. But while the policy which the resolutions foreshadow may prove a real assistance to certain of our growing industries, that assistance will certainly be as the inverse of the square of the amount of Government interference. That being so, we feel it best to defer any criticisms of details until this larger question has been satisfactorily settled, as we hope it will be, in the House of Commons which is the place where this sort of thing should be arranged once and for all without any loophole being left for the admission of official-made regulations.

The late Mr. Tom Ernest Gatehouse.

The exact influence that the Press of a country exerts on the actions and thoughts of the inhabitants must always be a matter for profound speculation. But whether that influence be small or great, for good or evil, its amount is undoubtedly determined by the character and energy of those who by their work on the various journals in some measure direct and control its tendencies. The more individualistic the outlook of those concerned the more arresting their message and the greater and more widespread the loss that is felt when Death lays his hand upon them. Heavy as this loss and great as the void must be in the case of the lay Press it is even greater in the case of a technical or trade, and therefore a specialised, journal. We must, therefore, offer the profoundest sympathy, in which we feel sure our readers will join, to the proprietors of our contemporary, "The Electrical Review," on the loss of their editorial and technical director, Mr. T. E. Gatehouse. Mr. Gatehouse has been connected with the "Review" for a space of some 40 years, during which period it has operated in parallel with The Electrician. But in spite of, or perhaps because of, the friendly rivalry that has existed between us on the business side, our relations have always been of the most cordial; and we can, therefore, appreciate more than most the loss which the electrical industry has sustained in Mr. Gatehouse's death.

Electricity in Housing.

The object of the special issues which we publish from time to time is frankly to assist in the development of the electrical industry. The Electrician Spring Trade Promotion Number, which appears to-day, deals, however, principally with housing, using that term in the broadest sense, and its use in furthering the expansion of the industry may at first sight therefore not be very clear. For a number of the articles are not on electrical matters, but deal with housing problems from the architectural, medical, physiological and sociological standpoints. Nevertheless the same idea will be found running, like a guiding thread, through the various opinions expressed and among the various viewpoints taken up. That idea is that one of the most pressing, if not the most pressing, of our national needs is not houses in the abstract, but houses that can be kept clean, warm, well-ventilated and comfortable, with a minimum of labour and with the least possible expenditure of time and money.

A Supposition as a Foundation.

This fundamental note will be seen on careful consideration to be illustrative of the change which has occurred during the past few years in our domestic policy. It is a change of outlook which is at once a revolt and a revolution. For the design of the houses in which most of us live, when it is not based on immemorial tradition, has as its foundation the supposition that sufficient servants will be available to perform that round of never-ceasing work which is necessary to keep such a building in a comfortable, not to say sanitary, condition. A secondary supposition, which is not without its influence, is that as servants must be paid they may as well be kept employed.

Such a tradition, besides being ethically wrong, forms, as Mr. Imrie points out, one of the greatest obstacles to any improvement in house design. For even the most radical of architects finds that his freshest ideas can never flower because they are cast on the stony ground of conservatism, a conservatism which is stronger in the domestic circle than in perhaps any other. Fortunately for progress the vacuum created by the lack of servants is removing this conservatism, and, as is not unusual, the force of change is being felt most severely by the middle classes of the community. Plutocrats, both ancient and modern, can still afford and obtain servants, while the self-dubbed proletariat have their own ways of dealing with the domestic problem. But the middle classes have been forced to realise that a corps of servants is a luxury they must do without, and that even occasional domestic help is often more bother and expense than it is worth.

"Servantless" and "All-Electric" Houses.

It is, therefore, not surprising to find that a demand has arisen for a class of house which shall be so designed that the necessary domestic labour to maintain it shall, by an elimination of all useless operations, be a minimum. It is still less surprising to find that this labour-saving can only be achieved by electrical means. In other words, the middle class householder must now make his choice between a human and an electric Mary Ann. If he can obtain a house designed on the lines suggested by Mr. Imrie there is no doubt what his choice will be. He will thereby save money and increase his comfort. For such a house as Mr. Imrie describes, with its electric heating and cooking, its psychological coal fire in the living room and its useful coal-fired boiler in the outhouse, its plate washer and its modern ventilating arrangements, combined with an absence of both back door and scullery, offers at once an encouragement and solution of the domestic problem which the middle class sorely need.

Propaganda, Education and Nursing.

Unfortunately there are many factors which prevent this development being so extended as we could wish. Conservatism is one of them; the competition, often unfair, of the gas interests is another, and assisting both of these is that British love of compromise which in this case is unfortunately likely to lead to a second best solution being adopted rather than one which would mean a real improvement in many of the conditions of present-day existence. For this state of things, as Mr. Hoadley rightly points out, propaganda and education are the remedies, but combined with these must go a close attention on the part of the supply engineer, and of the contractor, too, to the nursing of the consumer, so that after he has installed electrical equipment there may be no doubt that it is being used in the right way and is functioning in the most efficient manner. Attention to the consumer is a psychological point the importance of which is too often unrealised by electrical engineers. For whether the apparatus be working well or ill the consumer finds in the solicitude of the electricity authorities for his welfare a comfort and a guerdon which it is well worth the expenditure of a little time and expense to obtain.

Preliminary Work at Once.

There is therefore every reason why electrical engineers should pay the closest attention to housing questions, allowing their minds to dwell on the subject in the broadest possible way. Above all the pessimism, which is now not unnaturally prevalent, must be prevented from acting as a discouragement, nor must the inevitable hard work which will be necessary before we can realise our ideals of an "all-electric" country be an obstacle. The time is now ripe for great developments. For while it may be admitted that for the moment not much actual work can be done there are certain preliminaries which can be dealt with. Among these the most important is the education of the public, and no less the education of electrical engineers and the electrical industry, generally, in electrical ideas. For it is extraordinary to find that the public are in many ways more enthusiastic about the "domestic-electric" idea than is the electrical engineer, and though we agree that this attitude may be ascribed to ignorance it will be noted that we are careful to avoid saying on which side the ignorance lies.

Need for Suitable Design.

In inaugurating this education the fact that one of the reasons which is retarding the development of the domestic electric idea is that neither in design nor in manufacture is some of the apparatus which is being put on the market as good as it should be must not be overlooked. This is a point to which we have called attention before; a point to which it has been said publicity should not be given. But in our view the electrical industry can gain nothing by deceiving itself as to the quality of its products and it is therefore much better that we should realise and remove existing defects in domestic electric apparatus rather than leave them to be discovered by the public in what may be somewhat trying circumstances.

A Wide Field of Development.

As a field for electrical development housing is so wide that it is difficult to set any limits to what may be done in it. And while this development will be for the good of our industry it will, as Mrs. Councillor Palmer truly says, solve many domestic problems, lead to an improved environment for the individual, remove many inherited evils which are directly due to bad housing, check infant mortality and decrease immorality. This improvement in housing conditions will also bring with it a change in our methods of existence by the replacing manufacturing towns by garden cities where everyone's work shall be within walking distance of his home, where transport difficulties will be reduced to a minimum and where the amenities of life shall be within reach of all. This state of things, whose consummation is devoutly to be wished, can only come about with the assistance of electricity and electrical engineers, to whom the country looks to rid them of many of their present discontents. For it is axiomatic that much industrial and social unrest is due to that lack of fresh air which is imposed by present housing conditions in our large towns. Bad housing is indeed a festering sore on the social body, and our industry and trade must be stunted until that sore is removed. To achieve this revolution in the most efficient way possible there are many problems to be studied and solved, and the Spring Trade Promotion Number of The Electrician is a contribution to the clarification of ideas on this important subject.

Some Thoughts for the Morrow.

In our first leading article we have dealt with the influence that electrical development conducted on progressive lines must have on our future existence. But to approach that ideal a number of interesting and difficult technical and financial problems will first have to be solved, and in many cases the method of solution which will give the best results is still a matter of controversy. This will be evident from the opinions expressed in articles which we publish on other pages of this issue on such questions as distribution, design and finance. But though these articles regard the subjects with which they deal from different points of view, a study of this week's issue should tend to that co-ordination of opinion which cannot fail to be of assistance in solving the points at issue.

Overhead v. Underground Distribution.

Among the most important of these questions is that of the best distribution system to employ in housing schemes, garden cities and, indeed, in the development of electricity supply generally in order to achieve economy and, at the same time, to avoid the sacrifice of efficiency. We note that Messrs. G. V. Twiss and S. G. Leech in their article plump definitely for the overhead system, while, on the other hand, Mr. Burnand, though he realises the advantages which overhead work often gives, considers that underground cables, especially under certain conditions, show such advantages as makes their adoption desirable. Here is a very pretty controversy which must obviously be considered in all its bearings, though probably there is no general solution.

Each case will therefore best be considered on its merits. But in arriving at any solution, and in considering the factors which make that solution desirable, it must ever be borne in mind, as Mr. Tyler rightly points out, that there is a cheapness that is expensive and that in no case must efficiency be sacrificed to price cutting. In wiring, as elsewhere, the best is often the most economical in the long run and for that reason nothing must be allowed to rule out the use of good material and workmanship. If these essential considerations are borne in mind other matters assume a secondary importance and an adequate solution for them should not be difficult.

The Reliability Factor.

The necessity for reliability is also brought out, in connection especially with heating and cooking and other domestic apparatus, in the articles by Mr. W. A. Gillott and Miss D. Selby. Mr. Gillott lays down the rule that for cooking apparatus, and the same equally applies to heating equipment, reliability, accessibility and low cost of repairs are essential factors. These in conjunction with mechanical strength provide such a combination that, although questions of cost cannot be altogether ruled out, they take a secondary place. Miss Selby, in her turn, puts forward some interesting and important data on this subject from the woman's point of view, a point of view which is naturally of prime importance in connection with the development of electrical apparatus. One of her arguments is that woman has hardly had a fair trial and that salesmen and those interested in electricity supply should do all they can to educate her in the proper use of the apparatus. This, of course, is to some extent already done, notably by the Westminster Electric Supply Corporation; and the results that have been obtained are so satisfactory as to leave no doubt as to the soundness of the policy. The training courses which are being held in London and other centres in domestic subjects are also an assistance to this end, and should help to bring about a state of affairs in domestic life where that fool-proofness for which Miss Selby pleads will not really be essential because there are no fools.

The Hot Water Problem.

Another important problem and one which some electrical engineers ever despair of solving is that of how best to obtain hot water in the electric house. We at present are in a state of compromise on this matter. For even in the most modern houses no attempt is being made to provide hot water by electrical means. But that is a position in which we obviously cannot remain, and we therefore agree with Mr. Bastian that every effort should be made to find some economical means of obtaining hot water electrically. While, therefore, we are willing to admit that a partial electric house is better than a wholly non-electric house, we cannot go so far as to support Mr. Berry in his argument that a coal fire must always be an essential part of our domestic equipment and that, at best, electricity can only be used for adding the additional heat to what has been found a fair average temperature of water or air. Mr. Berry's arguments are unanswerable once we accept his premises, but that is exactly what we do not feel inclined to do. A compromise, it is true, is often a diplomatic solution of difficulties, but we consider that compromise should be avoided in this case, for our own sakes and everyone else's. And while it may be some time before a satisfactory electrical solution of the hot-water problem is discovered, harder things than that have been achieved, and we can see no reason why the ingenuity of those who are giving the matter their attention should not function in this one instance.

Nursing the Existing Consumer.

The development of garden cities with their wider-spaced houses and larger areas has raised in a new form the old question of the relative advantages of alternating and direct-current supply. In such an area a large number of feeding points is eminently desirable and for economic reasons the amount of copper employed must be kept down to a minimum. Some form of low-tension alternating-current supply would therefore seem to offer the greatest advantages. It is therefore interesting to note that this system is being employed on the up-to-date housing scheme in which Mr. Hoadley is interested at Maidstone. We may, in fact, shortly expect to see some further developments in this direction, but, in the meantime, the plea may be entered for greater energy in developing the loads of consumers already connected to the mains. The fact that new consumers cannot be connected is no argument for neglecting existing consumers, and it is certain that a campaign directed to encouraging the greater use of such small apparatus as irons, toasters, washing-machines and even heaters and cooking apparatus can be inaugurated with great advantage to the undertaking, and no great strain to the existing network.

Tariffs and Switching.

Apart from energy and enterprise, however, there are two factors which will have to be dealt with in this connection. One is the very burning question of tariffs, in the drawing up of which greater simplicity is necessary. In our opinion, a determined attempt should be made to find some scale which shall do away with, not only complicated methods of reckoning, but with dual systems of wiring. The system which Major Richardson has recently introduced in Dundee, though open to some criticism, seems to a great extent to fulfil this condition and has the added advantage that it has proved both attractive and revenue compelling. In some ways, on the other hand, there is a great deal to be said for a system which provides for one rate of charging during the greater part of the day and for a higher rate during the peak-load periods. But for such a system to be successful a reliable automatic change-over switch must be turned out which will operate without any fear of failure for weeks and even months without attention. Incidentally, a little considered advantage of using slot meters mentioned by Mr. Hoadley is worthy of attention. It places this much criticised apparatus in a new light.

Lighting and Health.

Other points raised in the articles in this issue which are only minor because they are less controversial are those mentioned by Dr. Harman and Mr. Dow in a discussion on the proper employment of the electric lighting, which is becoming more and more a necessity and less of a luxury in modern life. This change has resulted in a demand for more light and, incidentally, a need for greater care in the arrangement and shading of the units employed.

The points which we have briefly discussed are but a few of those which are rightly exercising the minds of those who are alive to the advantages of the domestic electric idea and its uses to the industry. That electricity for all the varied purposes for which it is required in the home must be employed more and more widely in the future is to this class of engineer an axiom, but it must be more widely spread, together with the realisation that progress can only come by a whole-hearted determination that whether it be in apparatus, skill and enterprise, the best of everything shall be only just good enough.

The "Electric" House from the Architect's Point of View.

By G. BLAIR IMRIE, M.S.A.

THE "all-electric" house has been the dream of the enthusiast for many years. A few such houses are, in fact, in existence, but before full use of electricity can be made in the majority of households a great deal remains to be done by the supply companies and the manufacturers of electrical apparatus. There is no doubt, however, that in certain types of houses a much greater use of electricity can and will be made.

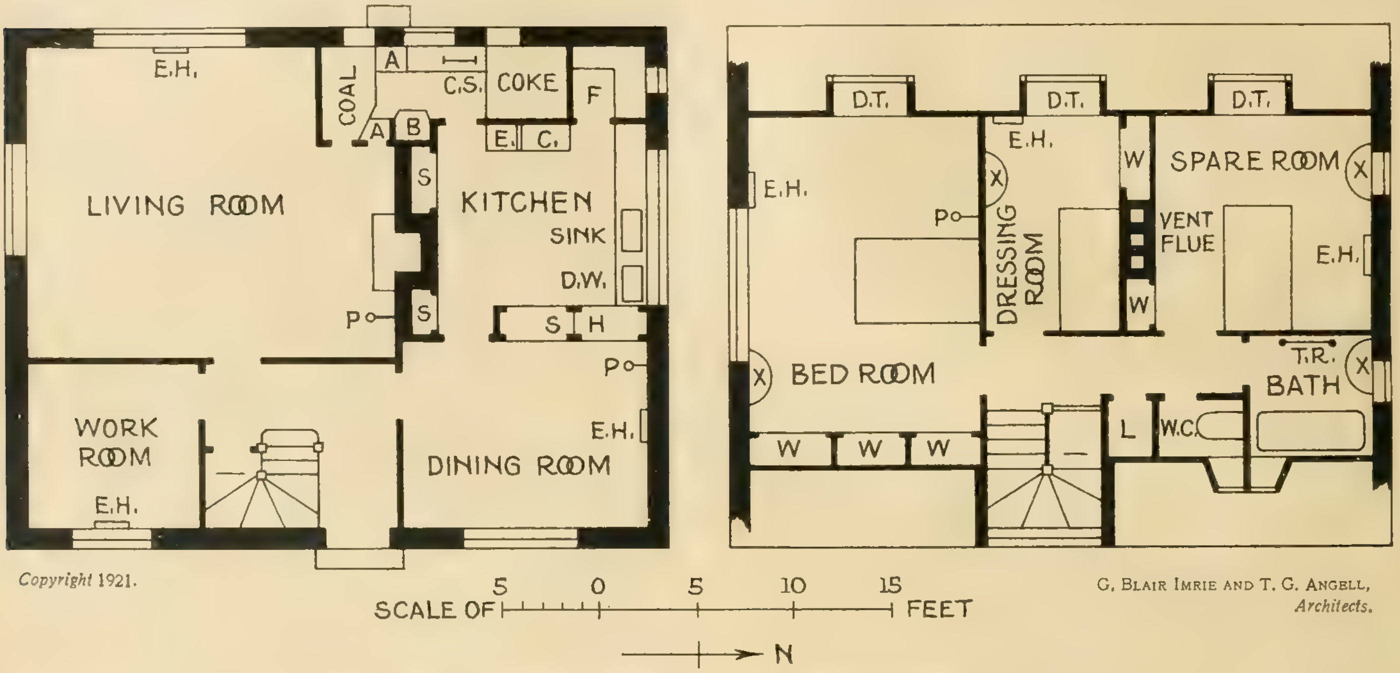


Fig. 1.—Plans of a Middle Class "Electric" House.

Ground Floor Plan

First Floor Plan.

A, ashes; B, boiler; CS, spindle for boots, &c.; DT, dressing table; EH, electric heater; EC, electric cookers; DW, electric dish washer P, plug; S, store; SH, dresser and hatch; F, larder; W, wardrobe; L, linen cupboard; X, lavatory basin; TR, towel rack.

"Servantless" and "Labour-Saving" Houses.

Much has lately been heard of the "servantless" and the "labour-saving" house, and the public are at last beginning to realise that it is only by utilising electricity to the full that these much-desired ideals can be attained. The architect may exercise the greatest skill in planning, provide easily cleaned surfaces and fittings which do not require cleaning at all, but without electrical equipment the house will still be far from perfect. In the past the speculative builder inserted a serving hatch and tiled his scullery and imagined he had provided a labour-saving house, but a higher standard of planning and equipment is required to-day.

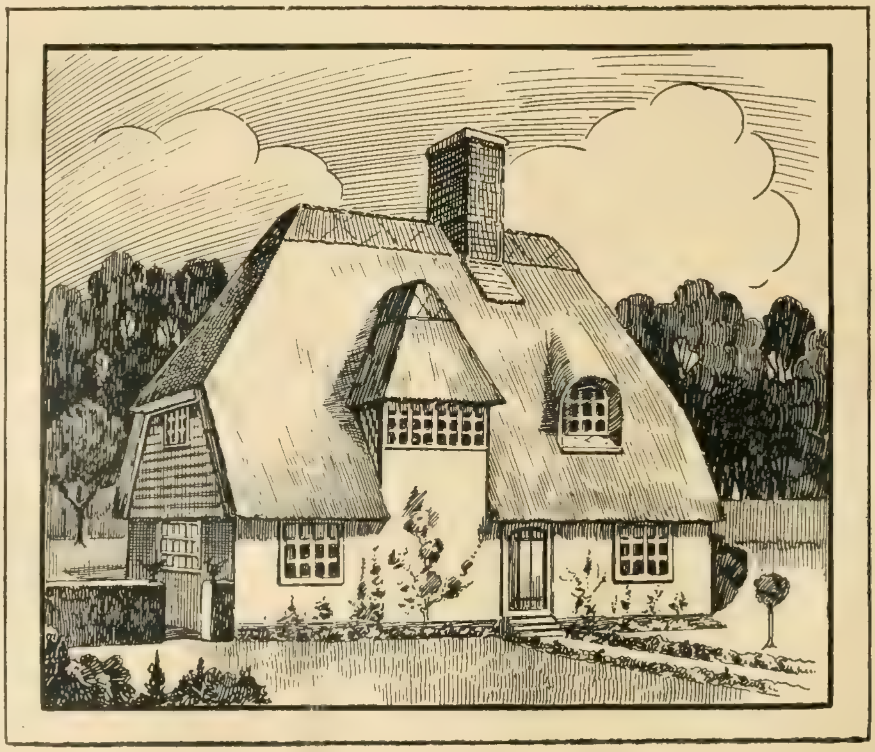


Fig. 2.—"Electric" House at Esher for J. P. Castle, Esq.

The architect is usually blamed for the badly-designed houses in which we suffered in the past, but (apart from the fact that he has had nothing to do with most bad houses) the architect was not the greatest sinner. It has been said that people get the houses they deserve, and this is, at any rate, partly true, for the greatest obstacle in the way of progressive design has been the terrible conservatism of the average building owner.

It is popularly supposed that the architect is solely interested in designing houses to be looked at, but he is as a rule just as anxious to make the working arrangements as perfect as he can. How many times has the architect, full of enthusiasm, explained to a client the great advantages of adopting labour-saving devices, electric cooking, &c., and improvements in planning, and how many times has the client's young wife (after consultation with her family and friends) decided to have a replica of her mother's kitchen, and also decided that "it would be very strange without a fireplace in the dining-room" Before the war, too, a large number of people (especially ladies) looked upon electricity as a mysterious, dangerous and expensive commodity, a thing of shocks and burns, and it was not really popular for domestic use even where power was cheap.

The War and Domestic Architecture.

Post-war conditions are, however, forcing the average householder to adopt a different sort of house and a different mode of life, and all but the very rich are now thinking a great deal about the efficient equipment of their houses. The high costs of living and building and the servant problem will alter the house and habits of many people. Before the war English households could be divided, very roughly, into three classes: (1) The workman's, (2) the householder employing not more than one resident servant, and (3) larger establishments with two or more maids. Let us consider the effect of post-war conditions on each of these classes.

The workers are perhaps least affected, but with high wages has come a higher standard of living and a natural desire for more leisure and comfort on the part of the worker's wife. The provision of electric cooking, heating, &c., in workmen's dwellings is not nearly so Utopian an idea as might be imagined, but until there is a general drop in the price of current it will only be used for this purpose in favoured districts or in industrial communities having a private source of supply. It must be remembered that the kitchen of the worker is also his living room, and that (like most of us) he insists on having one fireplace capable of burning coal and wood. The kitchen fire will, therefore, continue to be used for heating the living room and for cooking in the winter, an electric cooker being used for summer and occasional use. Electricity will also be used for washing and ironing, and electric heaters will take the place of the seldom-used parlour and bedroom fires.

The "All-Electric" Idea and the Large House.

In the large house the transition to "all-electric" will continue to be comparatively slow. Hot water will be used for heating with open fires for occasional use. Generally speaking, the owner of a large house fears the cost of electric cooking and heating when it is in the hands of servants who, as a body, do not take kindly to electrical apparatus. Electric vacuum cleaners, grills, hotplates, heaters for occasional use, &c., will be increasingly used, but until there is a general reduction in the cost of supply and more encouragement from the supply companies, the large house will continue to be numbered among the "partly electric." Large country houses where water power is available will, however, make much greater use of electricity, and windmills with a high efficiency and a properly designed generator (both of which are now being made on the Continent) will no doubt also enable electric cooking, &c., to be more freely used.

Electricity and the Servant Question.

It is the servantless or the one servant house which to-day offers the greatest scope for the increased use of electricity. A great many people cannot obtain a competent maid, and many prefer to do without rather than to endure the incompetent type. Others although willing to pay something cannot afford the wages now asked. These considerations, together with a perhaps diminished income, are creating a great demand for houses *really* arranged and equipped to save labour, and the full use of electricity combined with considered planning will make the servantless house a possibility and relieve its mistress of both drudgery and servant worries. One of the principal reasons why electricity will be more used in this class of house is that the rate at which it is supplied is not so important as it is in the workman's house and mansion. If all costs (such as waste, breakages, &c.,) are taken into account, the average maid to-day costs £100 a year and a large amount of electricity can be used for £100.

The exact plan of the electrically equipped servantless house will, of course, vary with individual requirements and local conditions, but a coke or anthracite boiler for hot water and an open fire in the living room should be provided. At first sight a coal fire in a servantless house may seem an anachronism, but the psychological aspect of the matter must not be forgotten. Even if we disguise the electric heater as a yule log no satisfaction can be obtained by poking it, and although the open fire may be hopelessly inefficient, dirty and troublesome, there is something more than mere habit in the demand for "one open fire." With regard to hot water it is useless to pretend that it can be obtained by electricity as cheaply and copiously as from a coke boiler, and, in addition, the presence of the small boiler fire, where there is no range, enables kitchen refuse &c. to be disposed of.

Details of the Electric House.

The house illustrated herewith is an attempt to combine the advantages of electrical equipment with a plan suitable for a servantless house.

The living room has an open fire and also a plug for an electric heater, so that the fire need only be used in really cold weather; another plug is provided for an electric kettle. The living-room fire is the only one in the house, and it is remarkable how much easier planning becomes if fire-places are eliminated and where there is no servant to consider economy convenience of plan is further improved. There is no real need for a back door with its usual lobby and a passage from front door to kitchen is unnecessary. In this plan about £120 has been saved by the omission of fireplaces and flues, and the cost will be further reduced by the omission of the work-making scullery and of much waste in passages. The total cost should be much below that of a "villa" type house with coal fires and an equal number of rooms of similar size. The fact that the dining room leads directly into the kitchen is an advantage rather than a disadvantage. The dining room has plugs for an electric heater and a hot plate, and there is also a plug in the workroom.

Kitchen Arrangements.

The kitchen has a bench to take the electric oven and hot plate, which are placed so as to get good side light. Next to the sink is an electric plate washer and this adjoins the china cupboard; this cupboard has doors on both the kitchen and dining room sides, so that after being washed the china is put into the cupboard from the kitchen side and then taken out from the dining room side when required for meals.

It should be mentioned that a water softener will be installed as it is difficult to get plates to "dry clean" when washed in hard water unless they are rubbed.

Opening out of the kitchen is a small room which contains the independent boiler and here all the dirty work will be done. On the bench under the window is a spindle driven by a small motor, the spindle will carry a brush for boot cleaning and a buffing wheel for polishing plate, &c. In this room are bunkers to hold coke and coal, and the coal bunker has a small opening on the living room side to save the carrying of coal; another opening from the living room forms a shoot for ashes &c. from the fire.

On the first floor is a bedroom for the owner, a dressing room and a spare bedroom, each with fitted furniture and a lavatory basin. The owner's bedroom has a plug for an electric kettle near the bed and the other rooms have plugs for heaters.

Electric light will, of course, be installed, and electric vacuum cleaners will be used.

Ventilation.

The ventilation of the small house is, as a rule, sadly neglected; where there is an open fire it is *supposed* to be sufficient, or if there is no fire an air-brick is placed in an external wall and this as often as not results in a cold down draught. The use of electricity makes efficient ventilation easy.

In this house each room has a controlled hit-and-miss inlet ventilator at floor level in front of which the electric heater will stand; the incoming cold fresh air will, therefore, be warmed, and silk-flap outlet ventilators will draw off the vitiated air at ceiling level. All these outlet ventilators will run into *one* flue in the chimney and this being kept always warm by the boiler flue a good up draught will be induced. The air change in the rooms can be regulated by the controlled air inlets.

Excluding workmen's dwellings, there is perhaps a greater demand for houses of approximately the size of the one just described than for any other, and it is to be hoped that the electrical industry as a whole will see that as many as possible are made "all electric."

Electricity Supply and Housing Schemes.

Some Practical Problems.

By W. F. T. PINKNEY
(Engineer, Lighting and Heating Department, Newcastle-on-Tyne Electric Supply Co.).

It is rather unfortunate for the electrical industry that whereas houses are being built without any prospect of obtaining a reasonable financial return in the way of rent upon the capital expenditure incurred, when the question of electricity supply to these houses is raised, it is fully expected that the electricity authority will be able to recuperate itself from the revenue to be derived, although the conditions which make it impossible to build houses on a paying basis, that is, high cost of labour and material, apply equally to the distribution of electricity.

The main problem, therefore, which the electricity supply authority has to solve in relation to housing schemes is one of finance. In fact, all the problems to be met are related directly or indirectly to this main one of finance, and the difficulty of the position is accentuated to an extreme by all the following points :—

1. The high cost of labour and material and the relatively low revenues to be derived from the sale of electricity to the housing occupants.
2. The lay-out of the housing sites in 8, 10 or 12 houses to the acre necessitates a greater amount of material and labour per consumer in laying networks than in the case of similarly sized houses, which previously were built in terraces or flats.
3. The uncertainty as to what margin must be allowed in network capacities to deal with future developments in order to avoid the overload on the networks now experienced in practically all industrial areas.
4. The uncertainty of whether or not housing schemes will ever be completed as laid out, and, if so, how long such completion will take, or whether the speculative builder will be required to step in, and, if so, whether he will build a different type of house, with a possible variation in the originally estimated electrical demands.

Cost-Cutting Troubles.

In recognising the necessity for keeping all initial costs as low as possible in connection with the supply of electricity there is a danger of storing up a host of trouble by cutting the costs too fine. For the most part new houses are being equipped for the use of electricity for lighting only, but it would be foolish in the extreme to design the distribution networks of such a capacity that they will only meet the lighting demands, as the many uses of what may be termed "domestic electricity" are rapidly gaining favour as they become known, so that such small distributors may become loaded up in a short time, and considerable cost incurred in reinforcing them. A great factor bearing upon the future demands for electricity is the extent to which educational propaganda in its use will be carried on. This has been sadly neglected in the past, but the work done in the last year or two in this direction—such as this special issue of The Electrician—has been so very valuable that if the progress is maintained, and if such an organisation as the British Electrical Development Association gains the support it merits, it will only be another year or two before electrical advertising and educational work equalling the wonderfully efficient organisations of our gas friends is in being. The increase in the use and sale of electricity will be in direct ratio to such educational work.

While keeping down the costs is one way of meeting the difficulty of finance, another way is to obtain increased revenue and profit from the additional uses of electricity other than lighting.

Probable Future Uses of Electricity.

It is, of course, necessary first to decide upon the capacity of the network, and to what extent provision must be made for future demands. This will depend to some extent upon the type of persons who will occupy the houses, as some classes or types of occupants will be slower to extend the use of electricity in their homes than others. For instance, in a mining area, where the houses are to be occupied by miners, it would be of little use laying a network capable of ultimately meeting the demands of "all electric" houses. The miners get free or very cheap coal, and live mainly in their "living-room-kitchens," so that there is little prospect of electricity entirely displacing the use of coal. At the same time the miner's family is quite ready to use and pay for such devices as electric irons—apparatus which will bring a valuable revenue and, owing to high diversity, make small demands upon the networks.

Alternatively, in the housing schemes on the outskirts of large towns or cities it is probable that the manual workers who may occupy them in the first place will drift in nearer to their work as occasion permits, and the houses will be occupied by town folk of moderate means. The latter have already proved themselves the most ready to adopt electricity for cooking, for occasional heating in bedrooms, parlours, &c., and for all minor uses. Leaving out of the question at the moment the "all electric" houses, which are referred to later, the demands for electricity in all housing schemes will eventually fall somewhere between the two extremes given above.

It is worth while giving some consideration to these future loads, and to their probable nature.

Cooking Demands.

The cooking demand (that is the *average* demand per consumer for a large number of cooking consumers) will be practically outside the lighting demand, so that if the network will deal with cooking, it will also deal with lighting without increasing the capacity.

Electric Heating.

Where coal is used for heating in the "living room," electric heating will only be required for bedroom use or for the parlour. The diversity factor will be high, the demands being made mainly at off-peak times.

The diversity of kettles, irons, boiling rings, &c., is so high that in a large colony little consideration need be given to their effect upon the network capacity.

In the writer's opinion then provision for an *average* demand of 0·18 kW per consumer will meet the requirements in the mining districts mentioned above, and an average demand of 0·5 kW per consumer in the areas where a fairly extensive use of electricity may be looked for in the future.

Overhead Networks.

What, it may well be asked, is the objection to overhead networks, which seems to be raised by so many Local Authorities? It is true that underground networks would be ideal from the purely æsthetic point of view; but overhead distribution is cheaper, and if well carried out the maintenance costs are low. It is easier to reinforce from time to time as demands increase; and it need be no more offensive to the eye than many things we put up with because we are used to them, such as lamp-posts, pillar boxes, or even houses themselves. It is a matter of great surprise to the writer that His Majesty's Office of Works should *only* consider underground networks for the housing schemes which they are erecting.

If overhead networks are decided upon, the poles should be of sufficient capacity to carry the heavier cables that may eventually be required; but in the meantime the initial cost can be kept down by erecting the lighter cables. Any increased demands later will bring in increased revenues to meet the additional cost of replacing or adding to the overhead lines.

Underground Networks

In the industrial areas supply will probably be given on the alternating-current system, and from a sub-station or sub-stations erected within the housing scheme site. Where for any reason underground networks are essential, provision should be made in the smaller housing schemes to meet the estimated ultimate demands. In large housing schemes of several hundred houses, where probably high-tension alternating-current supply is available, some care should be exercised in selecting the position of the transforming point on the site, and in choosing the route selected for any high-tension cable that may have to be laid, as it will be found that the low-tension networks can be designed to meet immediate requirements only, though they can be developed to meet the increasing demands which occur from time to time by increasing the number of transforming points.

Other Methods of Distribution.

A method likely to receive favour where the houses are suitably grouped in blocks of, say, six or more, is the running of distributors through the roofs and from gable to gable. There are, however, some objections to this method—viz., if the houses change hands and the occupiers become the owners, they may be in a position to demand exorbitant wayleave rentals, and Local Authorities would do well to protect themselves or the electricity supply authority by making suitable provision in the terms of sale. Another objection is that in case of faults developing on the distributors, there is always a possibility of delay in getting at the faults if the houses are unoccupied or the occupants are away from home. The first of these objections applies equally to pipe mains run under the eaves.

House Service Cables.

Housing schemes vary so much in the lay-out of the houses that economy may or may not be possible in the house service cables. With semi-detached houses, one two-wire service will deal with two houses only, which is more or less standard practice at the present day. If the pairs of houses are close together, and the houses sufficiently far from the distributor to make it worth while, one service can be laid between the houses and teed off, so that in this way one service can be made to serve four houses.

Where the houses are in groups of four, six or even eight, one three-wire or four-wire service may be laid to each group and terminated at a convenient point. From this point separate pairs of mains can be laid to each house, this work being carried out at the same time as the houses are wired.

Metering and Tariffs.

The question of the metered or unmetered supply has to be considered. On this point the writer's opinion is definitely in favour of metered supplies, and he considers the relatively high cost of the meters is fully justified. An alternative to a metered supply is to give supply on a fixed charge basis, the fixed charge being collected weekly or fortnightly, a system designed to meet an estimated consumption of current for lighting. This method has been tried time after time, and has been found to lead to enormous waste of current. In one district within the writer's knowledge, where fortnightly fixed charge payments were made, the fixed charge was based upon an estimated average annual consumption of 80 units per consumer per annum, whereas the actual average consumption reached the enormous figure of 580 units per consumer in one year. If was found that the lights were burning in many cases all day, and that high candle-power carbon lamps, obtained by some means from the nearest factory, were used, as these gave off a comforting warmth.

A second alternative is to install a current limiter, but this has the very serious objection that, if it is set to meet the estimated lighting demands, it necessarily prevents the use of such valuable pieces of revenue-earning apparatus as the electric iron.

A good prepayment meter costs, say, £5 10s., and a current limiter costs some 20s., so that the net extra cost of a prepayment meter over a current limiter is £4 10s. or thereabouts. An electric iron can be installed with little difficulty in practically every house, and will earn a revenue of 17s. or 18s. per annum with current paid for at lighting rates, and this alone justifies the additional expenditure upon a prepayment meter.

Lack of Methodical Erection of Houses.

A great source of money waste in some housing schemes is the fact that building proceeds in several isolated parts of the building site at the same time. That is, say, in the case of a total of 1 000 houses for which contracts have been let for 200 or so, instead of starting at one end with a view to building straight along from end to end, the builders may start at five different points on the estate. Now this means that the whole network has to be laid out in the first place, before a supply of current can be given to the first dozen or so houses erected, with the probability, but by no means the certainty, that the remaining houses will be built. Had the first houses been erected close together, the network could be laid as required, and extended from time to time to meet developments, with the probability that considerably lower costs would be incurred.

Street Lighting.

Where underground mains are laid and the public lighting is taken from street standards, separate street lighting cables can be laid at the same time as the distribution cables. If this is done and the supply is on the alternating-current system, it is an advantage to adopt a pressure for street lighting not above 100 V, even if the general distribution is at the more usual voltages of 200 to 250. This lower voltage enables lamps with stronger filaments to be used, and eliminates any danger from shock due to earthing. The lower voltage does not appreciably, if at all, increase the section of copper required.

Although in residential areas a great intensity of light will not be required, the lamps should preferably be further from the ground than has been usual in the past, as with the continuous improvement in the efficiency of electric lamps, there is a much better chance of taking advantage of the higher efficiency and of getting a better light distribution if the lamps can be 16 ft. to 20 ft. from the ground, than is the case when the old 10 ft. high type of lamp-post is used. On an overhead system the lamps will be fixed on the poles carrying the mains, and there is no difficulty in placing these at any reasonable height required.

Economy with the street lighting can be effected by erecting a portion only of the number of lamps ultimately required, and spacing the lamps well apart, so that the spaces can be filled in at a future date without going to the other extreme of bunching the lamps, and without necessitating altering the position of those lamps already erected.

"All Electric" Houses.

The factors bearing upon the design of a network to supply houses completely equipped for electric heating and cooking are still unknown, as there is no such all-electric scheme yet completed from which data can be obtained. In the Newcastle Electric Supply Company's housing scheme at Billingham a number of the houses are now occupied, but the permanent arrangements for supply of current are not entirely completed, and it has not yet been possible to get any record of the maximum demand on the network, or the time at which it occurs. It is of little value to consider the maximum demands of individual houses, as the diversity between individual cookers and between individual electric fires is very high, and again there is a big diversity between the cooking and the heating loads. In the case of Billingham a pretty ample margin was allowed in the distributors, and it was estimated that the maximum demand for the whole of the houses might reach as high as one quarter of the total connected load, but it seems likely that this allows for a very ample margin.

The writer anticipates that the maximum demand on such all-electric scheme will occur at times other than either the industrial power station peak load or the lighting peak, probably at about 12.30 on a Sunday. As only a very small total demand will be made at the time of power station peaks (where the peak is an industrial one), it will follow that in designing a tariff for supply of current for such purposes small provision need be made to meet power station capital cost.

Advantages of "All-Electric" Houses.

The main advantages of an all-electric housing scheme are so obvious that it is surprising that it does not receive greater consideration by the Housing Authorities. It is apparently not on the grounds of cost, because the question is not considered sufficiently, as a rule, for estimates of the costs to be prepared. The increased space in small houses afforded by the reduced number of chimney breasts is alone a great recommendation. The reduction in building costs due to the necessity of providing only one chimney, and to the reduced ceiling heights which can be provided without inconvenience to the occupants, will pay the extra cost of the electrical equipment, or go a long way towards doing so. The reduced cost of redecoration and upkeep of the houses will represent an appreciable annual saving to the Housing Authority.

These points should alone appeal to the Authorities, quite apart from the labour saving, the cleanliness, and the healthy conditions which would benefit the occupants. Our conditions of life and our habits make it desirable to install a coal fire in the living room (from which the domestic hot water is obtainable with the greatest economy), but apart from this a complete electrical equipment has everything in its favour. Lack of space, however, prevents the matter being fully dealt with here.

Three Important Points.

It is not possible in a short article to touch more than lightly upon the problems which present themselves in the supply of electricity to housing schemes. The writer, however, would like to lay stress upon the following :—

1. That to the Supply Authority the business is worth obtaining if at all possible, as the revenue from the supply of current is assured, and is not subject to fluctuation with the fluctuation in the state of trade and industry.
2. The fullest use of electricity should be made in all modern houses, and facilities provided for it.
3. The problems and their methods of solution should be more fully ventilated than is at present the case, and a greater interchange of ideas would be generally beneficial.

The Supply of Electricity to Housing Colonies.

By E. E. HOADLEY, M.I.E.E.

(Borough Electrical Engineer, Maidstone).

When, shortly after the conclusion of the Great War, the provision of the many thousands of houses that were so urgently required was being taken in hand by the municipal authorities up and down the country, the electricity supply industry awoke to the fact that in these houses would be a potential source of much revenue. To-day I think it must be confessed that actual attainment has fallen short of the original promise, and much that might have been done, and in some cases, ought to have been done, has not come to fruition. The reasons for this are many and various, in some cases general and in others purely local.

Tackling the Problem at Maidstone.

Thoroughly to explore the whole of the subject and to enter deeply into these reasons would require much more space than is at my command, but it may be of interest, and perhaps a certain amount of help, to recount what has been done and the various difficulties we have been up against in Maidstone. The housing problem in Maidstone was early recognised as one of the most pressing that the local authority had to face, and energetic steps were taken to deal with it, and I believe the Maidstone Corporation is counted as having done as well as most authorities in getting houses built and ready for habitation.

After a survey of the town for suitable land, four sites, all on the outskirts, were chosen, and competitive designs for cottage dwellings invited. Having chosen the design of the house for each site and the lay-out of the colony, tenders for the building were invited, and it was on their receipt that the first "snag" was encountered. The prices were so high that the first essential was to cut them down in every possible direction ; one way was in the arrangements for lighting and heating.

In Maidstone the electricity supply is in the hands of the municipality, while gas is supplied by a Company, two directors of which are members of the Corporation, one of them being the Chairman of the Housing Committee, so that it can be truthfully said that both sides had a fair field. The problem for the Housing Committee was to choose between electricity and gas for lighting, and between electricity, gas and coal for heating. The electricity department were not by any means idle and prepared many schemes for the consideration of the Housing Committee. What the electricity department put forward was a stove of the inter-oven type, burning coal for the heating of the main living room and on which the bulk of the cooking would have been done during perhaps seven months of the year when heat was required, a copper burning coke and all the house refuse for providing water for the weekly wash and for baths, while electricity would provide the means of carrying out the rest of the domestic services which comprise—

1. Lighting.
2. Cooking (particularly in the summer time).
3. Ironing.
4. Occasional heating.

The Gas Company put forward a scheme in which they advised—

1. A stove of the inter-oven type for the main heating.
2. A gas cooker.
3. Gas lighting.
4. Gas fires.
5. A gas copper.

Gas Conditions Prohibitive.

Their offer was accompanied by the condition that unless they were allowed to pipe the houses for gas lighting they would refuse to lay gas mains on the various estates at all, stating that the gas lighting made all the difference between the scheme being remunerative or not, and they offered to pipe all houses for lighting free of charge to the Housing Committee.

This was a very tempting bait, particularly where expenditure had to be cut wherever possible, but the first condition was not to the liking of the Housing Committee. The electricity department made the most of the advantages of electricity, particularly pointing out that the Housing Committee, as the owners of the houses, and thereby responsible for the upkeep of the decorations, would reap a very handsome return on the capital expended on the wiring.

How a Compromise was Arrived At.

The result of the struggle was a compromise, in favour of the electricity department, and the houses are fitted as follows :

1. A stove of the inter-oven type.
2. A gas copper.
3. Electric lighting.
4. Plugs for electric iron and electric fires.
5. Any further cooking stove can be either gas or electric at the wish of the tenant.

No gas lighting is allowed in the houses, and the electric lighting consists of one lighting point in each of the following rooms :—Parlour, living room, scullery, bathroom, landing and three bedrooms, while heating plugs are provided in the scullery for ironing or a cooker, and in one bedroom for occasional heating or in case of illness. As the amount of money allowed for electricity supply was limited to twelve pounds per house, and as it was to the advantage of the Electricity Department to get as much done for the money as possible, a great deal of thought was given to preparing the details of the scheme for wiring the houses, and it was decided to do the work by men employed in the Electricity Department paid at standard wireman's rates, to use the Henley or similar wiring system, and to employ switch ceiling roses operated by a pull chain instead of wall switches.

The first pair of houses was experimented on to find the most economical way of running the wires, both from the points of view of material and labour, and when this was found the remainder were done absolutely to standard pattern. The switch ceiling roses save quite a lot of both material and labour, and in connection with these we always run the operating chain over a small pulley, so that it hangs some little distance from the lamp and shade, thus obviating broken filaments, if not worse.

Factors Adverse to Domestic Electricity.

At the present time some 45 houses are inhabited and using electric light, but beyond lighting, the use of electrical appliances has not made much headway ; nine or ten electric flat irons have been installed and four electric fires. The reasons operating against the adoption of these domestic helps seem to be as follows : The rents of the houses are much higher than people have been accustomed to pay, and with the slump in trade and the necessary short hours, most of the people living in the houses have very little spare money, and during the winter, while they have a fire going, do their ironing with an ordinary iron. Much improved results are looked forward to from our canvassing efforts during the spring and summer, when failing an electric iron, a fire would have to be lighted for heating the iron.

With regard to electric fires, again it is a question of money. Most of the people in the houses are people with big families, they being given the first chance of the houses, and at present they have all they can do to keep and feed their families and pay the rent.

When trade improves and as a different class of people occupy the houses now under construction, it is expected that much better business will be done.

Cooking stoves are also out of it in the matter of price; most of the tenants use the inter-oven stove and nothing else, but several use, in addition, a very small gas cooker, hired from the gas company for under a pound per annum, whereas the hire for an electric cooker is 15s. per quarter; this, of course, includes maintenance, but even then it seems very high to a man earning, say, £4 per week. But bearing in mind the initial cost of the cooker and the cost of renewals, it cannot be put lower, except at a loss.

Slot Meters as Bill Collectors.

In connection with the cooking arrangements in these small houses one point has struck me very forcibly, and this is the amount of money that the tenant will put into a slot meter without grumbling.

I wanted to compare the cost of electric cooking in a household of six people with that of gas cooking, and obtained some actual figures of the money put into slot meters for this purpose. In one house, for *three people*—husband, wife and one child—18s. 10d. was paid for cooking by gas in one month and the tenant did not consider it anything out of the ordinary. The average actual cost of electric cooking per month for the household of *six people* worked out at 22s. 6d., and this in a house where the standard of living was much higher than in the former.

Still Hope for Electric Cooking.

From the foregoing, I still believe there is hope for electric cooking in this class of property, but success will, to a large extent, depend on energetic canvassing and particularly on the service which is given after the cookers are installed. Proper instruction in their use must be given and each job efficiently " mothered."

It would also help if, in all Council and other schools in which lessons in cookery are given, an electric cooker were installed and arrangements made for the girls to receive instruction in its use, as well as or instead of learning how to use a gas cooker. In this way the consumers for the electricity department would be " caught young " and much benefit would result.

Other difficulties in connection with the supply of electricity to working-class housing colonies mostly resolve themselves in the end to difficulties of a financial nature. From figures already obtained it is pretty evident that not more than an average of 60 units per annum per house will be consumed on a purely lighting load, and this, even at 8d. per unit, only produces £2.

For reasons connected with health and for aesthetic reasons these houses are well spaced out and generally have front gardens of some length ; this complicates and adds to the cost of mains and services. Overhead mains and services were taboo, as it was held that they did not accord with the amenities of the colony.

In Maidstone our housing colonies are supplied with alternating current at 230 V and 50 periods from a substation on the estate giving three phase current ; the phases are split up and roughly balanced, only one phase being taken down each road. The mains are paper insulated, lead covered and armoured cables laid direct in the ground ; they are laid close up against the front wall of the house in what is now the front garden. There is not one single underground joint in the whole of the cable on the estates, the cables are looped in from house to house and linked across in special boxes which also contain the main fuses for the house ; all cables are fed from both ends and the lamp posts on the estate were cast with special bases which are used as distributing and link boxes for the cables.

Tenants and Tariffs.

The tenants have the option of being charged on a flat rate of 8d. per unit or on a contract-demand system with current limiters, the price charged being 22s. per annum for each 30-W lamp. Most tenants prefer the contract-demand system, and every effort will be made on the part of the supply authority to induce them to keep on it, as, in my opinion, for a lighting supply it possesses nearly all the advantages and in addition assures the revenue. Care has been taken to wire the plug circuit separately, and energy for heating, cooking and ironing will be charged separately by meter. So far as my experience has gone up to the present I have undoubted hopes for the use of electricity in houses of this type, but whether, on a purely lighting load, under present conditions, it is a paying proposition, " I hae ma doots." Time alone can prove.

The Science of Home Making.

By Mrs. Councillor **PALMER, J.P.**
(Member, Electricity Housing Committee Southampton Borough Council).

Much controversy has waged round the relative importance of heredity and environment in the formation of character and type. It may be difficult to define the absolute effect of each factor, but all are agreed that environment is one of the most powerful forces in the moulding of the individual. The communal conscience has not developed rapidly enough to meet the necessities of present-day communal life, or we would surely have recognised this principle in connection with the housing accommodation of the people.

Bad Housing Playing Havoc.

Throughout the length and breadth of the land bad housing is playing havoc with vast numbers of our population, and wasting the real wealth of the nation. During the progress of the war the startling results of Army medical examinations provided painful evidence of this, and the persistently high rate of infant mortality also affords pathetic emphasis of the same fact. The medical records show that an alarming number of school children are suffering from preventible disease, while the spread of tuberculosis is a growing menace to the national life. If mental science were sufficiently developed, there is little doubt we could detect the equally disastrous results of these bad conditions on the mentality of the people.

Under these circumstances, one cannot estimate highly the intelligence or moral sense of a Government that is content to spend huge sums on prisons, lunatic asylums, hospitals, clinics and medical services without endeavouring to remove the primary cause of the evils these institutions exist to remedy.

One need not elaborate the moral aspect of the case, other than to say that if the physique and mentality of a people are weakened, it is bound to be reflected in their moral condition, to the consequent detriment of the whole community.

Good Housing an Insurance.

It naturally follows that if pleasant and healthy living accommodation is provided, an insurance is effected against disease, against the degeneration of the individual and against general social disorder.

Why, then, have the politicians done so little to make the promised "new world fit for heroes to live in?" Principally because the loud-voiced "big business" interests have monopolised the machinery of Parliament to benefit themselves, while women, who are the greatest sufferers through bad housing, are not yet effective in politics.

Apparently the only controlling idea behind the housing programme of the Government is that of immediate economy. It is a false economy indeed that pays no heed to the inventions of genius and the developments of science. Instead of the new houses being a monument to the combined skill of our architects and engineers, and an inspiration in the lives of the people, they are a most expensive and colossal blunder, and an object lesson to warn posterity against the folly of allowing a Government of vested interests to sacrifice the convenience and well-being of a people to private profit.

We have seen transport and industry practically revolutionised by the development of electric power, and yet our domestic workshop, the home, for which electricity is pre-eminently suitable, has gained little or no advantage.

Women's Revolt against Domesticity.

No wonder women have revolted against domesticity! They entered the munition workers' kitchen to find it brilliantly lighted by electricity, and provided with wonderful electric apparatus for the preparation and cooking of food, in every conceivable form. The cleansing of utensils was accomplished easily and swiftly with machinery driven by the same unseen beneficent "power." Dining rooms and rest rooms were rendered pleasantly warm by electric radiators or electric fires, and, generally speaking, women found that life could and should, be relieved of much of the toil and drudgery that falls to the lot of the average woman.

The community would gain if full advantage were taken of this attitude of mind to popularise every domestic labour-saving device. No conservatism or prejudice could long withstand the fact that the usual wearisome back-breaking and heart-breaking cleansing operations can be eliminated in womans' fight against dirt.

The Freedom of the Electric Home.

In the electric home, life would hold for woman a freedom and an opportunity for self-development, more to be desired than her present "sphere," which presumably is to cook, clean, wash, iron, mend and darn by the most obsolete methods for men who go to work in electric cars, who are raised by electric lifts to carry on their business in electrically operated factories or electrically lighted offices, who lunch in electric restaurants, and cure their rheumatism by electric baths, and who yet remain content to "switch off" the friendly current when they reach their own front doors! The home is indeed a woman's kingdom, but, unfortunately, it has frequently been her prison as well. Science is ready to set her free—let us not condemn her to further servitude.

The Case for Electricity in the Home.

The case for the use of electricity in the home is overwhelming. It is easily manipulated—it is the most perfect artificial illuminant—it is an element of safety rather than of danger in a house—it throws no impurities into the air, and consequently saves expensive decoration—it does not absorb the life-giving oxygen so essential to health, and it is readily adaptable for the manifold necessities of a household.

When considering the initial cost of supplying a general service of electricity we must remember the advantage gained by the abatement of the smoke nuisance for which the domestic fire is largely responsible.

It is calculated that 80 tons of soot are emitted from London chimneys every hour. The appalling effect of this pollution of the atmosphere, on the human organism, and the danger to health, cannot be too strongly emphasised.

The saving effected in the cleansing of our towns, in the making up of roads, and in the removal of refuse, is a very important consideration.

In every up-to-date housing scheme electric cables should be laid with the main sewers and water supply, before the houses are built. This would not only obviate the re-opening of the road, but the service could be used for light and power in the actual building operations. The houses should be wired throughout in the course of construction, so that all wires are protected in the most effective way, and a more satisfactory result obtained than outside casings could possibly give. Though the installation might cost more, the subsequent saving in maintenance should be considered.

Heating and Cooking Requirements.

In addition to one light at least in each room, there should also be a plug for an electric heater, and an electric boiler and cooker should be fixed in the scullery. The saving effected in construction by the absence of chimneys would nearly cover this outlay. A plug for an electric iron or other apparatus would be a great convenience in the kitchen, and a good airing cupboard, electrically heated, is also a necessity.

The ideal arrangement of course would be that the municipality should own the power supply, and every house be equipped by them. Meters, inspectors and collectors could then be dispensed with, and a great saving achieved, while a flat rate on the assessable value of the house would seem a fair method of charging consumers. Pending that desirable development, the installation of current limiters would ensure a reasonable use of the current. A prominent feature of the Electricity Supply Act, 1919, was the advocacy of the establishment of super-power stations, but perhaps the last word has not been spoken on that, for if we look forward to the possibility of central heating by the utilisation of exhaust steam, a number of smaller stations would probably better serve the purpose of the community.

Remembering all the advantages that would accrue from the general use of electricity in the homes of the people, we are entitled to expect that the Ministry of Health will assist in a propaganda to that end. Certainly, the highest tribute we can pay to the genius of Michael Faraday is to place his discovery at the service of men *and* women everywhere and so materially help the progress of humanity.

The Place of Electricity in Town Planning.

By C. B. PURDOM.

TOWN planning is the art of making towns fit to live in. It is, therefore, concerned with the planning and building of houses, factories and other buildings to meet the needs of communities, the lay out of roads, and the organisation of towns as complete units. Electricity is an important factor in town planning because it makes houses more comfortable and efficient, reduces dirt and improves health ; it makes towns cleaner and tidier, reducing smoke in particular. The chief importance of electricity, however, to the town planner is its influence upon the distribution of industries and population. Industry depends upon electric power, and will go (other things being equal) where such power can be easily and cheaply obtained. Population also depends upon cheap and rapid transport, electric trams, tubes and railways. For this reason the planning of electric distribution systems is of the utmost importance in connection with town development.

Electricity Supply Reorganisation as a Factor.

The new schemes for the reorganisation of electricity supply throughout the country are bound to have a considerable effect upon the growth of towns. They will mean that electric power at reasonable rates will be brought to areas that do not possess it at present, with the consequence that industries which hitherto have been crowded up will tend to spread. During the last century industries concentrated in the Midlands and the North because of the coal fields ; they developed in the London neighbourhood because of the presence of a large population and the importance of London as a port. But with highly developed road and rail transport systems accompanied by the accessibility of electric power the reason for such concentration of industry is disappearing. The evils of over-concentration of industry in particular areas are manifest ; they are at the root of much of the most serious social and political troubles of the day. These wens, as Cobbett called them (for though Cobbett talked about London as *the wen*, he used the same epithet when speaking of the overgrown manufacturing towns throughout the country), in which our great commercial supremacy grew up, were the products of a time when organisation in industrial planning was in its infancy, and when modern town planning was simply non-existent. Great towns grow to-day by reason of their own momentum, and practically nothing has yet been done to subject that growth to public control. Under the Town Planning Acts of 1909 and 1919 there is legislative provision for the control of the uses of land and the process of town development, but action in this direction is still in its early stages.

What Electric Power has Done.

The development of electricity for power purposes will profoundly affect the growth of the great towns by its influence over the distribution of population. Up to the present the effect of electricity upon towns is that it has made possible the spreading of population over large areas by means of the development of transport. Everybody knows how the growth of London has been effected by the extension of electric trams and tubes ; whole districts have been opened up in recent years by this means. There are, on the other hand, wide areas in the east and south-east that have halted in their development simply because of the lack of such transit facilities. It was believed at one time that by developing quick transit there were practically no limits to the extension of great towns. But time has shown that to be a mistake. The transport system of London, wonderful as has been its development in the last twenty years, is inadequate. It is not merely that there are districts without facilities, but the facilities that do exist cannot cope with the demand, with the result that travelling in London, which could be a pleasure, is a highly uncomfortable process. The London transport systems were not designed for this excessive demand. No one can call that transport efficient which involves the overcrowding of passengers, long waiting queues of people and strap-hanging. To supplement the existing systems proposals have been made from time to time for elevated railways and for vast underground roadways. None of these schemes could be carried out without vast expense, and even if they were desirable the money is not likely to be found for them.

A New "Satellite" Town.

But it is by widening the area over which power supplies can be delivered that electricity will produce its greatest effect upon towns. This will enable new areas of industrial activity to be started. An example of this method is seen in the Welwyn Garden City scheme, which made such remarkable progress last year. That scheme was projected to establish a new "satellite" town for industry of about 50 000 inhabitants. The main idea is that industries should be provided with the best of modern equipment on a new site, and that the workers should have good houses within walking distance of their work in a well organised town. This has only been made practicable because of electric power. Power can be supplied on the site at reasonable rates, and this, together with the best of road and rail transport facilities, makes the new town an ideal place for industry. Welwyn Garden City is in Hertfordshire, 21 miles from London on the Great Northern main line. It will occupy with its agricultural belt about four square miles. The town is within the area of the North Metropolitan Electric Supply Company, which will supply in bulk to the Garden City Company to distribute on an agreed scale to the town. Every house in the town, even the smallest cottage, is wired for electricity ; indeed, electric wiring will be a normal part of the construction of every building. Welwyn Garden City, though it will have gas for some purposes, will, so far as lighting is concerned, be an "all-electric" town. Electricity will also be available for the agricultural population.

The new garden city shows the way in which electricity will influence the future development of the country. The placing of factories along lines of communication, in touch with the great generating stations, is not what is required. Factories need a certain element of concentration ; they need to be planned in relation to the homes and the amenities of the lives of their workers. That is done in the garden city. It is the garden city system of town-planning which is likely to receive a great impetus from the development of electricity, and by means of which the greatest social and industrial advantages are likely to be secured for the community.

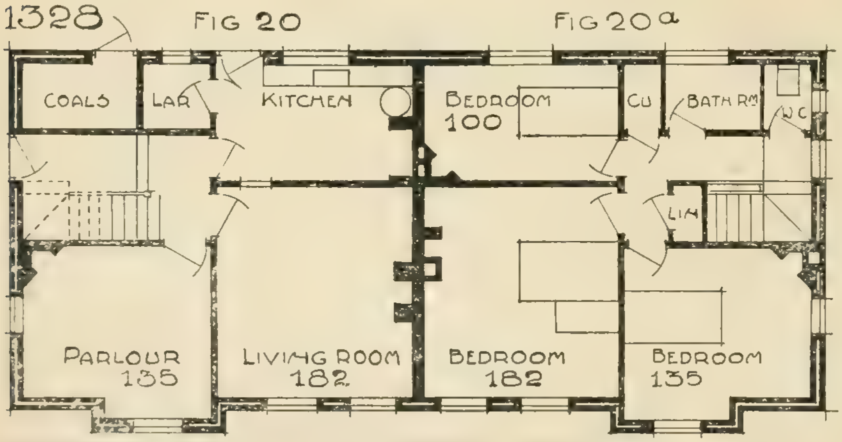
Electricity, Small Dwellings and Garden Cities.

By J. SILAS WHYBREW
(Secretary, the Labour Housing Association).

In addition to the great relief that the full or even partial use of the various electrical appliances now available will bring to the overworked and harassed housewife and mother, there are other very important improvements which can be effected by the use of this form of energy. These include a better and more economical form of construction of the dwelling and a very substantial increase in the habitable space provided within it, without any considerable increase in the rent chargeable. There can be no doubt that the necessity of providing for a number of fireplaces and a copper, according to the size of the house, has constituted a severe handicap to the most experienced architect, and as a consequence the majority of occupiers have suffered a large amount of discomfort and inconvenience. The supreme test of an architect consists in his talent to plan a small dwelling. This problem is much more urgent and serious than many people imagine. The new houses erected under the Housing Acts are now reaching completion, and it is possible for the first applicants to see the kind of accommodation afforded by a beneficent officialdom.

Defects of the New Houses.

The defects of the new houses are real. The small and awkwardly shaped rooms, the lack of suitable conveniences, and the impossible rents charged are all receiving keen criticism and causing much discontent, especially among the women folk. This dissatisfaction is so acute that in some parts of the country the people are declining to become tenants. The London County Council is one of the chief offenders. Some of the houses built by the Council, costing over £1 000 each, give very poor accommodation, and the occupiers only took them in the first instance because of the lack of housing facilities in the Metropolitan district. In one of the houses on the Norbury Estate the cellar is situated in the middle of the wall of the living room, under the stairs. The room itself is none too large, and it is inconvenient to put any article of furniture into it, alongside the wall, which cannot be quickly removed. The coalman has to come through the passage leading from the front door to get to the living room, and, needless to remark, a cloud of dust arises whenever a bag of coals is poured into the cupboard provided for the purpose. The scullery is so small that it is necessary to keep the mangle in the living room!



Reproduced from the Special Plans Number of "The Housing Journal"

Fig. 1. A "Tudor Walter's" Design of Working Class Dwelling.

A glance at most of the semi-detached villas, provided with the usual fireplaces, will show that three chimney breasts are constructed; whereas if electricity had been supplied at the time of erection, for heating and lighting, it would have been unnecessary to have built more than one chimney breast, thus saving the owner or tenant a fair item of expenditure.

The Tudor Walter Design.

To illustrate the great advantages that are possible, if electricity is adopted, a series of plans from "The Housing Journal" are reproduced. The plan, Fig. 1, is plan 40 of "The Tudor Walter's Report"; it is also included in "The Nation's New Houses," slightly modified by the addition of bay windows. This particular plan was selected as "the standard plan" for the "Daily Mail" Housing Exhibition held during last year. It may, therefore, be accepted as an authoritative plan for the ordinary type of house.

It has three chimney breasts, two of which are erected in outside walls, and provides for five fireplaces, a copper and cooking range. It would be impossible to build this type of cottage in terraces. The living room and the main bedroom are of the minimum sizes recommended by various Government Committees, but neither the parlour nor the second and third bedrooms give the adequate space essential for the health and comfort of a family of five or six persons. The kitchen-scullery opens directly to the open air. It is obvious that the women folk, who spend so much of their time in this working apartment, must always be subject to draught from below the outer door, and when the door is open, which it must be on the weekly wash-day, in weather more or less severe, according to the season of the year.

When the feet are chilled by draught blowing over a cold floor, and the head is immersed in warm stagnant air or heated atmosphere, a condition is created in the body which inevitably produces cold or some more serious complaint in the person affected.

The total habitable space in this much lauded plan is 734 sq. ft. The aggregate of the figures, 1 328, is the number of square feet measuring over the outer walls.

The Ideal Plan.

The plans in Fig. 2, also reproduced from "The Housing Journal," are examples of a new type of cottage dwelling, which give the maximum amount of habitable accommodation possible with the materials employed to build them. There is only one "centrally located chimney breast" which retains the heat created within the house, and provision is made for only one fire.

It will be observed that in the three plans shown that the roofed areas are much less than that in "The Tudor Walter's plan," but the habitable space in each is greater in proportion to their size. The extra space is obtained because there is only one chimney breast, and by the use of a new method of construction and a new form of walling, which makes a 6-inch wall substantial, and durable enough for adoption, instead of a 11-inch wall.

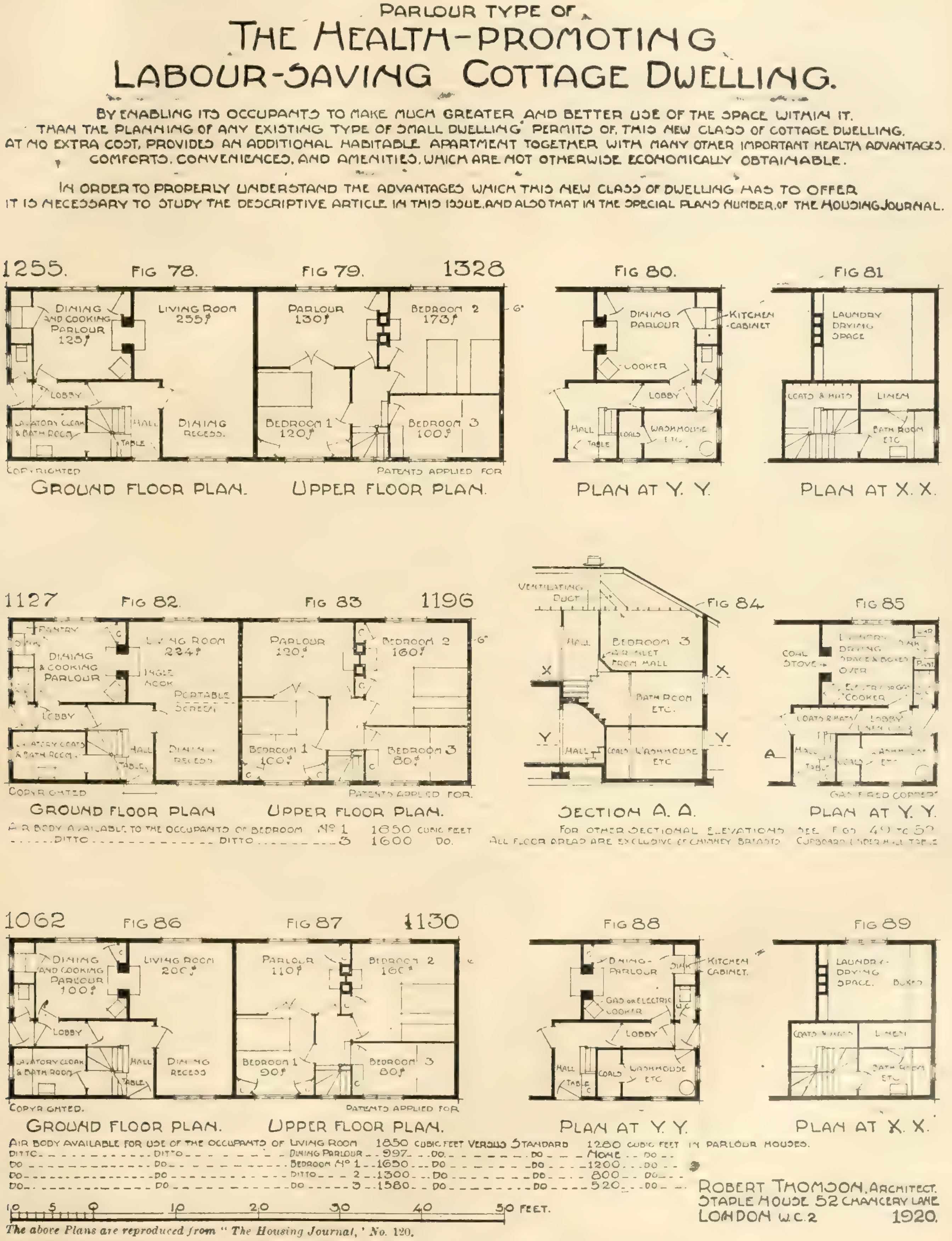
A feature of the new type is that the parlour is located on the first floor instead of on the ground floor. It is claimed that this arrangement enables the occupiers to make more frequent and better use of all the rooms in the house than they can do when the parlour is placed on the ground floor. It is quite certain that this form of construction gives a larger living room and scullery, and a bigger parlour, whereas in the usual type the downstairs accommodation consists of a small living room, a cramped parlour, and a miserable scullery.

The Advantages of Electricity.

For an exhaustive description of the many other advantages of "The Woman's House" readers are referred to "The

Housing Journal," No. 120. The fact seems clear that there is no reason why the working class or indeed anyone that can only afford a low rental, should not have quite adequate accommodation, with all the labour-saving devices which electricity can supply at prices within their means. The working women of the country are anxious to have the electric house, and also desire to employ electric kettles, irons, cleaners, and other household appliances, as soon as they can be provided.

The eight-hour day, or any kind of order to regulate the working time, is almost an impracticability in the domestic affairs of our people. The sensible and immediate method of reform is to introduce labour-saving machinery into the home, to abolish the causes of the perpetual dirt and grime, and thus reduce drudgery to the minimum; only the extensive use of electricity can make that desirable state of things possible.


PARLOUR TYPE OF
THE HEALTH-PROMOTING LABOUR-SAVING COTTAGE DWELLING.
BY ENABLING ITS OCCUPANTS TO MAKE MUCH GREATER AND BETTER USE OF THE SPACE WITHIN IT, THAN THE PLANNING OF ANY EXISTING TYPE OF SMALL DWELLING PERMITS OF, THIS NEW CLASS OF COTTAGE DWELLING, AT NO EXTRA COST, PROVIDES AN ADDITIONAL HABITABLE APARTMENT TOGETHER WITH MANY OTHER IMPORTANT HEALTH ADVANTAGES, COMFORTS, CONVENIENCES, AND AMENITIES, WHICH ARE NOT OTHERWISE ECONOMICALLY OBTAINABLE.
IN ORDER TO PROPERLY UNDERSTAND THE ADVANTAGES WHICH THIS NEW CLASS OF DWELLING HAS TO OFFER IT IS NECESSARY TO STUDY THE DESCRIPTIVE ARTICLE IN THIS ISSUE, AND ALSO THAT IN THE SPECIAL PLANS NUMBER, OF THE HOUSING JOURNAL.
1255.
FIG 78.
FIG 79.
1328
FIG 80.
FIG 81
DINING AND COOKING PARLOUR 125♯
LIVING ROOM 255♯
PARLOUR 130♯
BEDROOM 2 173♯
6"
KITCHEN CABINET
DINING PARLOUR
COOKER
LAUNDRY DRYING SPACE
LOBBY
LAVATORY CLOAK & BATH ROOM
HALL
TABLE
DINING RECESS
BEDROOM 1 120♯
BEDROOM 3 100♯
COALS
WASHHOUSE ETC
COATS & HATS
LINEN
BATH ROOM ETC
COPYRIGHTED
PATENTS APPLIED FOR
GROUND FLOOR PLAN.
UPPER FLOOR PLAN.
PLAN AT Y. Y.
PLAN AT X. X.
1127
FIG 82.
FIG 83
1196
FIG 84
FIG 85
PANTRY
SINK
DINING & COOKING PARLOUR
LIVING ROOM 224♯
INGLE NOOK
PORTABLE SCREEN
PARLOUR 120♯
BEDROOM 2 160♯
VENTILATING DUCT
HALL
BEDROOM 3 AIR INLET FROM HALL
BATH ROOM ETC.
COAL STOVE
LAUNDRY DRYING SPACE & BOXES OVER
COOKER
COATS & HATS
LOBBY
LAVATORY COATS & BATH ROOM
DINING RECESS
BEDROOM 1 100♯
BEDROOM 3 80♯
COALS
WASHHOUSE ETC
X
Y
A
COPYRIGHTED
PATENTS APPLIED FOR.
GAS FIRED COPPER
GROUND FLOOR PLAN
UPPER FLOOR PLAN.
SECTION A. A.
PLAN AT Y. Y.
AIR BODY AVAILABLE TO THE OCCUPANTS OF BEDROOM Nº 1 1850 CUBIC FEET
DITTO DITTO 3 1600 DO.
FOR OTHER SECTIONAL ELEVATIONS SEE FIGS 49 TO 52
ALL FLOOR AREAS ARE EXCLUSIVE OF CHIMNEY BREASTS
CUPBOARD UNDER HALL TABLE
1062
FIG 86
FIG 87
1130
FIG 88
FIG 89
DINING AND COOKING PARLOUR 100♯
LIVING ROOM 200♯
PARLOUR 110♯
BEDROOM 2 160♯
DINING PARLOUR
SINK
KITCHEN CABINET
GAS OR ELECTRIC COOKER
LAUNDRY DRYING SPACE. BOXES
LOBBY
COATS & HATS
LINEN
LAVATORY CLOAK & BATH ROOM
HALL
TABLE
DINING RECESS
BEDROOM 1 90♯
BEDROOM 3 80♯
COALS
WASHHOUSE ETC
BATH ROOM ETC
COPYRIGHTED.
PATENTS APPLIED FOR
GROUND FLOOR PLAN.
UPPER FLOOR PLAN.
PLAN AT Y. Y.
PLAN AT X. X.
AIR BODY AVAILABLE FOR USE OF THE OCCUPANTS OF LIVING ROOM 1850 CUBIC FEET VERSUS STANDARD 1280 CUBIC FEET IN PARLOUR HOUSES.
DITTO DITTO DINING PARLOUR 997 DO. DO NONE DO
DO DO BEDROOM Nº 1 1650 DO DO 1200 DO
DO DO DITTO 2 1300 DO DO 800 DO
DO DO DO 3 1580 DO DO 520 DO
10 5 0 10 20 30 40 50 FEET.
ROBERT THOMSON, ARCHITECT.
STAPLE HOUSE 52 CHANCERY LANE
LONDON W.C.2 1920.

The above Plans are reproduced from "The Housing Journal," No. 120.

Fig. 2.—Some "Housing Journal" Designs of Houses.

The rapid and widespread development of electricity in all its branches, especially as regards the general use of electrical appliances, depends to a very large extent on the enterprise and public spirit of supply authorities and manufacturers. It would be good business to co-operate with local authorities by providing wiring, stoves and other apparatus at the lowest price consistent with the cost of production and maintenance. It would be undesirable to enter into any arrangement to supply installations free, as the whole cost of these should be defrayed by the tenants in their payments of rent.

The initial costs for electricity may be greater than the estimate which provides for grates, ranges, gas stoves, when these articles are required for the ordinary type of cottage But if a substantial amount can be saved by the adoption of an economical plan which also implies the use of electricity, then the total charges should not be much, if any, greater. The cost for external and internal decorations will be decidedly lower in the case of the house in which electricity is in use, and as the price of paints and kindred materials is a big item, the saving in this connection should be taken into account.

Whether the supply of electricity is available in the district or not local authorities and others concerned in the promotion of housing schemes should allow for the use of electricity in the construction of the dwelling, otherwise the cost of an installation at a later period will add considerably to the expense, and in most cases prevent future tenants from enjoying the advantages which electricity can bring.

What Supply Authorities Can Do.

Electrical companies can perform a real service to the community, and play a very effective part in the regeneration of the life of the nation and the reconstruction of industry by taking an active interest in the creation of Garden Cities and new towns; such a venture would encourage the use of electricity, and prove the tremendous possibilities of electricity for industrial, agricultural, social and domestic purposes. It should be possible to create "An Electric Garden City."

The British Electrical Development Association would be well advised to call a conference of all classes of manufacturers in whose trades electricity is used to discuss this project. Instead of industrial companies buying land and extending their premises within the large towns, which are already too big and unhealthy both for living and working in, the better way is to establish entirely new factories with the latest electric machinery, surrounded by electric houses arranged on garden suburb principles, with the pleasure resorts and educational facilities provided in the existing cities. What cocoa and soap companies have achieved at Bournville and Port Sunlight is possible on a much more extensive scale. It is an enterprise that the Co-operative Productive Companies and the Co-operative Wholesale Society should take a keen interest in promoting. The most effective way to sweep away "the black country" is to create a white, yellow, red, blue, and green country; but if those connected with the supply of electricity do not exercise some initiative in the pursuit of such an experiment, then the progress from the existing conditions of dirt, depression, and disease to the townships of colour, health, and happy surroundings will be slow indeed. The captains of the electrical industry have a great opportunity. Some of them employed their ability and experience in one and another of the departments set up during the Great War. The present time offers to them far greater opportunities to serve their country to noble ends.

The Application of Electricity to Middle Class Houses and Flats.

By S. H. STANLEY
(Westminster Electric Supply Corporation).

SOME years ago the Westminster Electric Supply Corporation, Limited, recognised the immense field awaiting development in the use of electricity for domestic purposes, and laid themselves out to meet it by supplying current to their consumers for cooking, heating and power at 1d. per unit. That this policy has proved effective is shown by the additions to the Company's business during recent years. The Company claim that houses completely equipped electrically for lighting, heating and cooking with a storage tank for hot water would be not only healthier and cleaner, but actually more economical to live in than those fitted with the present arrangements. They believe that in the near future this will be so generally realised that there will be as great a demand for electricity for these purposes as at present exists in America.

Organisation and Propaganda.

We have a consumers department for developing this side of our business. There is also a showroom fully equipped where the latest type of apparatus for heating, cooking and domestic labour-saving devices may be inspected by consumers, and demonstrators are always in attendance to give advice as to how to obtain the best results at the least cost from their existing wiring for lighting, heating and cooking.

The area is divided into districts with an engineer detailed to call on every household and keep in touch with and educate the consumer to heating and cooking by electricity. To the least observant it is obvious that in this direction enormous strides have been made and that electric heating is rapidly becoming the chief form of heating in use to-day, not only because of its adaptability, but also because of the economy and health which it permits its users to enjoy. The results obtained by the company may therefore be termed satisfactory.

Co-operation with Manufacturers.

The manufacturers come to the Company with their apparatus, and ask for our co-operation so as to enable them to cater for the consumers' wants, and they are always willing to modify their designs in accordance with our views. The manufacturer in fact now generally finds that with the co-operation of the Supply Authorities he can make a standard pattern of equipment at a greatly reduced cost.

Originally the Company hired fires to its consumers beginning in quite a small way until at present they have connected to the system 14 604 kW of heating load. They only employ four types of standard fire for hire at a yearly rental of 10s. 6d., and when the consumer is satisfied with the result of electric heating, he invariably either buys a fire outright or wants to purchase a more ornamental one.

When we examine electric cooking we not only find perfection but economy as well. Cooking, it may be said, is pre-eminently the loadto fill up the "valleys," an ideal which the Westminster Company are out for as much as any other supply authority, and without any fear of contradiction, for baking and grilling, electricity cannot be beaten by any other method. In what other way, it may well be asked, can you raise an oven to a temperature of 400 degrees in 25 minutes at an expenditure of 1d., by switching down to 500 W, retain for 30 minutes the desired cooking temperature; and then by switching off entirely, retain enough heat for another hour or more to complete the cooking with no expenditure of current at all ?

In the early stages of applying electricity to this very domestic purpose, much experimental work was undertaken, and it was definitely established after a four years' test in which the writer was concerned, that in the cooking of meat no loss in weight was experienced greater than 12½ per cent. In fact an average of eight per cent. was maintained. Surely this is an immense advance on any results obtainable by the use of either coal or gas, and as to cost electricity compares quite favourably with any other method.

Cooking Organisation.

At first the Westminster Company hired a cooker at £2 2s. per annum with very satisfactory results, and from the experience thus gained they drew up a specification in co-operation with the manufacturers, embodying further improvements. At present about 2 000 kW are connected to the mains for cooking purposes.

The use of electricity, it may be added, will also reduce the cost of building considerably. The employment of electric ventilation and heaters will at once do away with all chimney breasts, thus considerably reducing the expenditure on bricks, at the same time allowing more space. It follows, therefore, that for a given sum a larger number of houses can be erected. That the application of electricity will eventually solve the housing problem is, I think, proved beyond doubt. For it will accomplish two things. The future house will be perfect, both from the point of view of economy, and in promoting a condition whereby the occupier will have the greatest chance to retain perfect health.

It is not too much to say also that in the near future the application of electricity will cause a much more rapid rate of construction to be possible owing to the continual invention of labour-saving devices. That this state of things may come to us quickly is doubtless the fervent wish of all those who are looking for houses.

Selling Electrical Energy in Bulk to the Domestic Consumer.

By Major H. RICHARDSON, O.B.E., M.C.

(President, Incorporated Municipal Electrical Association).

It cannot be denied that even up to the present day the electric supply service to the ordinary domestic consumer, as viewed generally by supply authorities, has never got beyond the limit of purely lighting needs, with the result that now, when the public are awakening to the fact that electricity can be efficiently employed in many other spheres of usefulness in domestic work, such as cooking and heating, there is still an inclination on the part of the electricity supply engineer to adhere to that principle, and no endeavour is made to encourage the consumer to take up the new methods of electric heating and cooking, simply because the rate of charging at which the undertaking will give the supply is not suited for these auxiliary uses.

True it is that many supply authorities have had in operation tariffs which were intended for such loads, but they were not entirely successful, especially when the heavy-loaded element was introduced, as is now the practice in all electric heating and cooking apparatus. These tariffs were, as a rule, based on purely technical data, and were quoted on such bases, with the result that consumers were never quite sure in their own minds what the bill would ultimately be, so that if it exceeded an assumed limit, the chances were that the consumer dropped out after the first year of working. In addition the consumer generally had to provide a separate circuit for "auxiliary uses." This is just one of the weak links in all electrical supply tariffs, which the consumer cannot understand, viewing electrical energy, as he always has and will do, as being one single service, no matter how he uses it for lighting, heating or power.

Fixed and Running Charges for the Domestic Load.

Most large supply authorities have catered for the large industrial power consumers on the "fixed and running charge" principle for all purposes. Why cannot a similar proposition be put forward for the ordinary domestic or shop consumer and let us *sell them the energy in bulk as well?* The tariff must be free from any terms which the ordinary layman will not or cannot understand—it must allow him to use the energy how and when he pleases, and provide a reasonable average or running rate on the apparatus in use without always counting the cost. Relative to any tariff for electrical energy, especially a domestic tariff, it has to be borne in mind that our competitors can always give the single service and that their apparatus is very much cheaper on first cost, so that unless a more popular method of charging for electrical energy can be devised, the maximum business obtainable both by the manufacturer and the supply authority for domestic heating and cooking will be from one or two of the wealthier class consumers (a mere fraction of the field which might be cultivated).

It is admittedly a difficult proposition to sell electrical energy on a similar basis to, say, that of our gas competitors (theoretically it is not possible), and it is also difficult to devise a simple tariff for electrical energy which leaves out such terms as maximum demand, hours of maximum demand, kilowatts, 50 W and 100 W lamps, &c., &c. There is no reason, however, why the supply authority should not substitute for all these common everyday terms understood by everybody, and so eliminate at least some of the misapprehension, provided the result is the same so far as the £ s. d. is concerned. This is exactly what has been done in the Dundee Corporation rates of charge for some time past and it has already proved an exceedingly popular method with the consumer. In the case of domestic consumers a "Fixed and Running Charge" Tariff is in operation as follows:—

(*a*) Fixed Service charge of 2s. per 100 square feet of the area of the living rooms per quarter.

(*b*) In addition all units registered through the meter for whatever purpose, at the rate of ⅞d. per unit.

How the System Works.

With domestic consumers the area of the living rooms only is taken. By that is meant the actual rooms in which the energy is used or likely to be used to any extent. In assessing the fixed charge, therefore, no account is taken of landings, passages, bathrooms, cellars, lumber rooms, &c. The whole of the premises are measured up, however, and the total area stated on the offer sent, on which is also given the assessed area for arriving at the fixed charge. This system of charging was only put into operation in June last year, but already there are 1 000 consumers (domestic, shop, warehouse, and other trading premises) taking advantage of it, bringing along in fixed charges alone £8 000 per annum, or an average of between £7 to £8 per consumer per annum. No attempt has been made so far to press the advantages of the tariff, due simply to lack of plant adequately to meet the demand, but its popularity and self-advertising effect has been solely the cause of it being taken up to the extent shown within the past six months. The advantages of such a system of charge are, of course, obvious, and of a varied nature, but since its introduction one special feature has been brought out.

The consumer himself appreciates, greatly, the facts that he can check very simply for himself the offer made to him, and that the selling price is the same for all purposes for which current is used. The system shows him that energy can be "sold across the counter" in parcel or in bulk, and that he need not further worry himself about maximum demands, rateable values and other puzzling factors, generally introduced to his utter confusion. He understands the area of the house and immediately is willing to pay a certain amount for distributing the light over the floor area of that house (these two features of the tariff appeal to him, at any rate, as being closely connected with one another), and when you allow him to use the service where and how he pleases at as cheap a secondary rate as possible without utilising separate circuits to get beneficial rates for what he considers the same article he will introduce the accessories we are all striving to push forward, when he is allowed to turn on the service tap at will, and bring down his average rate by the extended use of the secondary charge through his meter. While it is not claimed that such a tariff is by any means perfect (and while it has been looked upon, in some quarters, as bold) I am fully convinced after a short trial period that the fixed and running charge tariff, if based on simple lines, such as the foregoing, will sweep away a multitude of difficulties when pushing the sale of electrical energy for purposes other than pure lighting in the domestic class.

Some Aspects of Domestic Lighting.

By J. S. DOW.

DOMESTIC lighting offers a very wide range of problems and it is exceedingly difficult to lay down hard and fast rules. Some indication of the chief points to be considered in an average middle class house were given in a recent booklet.* But it is evident that the conditions in a working man's house of the type now being erected under various housing schemes differ so widely from those prevailing in a house in the West End of London that we cannot scarcely apply the same criteria in judging the conditions of illumination present.

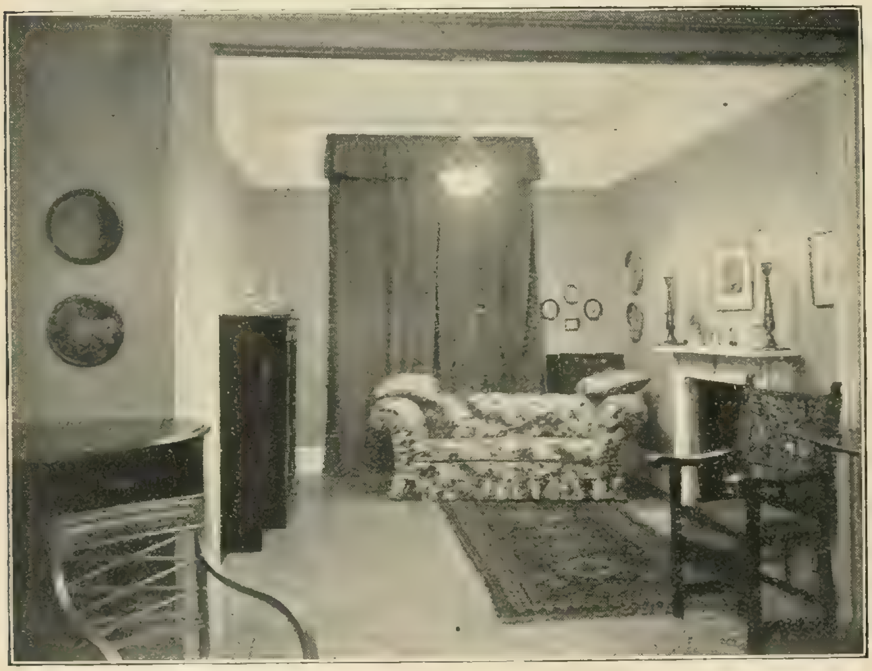


Fig. 1.—Typical Effect of Semi-indirect Lighting in a Drawing-room.

Supplementary light is afforded by the portable lights on the mantlepiece, the purpose of which is chiefly decorative.

In wiring and lighting a worker's dwelling economy is usually regarded as the main factor. But this may be pushed too far. Lighting, after all, is a necessity, not a luxury. As the great majority of the working population mainly use their houses during the period of artificial light, it is surely natural that the illumination should be conducive to comfort. It would be more reasonable to allot to the cost of installation an amount forming a certain fraction of the total cost of erection of the house. In existing circumstances this fraction is often too small. People not infrequently come to the consideration of their lighting only after they have already received a shock in the form of unexpected increased costs in building, decorating or furnishing. The illumination is, in fact, usually the last thing to be considered and it suffers accordingly.

The Chief Evils.

The chief evils that one commonly finds in domestic lighting include improper location of lighting units, undesirable forms of shades and reflectors, and inadequate facilities for subdivision of the lighting by switches. The conventional rules for the positions of lights, if adhered to, give fairly satisfactory results, but they do not err on the side of generosity. As regards the choice of lighting fittings, small consumers commonly err in one or two ways; either they muffle their lights in coloured silk wrappers, which involve undue obscuration of light, or they resort to the conventional shallow opal shade, which may have answered fairly well for the carbon filament lamp, but is unsuited to the metal filament lamp with its longer projecting bulb, and is quite unsuitable for use with the gasfilled lamp. Statements to the effect that electric light is "trying to the eyes" can be very frequently traced to the exposure of bare filaments in unduly shallow reflectors. The wealthy consumer can afford something better and commonly does so—except in the kitchen and the servants' quarters. To the poor man the higher cost of properly designed reflectors is naturally a consideration. Makers of reflectors might with advantage consider the production of deeper reflectors capable of competing with the ordinary conical opal shade. The problem should not be insuperable if once such shades could be made in large quantities.

An Analysis of Lighting Arrangements.

In the booklet to which reference has already been made the method was suggested of starting at the threshhold of a typical small house and considering each room in succession. It may be convenient to adopt a somewhat similar plan, and to discuss a few of the customary methods of lighting various classes of rooms, with a view to finding improvements on existing practice. The first point that strikes anyone in traversing a suburban street by night is the fact that names or numbers of houses are so rarely illuminated; this makes it difficult to locate a house in a strange neighbourhood. If a light is used in the porch it is not infrequently hung at an unduly low level and unshaded. In these circumstances it is not only glaring and annoying to people entering or leaving the front door, but does little to illuminate the step—its primary object. Porchlights therefore should be at a level well above the top of the front door, and should be equipped with a concentrating reflector throwing the light on the steps. Frequently there is an opportunity to conceal this light behind a projecting cornice above the porch ; if so, this should be utilised. Above the front door there is commonly a sheet of clear glass, which may or may not bear the name of the house. This receives some light from the lamp in the hall, but naturally a name on clear glass is not well illuminated. It would be better if the glass were of a diffusing character, so as to appear evenly lighted. A name or number stencilled in black on this would be perfectly legible. It need not receive much light. If the lamp in the hall is equipped with a suitable reflector throwing most of the light downwards (not a densely obscured or ruby globe) there will be sufficient light transmitted through the shade to light up the name-plate.

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* "Electric Lighting in the Home," by L. Gaster and J. S. Dow.

Figures are not infrequently given for the amount of illumination desirable in various rooms throughout the house. In practice, however, the amount of illumination depends greatly on the taste and occupation of the inmates. Some people use their drawing-rooms almost exclusively for conversation, and prefer a dim and restful light ; they are usually strong advocates of silk shades. Others use this room for reading and writing, and their demand for light is much greater.

The Demand for More Light.

One of the most striking things in the present lighting age is the continually increasing demand of most people for more light. The writer has in mind a drawing-room which was at one time lighted solely by four central 8 c.p. carbon lamps. The introduction of vacuum metal filament lamps (adequately shaded) was at first condemned on the ground of glare. Before long this objection was superseded by a demand for more light, and lamps of higher consumption were used. Ultimately a central 100 W gasfilled lamp, supplemented by small wall-lights was adopted. This was again at first considered glaring ; but to-day the occupants are not only reconciled to the change, but are again demanding more light. The users of this drawing-room, it may be mentioned, read a good deal.

In the writer's experience, if any considerable amount of reading or writing is done, either in the drawing-room or in the library or study, the available illumination should be at least 3 ft.-candles. Generally speaking, the most acceptable plan seems to be to rely on a central semi-indirect unit for the majority of the light. This may be supplemented by local silk-shaded lights, or bracket lights to avoid monotony, but the latter should be well-shaded. A great advantage of central semi-indirect lighting is that it provides ample light for a number of people seated round the fire reading, the light coming over their shoulders in the approved manner. Bracket lights on either side of the fireplace are in general not of great value for reading, as little of the light will reach the surface of a book held at an angle by persons facing the fire. Moreover, such lights fall within the direct range of vision, and must therefore be very completely shaded. Fig. 1 is an attractive example of the use of semi-indirect lighting. The candles on the mantelpiece are purely ornamental, but a special light is attached to the piano for illuminating the music. People who are much attached to silk shades may be reconciled to semi-indirect lighting by the adoption of a silk-covering (preferably of a pattern to match the general scheme of decoration) under the diffusing bowl. If the latter is of a well-designed type, for example, of suitable prismatic glass, the proportion of light transmitted downwards through the glass is relatively small, and the absorbtion of light by the silk is therefore of small moment. One difficulty met with in indirect lighting, and to some degree also with semi-indirect lighting, is the formation of a shadow-line on the walls, corresponding with the edge of the bowl. If this can be made to coincide with the line of the cornice it is less noticeable. It might also be softened by the use of the new gasfilled lamps with opal bulbs.

These gasfilled lamps with opal bulbs would seem particularly well adapted to domestic lighting. In general, in spite of the effective diffusion produced by the opal glass they still require some form of shading. In many cases, however, quite a light form of shade will answer. Fig. 2 shows the use of such a lamp, in conjunction with a very light drapery in an alcove of a drawing-room as a supplement to the main lighting.

Candle Lights and Semi-Indirect Lighting.

Bracket candle-lights are probably less used at present than was the case some years ago. Provided the users of a room do not require a very high order of illumination, the interposition of a simple silk screen and the reflection of rays from the light surface of the adjacent wall can yield quite charming results. Fig. 3 is an example of a room so lighted, which was described before the Illuminating Engineering Society some years ago. Although apparently primitive as a lighting device, this method gives excellent diffusion, and has the advantage of leaving the centre of the room clear.

In rooms where close study and much reading and writing is done, semi-indirect lighting is again, in most cases, the best method, as it yields the requisite diffused light for reading and also illuminates the shelves of books in a convenient manner. Some people profess a preference for a local table lamp. In a library this requires to be supplemented by moderate general illumination from lights at a high level. Otherwise the contrast between the illumination on the table and the relative obscurity of surroundings is excessive, and the titles of books on shelves cannot be easily read.

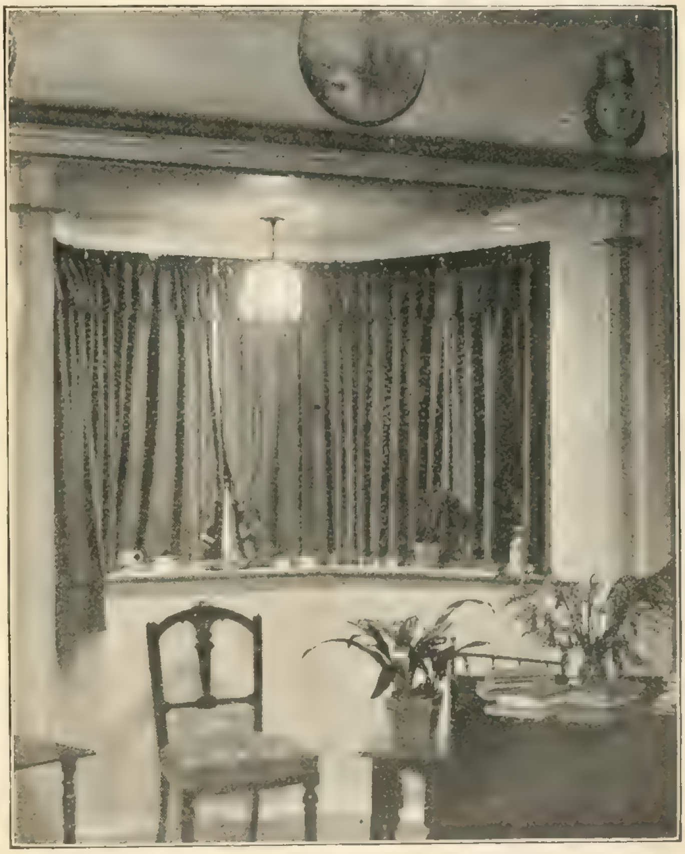


Fig. 2. Showing Use of an Opal Bulb Gasfilled Lamp for Lighting a Small Alcove in a Drawing-room.

Owing to the diffusive effect of the bulb, such lamps can be screened by a very light drapery.

Dining Room Lighting.

The dining room again presents the same characteristic as the drawing room of being used by different families in different ways. Its primary use is for meals ; some people, however, use it for reading and writing at other times. Most people prefer a strong even illumination over the table, and comparatively little light in the remainder of the room during dinner. A common method is to use a ring-fitting, open at the top and frequently carrying inside the shade a cluster of lamps. The idea is that some light escapes upwards to illuminate the rest of the room. In the writer's experience this method does not answer well. It is better to line the inside of the coloured shade with white silk, and to close it in at the top by a suitable flat reflector; and to provide illumination in the rest of the room by supplementary methods (*i.e.*, either a cluster of lamps mounted direct on the ceiling at the central point whence the pendant emerges, or portable silk-shaded lamps at various points round the room). In these circumstances quite a large table can be lighted by a 60 W lamp. The fringe of the shade must not be too shallow, otherwise persons seated round the table will be faced by an irritating glare from exposed filaments. The writer has used a single opal-bulb 60 W gasfilled lamp with success. Even if seen, such a lamp, visible against the illuminated white silk lining of the shade, does not appear distressingly bright.

The desirability of some form of lighting supplementary to the main unit over the table is illustrated in Fig. 4, which is a photograph taken entirely by the light of the shaded unit seen in the picture. The illumination on the table is ample, but the rest of the room is in comparative obscurity, and the faces of people seated round the table will hardly receive sufficient light. In some dining rooms it is now customary to prove moderate general lighting from above, and to rely on shaded wax candles to "brighten up" the table.

Bedrooms are very frequently inadequately lighted. Extreme economy is represented by a single light over the dressing table, moderate expenditure by one on either side and the provision of a plug beside the bed for a reading lamp. While two lamps screened in translucent reflectors, one on either side of the dressing table, answer their immediate purpose, it cannot be said that they afford much light to the room as a whole. Moreover they necessarily afford little light to the vertical faces of the drawers of the table. This condition is illustrated in an extreme form in Fig. 5. A lady dressing for a dance or the theatre, requires the room to be as well lighted as any in the house. She cannot otherwise judge of her appearance, as she desires, by a full-length mirror. Sometimes lights on either side of such mirrors are also fixed. By this time, however, we have already approached full general lighting in the room, and one might just as well go the whole way and provide a central semi-indirect unit. The plug beside the bed should be under control from the bedside, so that a person reading at night can finally extinguish this light without getting out of bed; or, conversely, can obtain light at once during the night without rising. In children's bedrooms the provision of a plug, as an incentive to the pernicious habit of reading in bed, is rightly discouraged. In the case of young children there should, however, be some form of night light; on alternating-current circuits, small lamps operated by a transformer are available for this purpose.

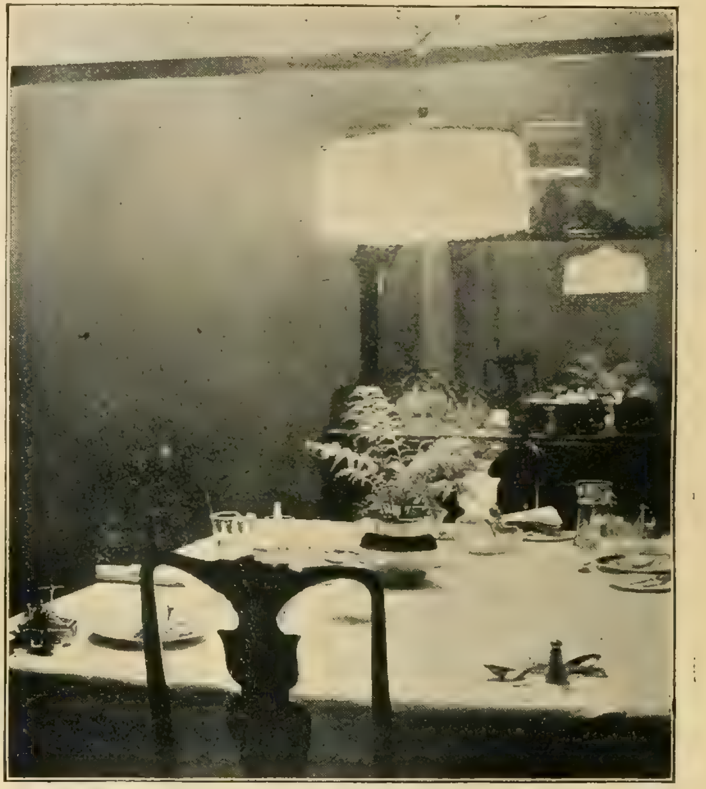


Fig. 4.—Showing Effect of Single Silk-shaded Light above Dining-room Table.

The illumination on the table is ample, but the contrast with the very subdued light in the rest of the room is excessive. Supplementary light from local shaded lights is therefore necessary.

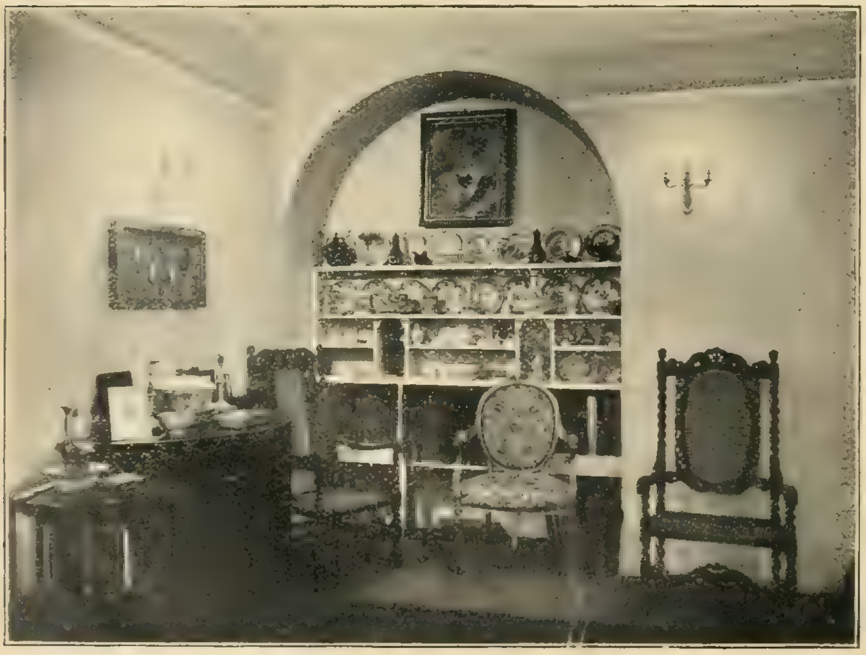


Fig. 3.—Showing Lighting of a Small Drawing-room by Bracket Lights, Screened with Silk on the Side Facing the Interior of the Room.

The Illumination of Domestic Offices.

Kitchens, sculleries and pantries deserve more attention than they usually receive. This is one part of the house where the shallow conical opal shade is almost invariably used. Sometimes only a single point in each room is provided, and argument ensues as to whether this should be located above the range, the sink or by the dresser, &c. In a pantry or scullery, usually of small dimensions, a well-shaded lamp over the sink will often be all that is needed, provided the walls and ceiling are light in tint. In the kitchen, however, light is required at so many points that a simple form of semi-indirect fitting, possibly supplemented by a plug and reading lamp, might well be considered. Good lighting of this description adds considerably to the comfort of the servants, for whom the kitchen has to serve both as the working place and the room in which they take their recreation. It is therefore the more important that they should be able to read or sew in comfort in the evenings, or when not engaged in work, and a little attention to the lighting is, from the domestic standpoint, a good investment. It may be remarked in passing that needlewomen almost invariably seem to prefer a local shaded lamp, however adequate the general illumination may appear to be. Sometimes a well-shaded oil lamp is preferred to anything else.

Possibly the nature of the work demands a higher illumination than can conveniently be obtained from general lighting, but is attained with a local lamp by bringing the work quite close to the light. Probably also the brighter local illumination is favourable to concentrated effort.

A bathroom, with its white-tiled walls is an easy subject for lighting. The lamp is usually placed above the washing basin, and enough light will be diffused into the rest of the room. The lamp should be equipped with a translucent reflector, and should be placed sufficiently high up to be out of the way of motions of towels, &c. The lighting of landings, passages, stairs, &c., calls for little comment. The chief essential is that lamps should be adequately screened so as to avoid glare, especially in the case of lamps above flights of stairs. About 0 5 to 1 foot-candle is usually considered sufficient illumination in such circumstances. It is worth while to install a light in the coal cellar though both reflector and lamp quickly become coated with grime. The lamp may be mounted in a metal reflector direct on the ceiling, and the filament should be completely out of sight of a person entering the room. Owing to the dark nature of the surroundings, the illumination is almost bound to appear inadequate, but it is in fact better than that obtainable from the usual wax candle, with its drawback that grease is apt to be dripped on the stairs leading to the cellar.

While, as already mentioned, one cannot define the illumination desirable in domestic lighting in the same precise way as might be possible for an industrial process, it may be useful to give some indication of the values that might be anticipated in practice. This is done in the following table :—

Table I.—*Conditions of Illumination for Domestic Lighting.*

Nature of room.	Conditions of illumination.	Approx. value of illumination.
Passages, stairs & landings.	Well-shaded lights at intervals......	0·5-1ft.-candles on floor.
Libraries, studies, &c.	General semi-indirect lighting from central unit over table, supplemented by portable well-shaded lamp if desired.	3-4 ft.-candles on table : 1 ft.-candles on shelves (vertical)
Drawing-rooms...	Considerable latitude permissible. Central semi-indirect lighting, supplemented by shaded local lamps recommended.	For reading & writing, 3-4 ft.-c.; for general illumination, 1-2ft.-c.
Dining-room......	Shaded light over table supplemented by shaded portable lamps or brackets round room.	On table, 4-5 ft.-candles.
Bedrooms	Shaded lights on either side of mirror at dressing-table. (*a*) If room is much used by adults for dressing for receptions, &c., general semi-indirect lighting in addition. Portable lamp at bedside for reading. (*b*) In children's bedrooms, light at dressing table, controlled both from door and bedside. Night lights, for very young children.	On dressing-table, 4-5ft.-c General illumination in case (*a*) 2-3 ft.-c., with max. in front of full size mirror.
Kitchens, sculleries, pantries, &c.	Moderate central semi-indirect lighting for large rooms, local lights over cooking range, sink and dresser, simple portable lamp for sewing and reading.	Over cooking range, sink, dressers, &c. 3 ft.-c. Gen, illmn. 0·5-1 ft.-candles.
Sewing	(*a*) White material, simple work, general illumination will answer. (*b*) For fine work with dark materials, a well-shaded portable lamp desirable.	(*a*) 2-3 ft.-c. (*b*) 5-15ft.-c.

SOME SPECIAL PROBLEMS.

In conclusion, a few words may be said on special problems, which, while not forming part of ordinary domestic lighting, are, nevertheless, often met with in large houses. The conditions of lighting desirable in card-rooms are commonly met satisfactorily by ordinary drawing-room methods, provided the lamps are well shaded and there is no glare. A lamp over the centre of a card table is not *per se* sufficient, as when the cards are held in the hand and tilted they would be in partial shadow, and are apt to be exposed by players seeking to find a position giving better light. There should, therefore, be supplementary illumination coming over the shoulders of players in the form of diffused light. In billiard rooms the conventional method of using pendant lights in deep opaque cardboard shades has the sanction of experience, and appears well devised. But a caution may be given against the use of bracket lights to provide the necessary subdued general lighting, unless such lights are very well shaded. Otherwise they are apt to fall within the view of players at a critical moment, when even an object of moderate brightness may cause distraction. It is better, therefore, for the general lighting to be subdued and highly diffused, from sources well above the normal range of view of players.

The lighting of pictures presents special difficulties owing to the liability to reflected images of light-sources in the glass. Local shaded lamps placed above and somewhat in front of each picture are sometimes tried. Many fittings of this kind give very uneven illumination, and special design of the reflector is needed to illuminate satisfactorily a large vertical surface. Such lighting units do, however, avoid the difficulty of shadows being cast by the bodies of observers, and reflected images should not be in evidence except at very close quarters. Where there is a large collection of pictures, such as is found in large mansions, the conditions approach those of a picture-gallery, and special overhead diffused lighting, *e.g.*, lamps in concentrating reflectors placed above light muslin, or indirect lighting, deserve consideration. The use of "artificial daylight" units may also be considered if the higher expenditure of energy involved is permissible.

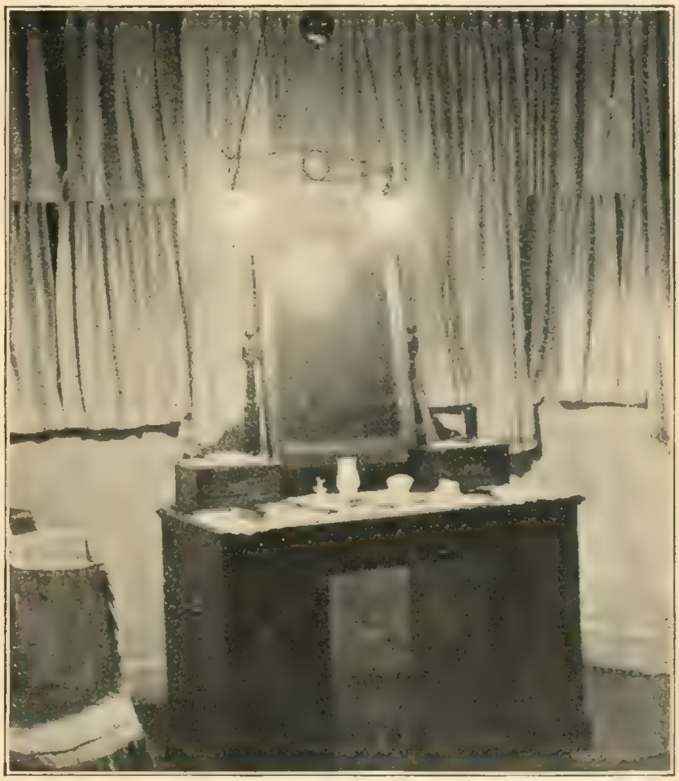


Fig. 5.—Lighting of a Bedroom Dressing-table by Two Lights, One on Either Side of the Mirror.

Ample illumination is provided on the table, but the vertical faces of drawers are left in obscurity, and comparatively little light is distributed over the room as a whole.

THE ARTISTIC TREATMENT OF LIGHTING PROBLEMS.

Finally, there are great opportunities in many houses for the more artistic treatment of lighting problems. Rooms furnished in a distinctive style, it may be admitted, require lighting fittings to harmonise. The application of modern illuminants to interiors executed in styles evolved in the days of oil lamps and candles has been much debated. Except in a few cases, where candles and oil lamps are obstinately adhered to, the use of electric light is now accepted in such cases. But care must be exercised to provide adequate illumination without undesirable glare. Ornamental lanterns of traditional design, for example, are probably best equipped with panes of diffusing glass, so that the nature of the source is hidden. The display of a bare filament in a lantern of antique ironwork is bound to be incongruous. Similarly, when "electric candles" are used in chandeliers of Dutch or other distinctive style, it is probably best to conceal the sham effect of an electric filament emerging from an imitation candle by the use of appropriate decorative shades.

Some Suggestions for the Future.

On the other hand, in buildings which, while of artistic and decorative value do not follow any traditional style, it should be recognised that there is an opening for newly evolved modern methods of lighting, designed to fill a decorative purpose and yet meeting practical lighting requirements. This field has been incompletely explored as yet, and there are many possibilities that deserve study, though it is admittedly not usual for a consumer to sanction radical departures of method in lighting. Among the possible devices are the use of artificial skylights—*i.e.*, recesses in the ceiling carrying lamps concealed behind panes of diffusing glass, the use of similar recesses in walls, and, generally speaking, methods of concealed lighting which depart from the conventional suspended bowl or cornice lights.

Such methods might be combined with special colour harmony effects, but they naturally demand special planning of the architectural features, and can only be executed with complete success if the planning of the house and the design of the lighting are carried out together. Yet another possibility is the use of light to illuminate specific objects, and at the same time to furnish general illumination to the room. For example, a certain measure of valuable reflected light might be obtained from lamps concealed above china or other objects of interest in cabinets. Similarly, pictures or photographs might be replaced by painted transparencies or photographic positives backed by diffusing glass and illuminated from behind, forming pleasing objects in themselves and contributing to the general lighting of the room.

In view of the much wider range of contrast thus obtainable in a picture the method deserves exploration by artists. This method has been used with increasing success in the case of illuminated advertisement signs. Such devices would naturally involve more loss of light by absorption, and might be comparatively "inefficient," but deserve attention in view of their artistic possibilities. They might ultimately lead to what may be regarded as the ideal method of lighting an interior—a system such that no source of light is visible, but every object in the room receives its allotted illumination, occupants only being made aware of the fact that it *is* artificially lighted by their ability to see every object in the room with perfect ease.

Light and Health.

By **N. BISHOP HARMAN, M.A., M.B. (Cantab.), F.R.C.S. (Eng.)**

(Senior Ophthalmic Surgeon to the West London Hospital and the West End Hospital for Nervous Diseases).

He was a shrewd deep-seeing old philosopher who opened the scene of creation given in the early pages of our Bible with the words: "Let there be Light." Of all the essential influences on our physical, mental and moral well-being there is none greater than light. To us dwellers in these northern climes there has been no greater boon than the discovery and development of electric light. Our long winters would be no longer the dread of a light-loving Shakespeare. We can at will banish the close-enfolding darkness of the night by the touch of a button. The lamp of the genii is ours, and we can summon the slaves of the lamp at will. Our streets we can wreath with glowing globes, dark alleys and holes no longer give place to lurking terrors, for where light enters darkness and evil flee. Our homes are bathed in an effulgence which can make the humblest more desirable than the palace of the Tudors. The children scamper down passages upstairs and into distant rooms, no longer fearful of the ghosts conjured up by the flicker of a lamp wick. We rise on the darkest dreariest winter morning assured of the welcome of golden rays. The deepest fog of our cities is mitigated by their penetrations. Our evenings when toil is done are ours to the full, both in the place of common concourse and in our homes, for there is light at our command. Truly the maker of light is a benefactor whose name all men should delight to honour.

Health and Electric Lighting.

But my business here is not to write a panegyric upon light. But to deal with some of the problems of electric lighting as they affect our health. There are still some odd prejudices abroad, against light and against electric light. It is said by some that it is bad for the eyes. Let us examine its qualities as compared with other forms of lighting, and see if there be any basis for this prejudice.

Of all artificial lighting that obtained by means of the electric current through the glow lamp is the only form of illuminant which gives light without at the same time producing other effects. Light produced by burning materials, whether these be the pitch-pine torch, the oil wick, the candle or gas, is always and inevitably associated with the evolution of the effects of combustion at the source of illumination. Heat and fumes are generated by the dissolution of the burning substances; heat in proportion to the intensity of the combustion; fumes varying in their noxious character according to the nature of the substance burning. Even when the purest of complex ethane derivatives is burned in the most perfect of burners the life-giving oxygen of the air is consumed and replaced by the dead and irrespirable carbon dioxide. But conditions of such purity are rarely realised, so that there are added other gases whose noxious influences are felt by our bodies, and demonstrated to the eyes in blackened ceilings and tarnished fittings. The electric glow lamp is free from the objectionable concomitants. The heat is negligible. It consumes no air. It emits no fumes. It blackens no ceilings. It tarnishes no gilding. It despoils no paintings. It is the one completely healthy artificial light. It is the product of combustion truly, at least in our coal-bearing country, but the combustion is effected in the generating station, and not in the living rooms of our home. Since the eye is a part of the body, and functions well or ill as the body is well or ill, it follows that the body unharmed by the foul products of combustion will bear eyes that are undimmed, and capable of better and less fatiguing exertion.

The Dangers of Flicker.

Light produced by burning varies with the rate of burning. This is determined by air currents or draught. Torch, oil wick, candle and gas burner all depend on these conditions. And since draught is variable the light engendered in the air current is also variable. This variation we call flicker. There is nothing that the human eye abhors more than flicker. It is more wearing and nerve exhausting than any other defect in light. We have only to watch flicker at its worst, in a bad cinematograph film, to realise how wearing it is. The electric glow lamp knows no flicker. Thus it is a good light for the human eye.

Quality in light is a material factor in comfort. A light may be free from risks of gassing, steady as the daylight, and yet of such a quality as to be unpleasant to the eye and therefore deleterious. The light that the eye likes best is daylight; a perfect mixture of the spectrum emanating from an immense illuminated sky. The sun in a cloudless sky may be overpowering; on the High Alps actually injurious. But embosomed in fleecy clouds veiled by the denser lower atmosphere, the sun is a comfort and pleasure. The electric light is like the sun in these respects. It needs suitable environment; reflectors for clouds, glass for atmosphere to ensure its happiest effects. Much has been said in recent years of the effects of ultra-violet rays and their dangers. These rays are light rays that we cannot see or scarcely see. They are present in all light, giving a full spectrum. Sunlight abounds in them, and it is these rays of the bare unfiltered sunlight of the High Alps which cause the painful snow blindness. On the lower levels the rays are lost, cut off by the layers of atmosphere through which the light has to pass. Electric light has a full spectrum. The more intense the arc or glow lamp, the fuller the spectrum. The metallic fillament lamp has a fuller spectrum than the carbon fillament lamp, the half-watt lamp a fuller spectrum than the metallic fillament lamp. It follows that from the newer more brilliant lamps there may emanate more ultra-violet rays than from less intense forms of illumination. When therefore we are dealing with modern electric lamps we should remember that they are veritable suns in miniature, and to be used in the same fashion as we like to use sunlight, with suitable reflectors to spread the effective course of illumination over a wide area, and through the medium of glass, which is as effective as the atmosphere in stopping the passage of ultra-violet rays.

Use and Ignorance.

From the general let us turn to the particular, the manner of using electric light.

Wherever one goes, in streets, public buildings and homes, there is found evidence of much ignorance or laziness in the usage of light. Ignorance which results in much eye fatigue and in much waste of valuable light and therefore of money. In the streets shop windows abound where the lighting is so excessive and so badly arranged that the passer-by cannot see the goods for the glare. If only the shopman would mix a little brains with his lighting he would learn that half the light well distributed by efficient reflectors would mean lower costs and more customers. Busy street corners are made confusing and dangerous by the glare of powerful exposed lights; pedestrians are worried, and vehicle drivers wearied by these callous displays of selfish ignorance. Some of our theatres are intolerable from excessive lighting; new lamps have been placed in old settings without thought. Churches have been made lighter by night than by day, and with the same reckless scattering of unscreened lamps. In our homes little thought is given to the use of the room when the lights are put in; so many points are arranged, and the fittings are chosen at the shops or left to the sweet will of the purveyor.

The Ideals of Home Lighting.

Let me give you my idea of home lighting. We should enter the front hall to find it bathed in a suffused glow from a lamp within an opalescent globe or bowl; similarly at salient points of staircase and passages would be other glowing bowls. If the house be large and lofty after the Georgian pattern it would be more economical to use clear prismatic glass surrounds to scatter the light far and wide. The dining-room table would be lighted by a pendant enclosed in a valance of warmly-tinted silk, so that light on it was brilliant and the faces of the diners bathed in the comfortable warm glow; lights for the serving table would be screened from direct observation. The drawing-room would be brilliant, and to secure this there is no finer effect than lamps enclosed within a lustre design of cut glass prisms, whereby glare is replaced by innumerable scintillations, so that the assembly itself becomes brilliant and sparkling in turn. The evening-room, library or study, whatever it be called, would have a suffused glow of light from standard or pendant, with the provision of a couple of reading lamps with flexible attachments to wall plugs. The school-room would have large semi-indirect illuminant so that the children could play as well in the evening as in the day time; also a separate switch would control a pendant light with a deep opal shade which would give a perfect illumination over one side-table for use when lessons are done.

Bedrooms are put to many uses. We dress, we read, we sometimes lie awake in them. The pendant light in a prismatic shade over the dressing table would meet the needs of dressing; but for other uses a shaded pendant over the bedhead with a switch at hand would fill many purposes.

To conclude. I will give an example of the value of reflectors. A single 16-c.p. carbon filament lamp was hung from the centre of a room, and the light given by it under various conditions measured with a photometer. The measurements were taken at a level of four feet below the lamp, immediately below it, and at distances of 1, 2 and more yards away on the same level. The following table gives the results :—

	Light in Foot Candles.				
Shade.	Perpendicularly 4ft. below lamp.	1 yd.	2 yds.	3 yds.	4 yds.
None	0·5	0·3	0·1	0·1	0·1
Opal. 110° 3½ in. deep	2·0	0·9	0·5	0·3	0·1
Opal. 80° 5 in. deep	3·0	0·9	0·5	0·2	0·1

It will be noted that with no shade the light is everywhere insufficient at the working level. With an 80-degree opal shade the light is immediately brought up to an efficient standard below the lamp.

There is no boon so great as light. There is no light so good, so healthy and so safe as electric light. There is no light that better repays intelligence in planning. And there is no light which is capable of such infinite variation in planning.

Electric Flats in Practice.

Some interesting figures of the energy consumption in certain flats and houses in the area served by the Brompton and Kensington Electricity Supply Company, Ltd., have been kindly given us by Mr. R. S. Downe who, as is well known, has devoted considerable thought and energy to the development of the domestic load in his area. His task has been simplified to some extent by the conversion of a considerable number of large houses into flats and the corresponding necessity for the installation of convenient means of heating and cooking to take the place of the old-fashioned kitchen.

We may take as our first example of what is being done, a large house which has been divided into three flats. In one of these flats cooking is carried out by means of a 6·5 kW B. and K. cooker, heating is provided by two radiators of 1·5 kW capacity each, the hot water supply obtained from both a gas circulator and a coke boiler. In the second flat the cooking is carried out electrically on a 3·8 kW B. and K. cooker, while the heating of the rooms and the water supply is obtained by older methods which do not at present interest us. In the third flat the cooker has also a capacity of 6·5 kW, and there are two radiators of 1·5 kW each, hot water in this case being obtained from a gas geyser. The total consumption in this house taken over a period of twelve months was for lighting 603 units, and for cooking 13 974 units, *i.e.*, mostly at "off-peak" times.

In a certain terrace in the district the houses have also been converted into service flats, there being four flats per house. The inhabitants in these flats are provided with service, and the cooking for the whole is done on four electric cookers and one coal range in a central kitchen, no gas being available. There is a central hot water supply. The heating of the rooms is effected by electric radiators of various sizes, and the total consumption for the twenty-eight flats over a period of ten months providing for the needs of about 110 people, was for lighting 3 774 units, for heating 12 152 units, and for cooking 11 081 units.

In another case where a large house has been divided into six flats and a caretaker's quarters cooking is done on seven cookers, each with a loading of 3·8 kW. Heating is done by electric radiators, there being neither gas nor coal available, while the hot water supply is obtained from a central system. The energy consumption over a period of 12 months in this case was for lighting 1 370 units, heating 5 093 units, cooking 10 910 units. After considering these figures those who think there is nothing in the domestic electric idea might well be asked whether they require any further witnesses.

The Design of Electric Cooking and Heating Appliances.

Some Requirements for Domestic Purposes.

By W. A. GILLOTT, A.M.I.E.E.

ELECTRICAL cooking apparatus for housing schemes must be designed to embody the following essentials:—

1. *Reliability:* 2. *Accessibility:* 3. *Low Cost of Repairs.* To incorporate these salient features in an electric cooker is the object of the progressive and up-to-date firms engaged in their manufacture. The products of some manufacturers indicate that careful thought and attention are given to details, and it is only by close attention to these apparently minor considerations that makes that little difference, which is all the difference, between partial and complete satisfaction. Specialisation is therefore imperative.

Owing to the strenuous demands made upon the apparatus in houses of the artisan class, reliability must be present in the widest sense. Cookers, &c., must not only perform their functions with satisfaction, but they must be mechanically strong enough to withstand the rough usage they will be subjected to. Light sheet or tin cookers are of no use for this work, a sheet steel body is very satisfactory if built up upon a cast iron frame with a cast iron base and hob, while open-type boiling plates are preferable for domestic work. Wash-boilers and fires must also be substantial in their mechanical construction as these will undoubtedly receive hard usage. The washboiler, for instance, must be of welded steel, and the studs holding the heating elements welded to the underside and so designed that if the equipment is accidentally boiled dry, no serious damage is likely to occur, even if the pan itself becomes red hot.

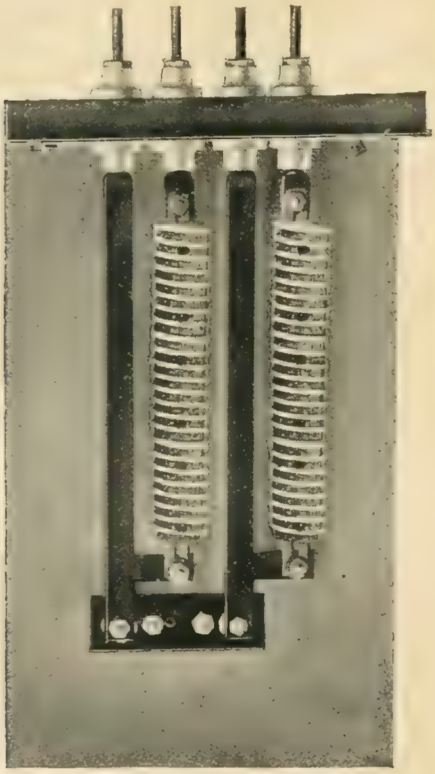


Fig. 1.—Element Frame of Electric Oven showing arrangement of Solid Connection.

Connections and Leads.

The electrical connections on all cooking and heating appliances must be solid, from the main terminals to the actual end of the heating element, and must be permanently fitted in such a manner that they will need no further adjustment or repair. Loose leads, beaded or asbestos covered wires must be entirely eliminated and no mica employed for insulation purposes —with the possible exception of the clamped type of heating elements—air and porcelain being the best insulators to employ. The heating elements for an oven, grill, or open-type boiling plate on a cooker, must be so designed that they fit upon suitable terminals (fitted with lock nuts or spring washers) and make connection direct to the busbar of the element, thereby overcoming the difficulties met with if "wired" or pigtail connections are used. Similar methods of connection are used with the washboiler, the link between the solid rod and clamped element being made by a piece of nickel strip, which at the element end is under mechanical pressure—in addition to the electrical joint—to ensure a good

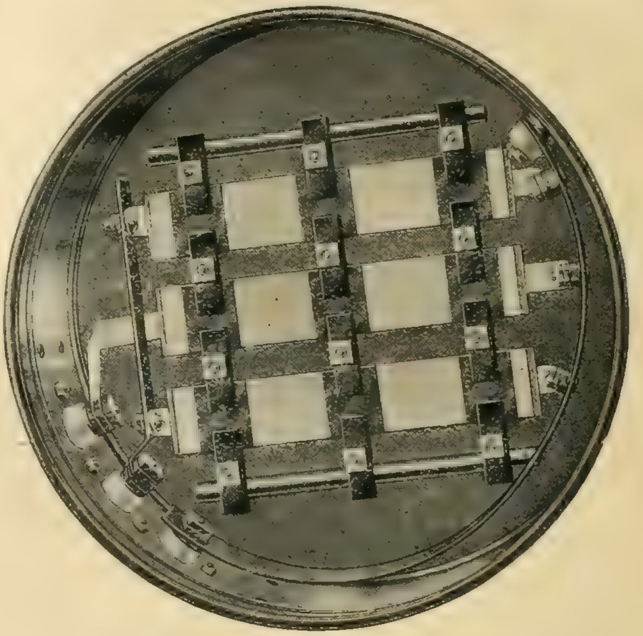


Fig. 2.—View of Underside of Electric Boiling Pan.

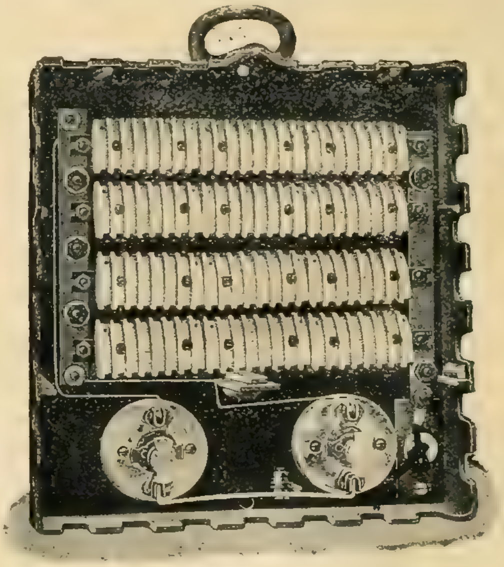


Fig. 3.—Internal Connections of Electric Fire.

connection. As a further step to reliability, all long hour use elements must be connected in series parallel, so that when working on "low" heat they are operating at one quarter of their total capacity. Electric fires should be connected in a similar way to that described for the cooker, *i.e.*, solid rods for all internal connections.

Accessibility and Low Cost.

Accessibility and low cost of repairs are so closely bound up with each other that they can be dealt with as one. The secret of low maintenance costs lies in all parts being accessible and those parts that occasionally need repair must be of unit construction, or divided up so that a defect is localised to a small section only. The first step towards this feature on a cooker is to provide for a lifting or hinged hob, so that all connections underneath it become visible immediately it is raised. The oven connections must be exposed in the same way by removing the lift-off guards, the leads being solid and mounted on insulators to permit of a rapid inspection of the circuits. Heating elements, of the type referred to above, allow speedy replacement, and by winding the heating wire in the form of a spiral, on top of a fireclay former of great mechanical strength, the cost of repair is reduced to that of the wire only. This applies to all elements of the open-type. In actual practice a complete element would be kept as a spare but upon return to the workshop a boy should be able to rewind a new spiral on the old former. Another advantage of using solid connections and open-type elements is that any defect can be seen at once without the necessity of testing for them.

In the case of boiling pans fixed to a cooker or in washboilers where the elements being clamped to the underside of the pan must be protected by a quickly removable cover, giving access to all connections at once, the clamping bars must be fixed so that any one element can be inspected or removed without disturbing the others. This condition is secured by staggering the clamping bars, and at the same time obtaining an even mechanical pressure over the entire surface.

Illustration of Principles.

During the war firms who specialised in the manufacture of electrical cooking and heating appliances devoted the whole of their energies to the production of apparatus that would work under most severe conditions of wear, and incorporated in their large appliances the methods of construction stated above. These ideas are now applied to the more peaceful surroundings of the home. To cite one firm I would mention The Jackson Electric Stove Company, Ltd., and the illustrations clearly show how these principles are applied to the apparatus manufactured by them. Fig. 1 is the frame of the oven elements, showing the method of fixing and how the terminals are carried through the back of the oven and protected by porcelain insulators. Fig. 2 is a view of the underside of the washboiler or boiling pan, which indicates simplicity of design and freedom from trouble, whilst Fig. 3 exposes to view the internal connections of the standard fire. In each case the absence of pigtails or loose leads should be noted, while quick and cheap replacement and undoubted reliability are other properties which the equipment may be said to possess.

The "Colec" System of Central and Radiant Heating.

By HERBERT H. BERRY, M.I.E.E.

The "Colec" System, as its name suggests, has been created by the writer to combine the advantages of the central heating system, prevailing in America, but invented by an Englishman, with the added advantages of the radiant warmth and comfort of the Britisher's coal fire, while eliminating the disadvantages of both. The claim is admittedly a very wide one, particularly having regard to the fact that it postulates that this method of heating is the most economical, the most healthy, and yet the most luxurious system that has yet been introduced into the modern home. The "Colec" system does not merely include the heating of the home, but brings within its scope a method of cooking by the combined use of coal and electricity, reducing not merely the cost of cooking in the home by a figure equal to at least 25 per cent., but reducing the time taken for cooking by a very considerable amount as compared with all other methods.

Coal Better than Electricity or Gas.

I will first start with a description of the "Colec" system, as applied to the heating of the home. The word "Colec" suggests a combination of coal and electricity. I state as a definite fact, that where the heating and cooking load is fairly constant as in an average flat or residence, both electricity and gas must be classed as secondary methods of dealing with the problem. While we continue primarily to employ the use of coal for the generation of secondary electricity or gas and making due allowance for by-products, the intervening losses between primary and secondary sources of energy are such that the resultant relative efficiencies must substantially favour obtaining the bulk of the heat energy required in the home from hard coal as the primary source. In effect, it is possible to provide a furnace for the home which will burn hard coal and the house refuse, with a degree of efficiency comparing most favourably with the heat efficiency of the boilers in our large generating stations. The heat energy from this small, continuously-burning furnace is utilised to provide a constant supply of hot water which may vary according to requirements from 140°F. to 180°F. This water when so heated serves a double purpose; it is arranged so that in conjunction with a battery of convectors, preferably camouflaged and adapted to the size of the house and the number of rooms, it distributes heat energy equally through the passages as in the rooms. As the temperature in the passages and the rooms, however, should never be continuously heated above 55°F. to 65°F. as a maximum, a furnace of approximately half the size that is usually adopted on the American plan and consuming about half the amount of fuel, is suitable for maintaining the temperature at this comparatively low degree.

The Domestic Hot-Water System.

The second function of this furnace-heated water is to provide a domestic hot-water system, in such a manner that the two waters do not actually mix, thereby avoiding all possible trouble from hardness, or from lime deposits in the water. A constant supply of hot water for baths and other domestic purposes is a necessity in a properly organised home where economy, labour saving and hygiene are considerations. Most of the labour-saving processes in the home depend upon a cheap and abundant supply of hot water being always available. With such a provision it is possible to reduce the domestic work in the home by 60 per cent. and to eliminate all drudgery. It is impractical, on the grounds of economy, to obtain a bulk supply of hot water from electricity or gas, under normal circumstances. It is, however, most economical and desirable, both for the purpose of heating and cooking, to use preferably electricity or when it is not available, gas for "topping up" the temperature. Secondary methods of heating are the most economical for intermittent requirements, the most labour saving, and the quickest method of obtaining the best results. For example, electricity can be employed for equalising the temperature of the human body in any particular room at any moment more healthily, more evenly, more quickly, and often more cheaply than by any other method. With equal economy and success it may be used for bringing water to the boiling point in small quantities when this is intermittently required.

Where the "Colec" System is an Improvement.

Having now briefly described the "Colec" system and my method of producing primary and secondary heat energy, I will return to the original point and endeavour to show how the "Colec" system eliminates the characteristic disadvantages of the two prevailing systems—the open coal fire and the inefficient old kitchen range of Great Britain, and the central heating system of America.

To deal with the latter first, every Englishman or woman who visits Northern America or Central Europe during the winter months is struck with certain desirable features in a centrally-heated home, particularly having regard to its distinct economy—they are, however, invariably conscious of an aggressive atmosphere, stuffy and always super-heated. The atmosphere generally smells of burnt dust; this unpleasant smell is caused by the dust which accumulates on the convectors being burnt when the latter are above a given temperature. The general criticism of the average Britisher may be summarised as follows:—

> It is certainly very nice to be warm; it is very comfortable to have no draughty passages; pleasant to know one saves money; but give me my old English coal fire with all its admitted discomforts.

The question arises, "Why does the American and Central European super-heat his rooms? Does he do it by accident or design?" The difference in the humidities does not provide the answer. I have found upon investigation that he does it by design—that the American heating engineer specifies that the plant must be capable of maintaining in any given room a minimum temperature of 73°F., irrespective of the external temperature. In practice it will reach 80°F. to 85°F. The temperature of health, according to Negretti & Zambra and our bacteriological experts, is a temperature between 55°F. and 65°F. Above this temperature, particularly when subject to extreme changes, the human body is more likely to contract bronchial, pneumonic, and tubercular complaints. It is evident, therefore, that it is not upon the grounds of economy, good health, or hygiene that the American super-heats his rooms. The reason, however, is not far to seek, and upon investigation it appears strikingly obvious. This is my explanation:—

An Explanation of the Obvious.

In this country, when anyone comes in from the outside cold, maybe wet, with frozen hands and feet and generally below par, he proceeds to the coal fire, and in the temperature of 300°F. to 400°F. is rapidly able to warm up. Having brought himself to a comfortable temperature, he is able to move about and emjoy with some degree of comfort a sweet and clean atmosphere. There is the disadvantage, however, of varying temperatures in different parts of the room. He is subject to draughts when the door opens and lets in cold air from the passages; even so, the average Britisher prefers this system and its admitted discomfort.

In America and Central Europe, however, the apartment houses and hotels are built without fireplaces. Coming in cold, no one can proceed to the heating furnace in the depths below to warm himself, and so the temperature of the home is designedly kept up during most of the twenty-four hours to a temperature of super-heat in excess of the temperature of health. The rooms are heated 10°F. above the normal health temperature as a minimum, thus providing that when one comes in below normal, one can more quickly thaw and become comfortable. One would be miserable and shiver in the temperature of health.

The English Fire at Its Best and Brightest.

The "Colec" system has introduced a fire, which is an exact reproduction of the English coal fire at its best and brightest. It is practically an impossibility to detect that the fire, which is fitted into an ordinary fireplace, is not a mass of bright burning fuel on a cold frosty day. This electric fire, however, can be obtained at a very negligible cost, taking the average price at which electricity is charged to-day for heating purposes, the cost of obtaining this bright fire with minimum heat is less than the cost of burning a wax candle. The current consumption of the fire varies according to its size—from 40 W to 240 W in its initial bright burning stage. When the temperature of the room is at 60 deg. (the ideal temperature in this country) there is no necessity to switch on the additional heat, but should one enter the room with cold hands and feet, it is possible by approaching the fire to provide radiant heat, the nearest approach to the life-giving rays of the sun—the same kind of heat ray your medical man will order you to cure your rheumatism, lumbago, skin complaints and general debility—at a temperature of 300°F. to 400°F exactly as with a coal fire. Having rapidly brought the body to an even temperature of comfort and warmth, it is then possible to enjoy the even temperature of health. There are no draughts, the rooms and passages being equally warm. The adjustments of heat on the electric fire are such that the room can be kept at a steady temperature between 55°F. and 65°F. according to the occupier's requirements.

Ninety per cent. of the heat of the home, however, is provided from the central heating furnace below, the same fire being used for the purpose as would be necessary under any circumstances to give constant bulk supply of hot water for domestic purposes. It is claimed that the coal or coke that will be saved during the twenty-four hours by using a furnace of half the normal size, should be sufficient to pay for the electric current bill for "topping up" the temperature to the required degree, and for giving the balance of temperature that is required to meet the fluctuations in external temperatures.

The "Colec" System for Cooking.

The "Colec" system of heating can also be applied to electric or gas cooking. A tapping from the hot water supply to the electric or gas oven keeps the oven, in effect, a constant hot-cupboard, which can be utilised as such. The primary expense in cooking operations is the water-heating proposition, and secondary methods, unqualified, such as electricity or gas, are too costly. On the "Colec" system water is provided at the electric cooker from the central source at a temperature of 160°F. or thereabouts. It is delivered to the cooking utensils, which in turn are heated from a hot-plate, already warm, the hot-plate being a part of the hot-cupboard and of the central heating system, and never allowed to get cold. The result, therefore, is that instead of having to raise water from a temperature of, say, 45 deg. to 212 deg., a smaller amount of electricity only is required, sufficient to raise the temperature about 52 deg. or one-third of the whole. Electric geysers have not been universally used hitherto, due to the heavy loading and large service cables required, but upon the "Colec" system a supply of boiling water can be obtained day or night, not merely in the kitchen, but at any point of the system, and the ordinary electric radiator circuit is all that is necessary. Think of the convenience to the average housewife to touch a button, and immediately at any time have your tea ready for service!

The oven, which is our hot-cupboard, during the non-cooking hours of the day and night, requires about two-thirds of the time to heat up, and a proportional amount of heat energy is saved. With the electricity bill reduced thus, gas, which has many disadvantages, should find it difficult to compete excepting where electric current will be unobtainable at any price.

Having regard to the fact that the homes of the future will be built without chimneys and flues, and that only dummy fireplaces will be fitted in the most convenient positions in the room, the saving in building construction will go a very considerable way, if it will not entirely defray the cost of the initial central heating installation. A complete plant installed upon the "Colec" system, in an ideal home, with model kitchen, scullery and laundry, may be seen at "Touchbutton House," 86, Newman-street, W. 1.

Electricity and the Domestic Hot Water Problem.

By C. ORME BASTIAN, M.I.E.E.

THE domestic hot water problem has recently been forced to the front owing to the mandate against the coal fired kitchen range, or, in other words, against the boiler on which we have learnt to depend for a more or less unreliable and irregular hot water service. The coal fired kitchen range has already suffered from a heavy frontal attack by the gas industry, and with a flank badly exposed by the action of the Smoke Abatement Committee, it would seem that the old-fashioned method is doomed.

It is beyond argument that gas has been adopted for cooking purposes to a tremendous extent, and to a much greater extent than would have been the case had it been necessary to provide a separate heating agent for the water supply. For over 40 years the gas geyser has been available, and with this or the califont, or the circulator, all the hot water required for domestic purposes can be, and in thousands of cases is being supplied by gas.

An Electrical Fallacy.

The electrical industry is badly hampered in its efforts to introduce and popularise electric cooking, because, for some inscrutable reason, the heating of water by electricity at any price is regarded by a section of electrical men as not worth consideration. Nevertheless, we shall never make real headway with electric cooking, for which an ample supply of hot water is a first necessity, and we shall never realise the "all electric house" until we have succeeded in devising means that will enable us to offer electrical energy for water heating, with all its attendant advantages of cleanliness and convenience, at a price that will compete reasonably with other agents.

The ground already captured by the gas industry has been captured, because they have had a long start, and they have been furnished with weapons, that we must admit we cannot utilise. For we cannot produce and exploit the electrical equivalent of the modern gas geyser, if only for the reason, amongst many others, that the cost of the house service would be enormously increased, owing to the heavy loading required.

The "Therol" Idea.

It must be 20 years ago since Mr. H. H. Bell, of the Hammersmith Electricity Department, came forward with his suggestion to heat water for household purposes in a well-lagged tank by means of a mere trickle of electricity continuously applied. The success of the "Therol" tanks placed on the market under Mr. Bell's patent was marred by the fact that difficulties were encountered with the heating elements employed, and the apparatus was liable to become choked with fur, owing to overheating of the water. Such tanks may be best described as storage geysers, and assuming that they are now, or will become, available in satisfactory form, let us examine, broadly, the possibilities suggested by Mr. Bell's idea.

As electrical energy cannot—except on a very small scale —be generated continuously at a steady rate and stored in accumulators, as gas is stored in gas holders, we are to that considerable extent handicapped at the generating end of the industry, and the cost of our product is very much higher than it would be if a 100 per cent. load factor on our generators could be attained. Any improvement in the load factor must bring in its train a corresponding reduction in the generating and capital costs, and it is self-evident that the utilisation of electrical energy at a steady, continuous rate for conversion into and storage as heat would be just as beneficial in its effect upon costs as the storage of equivalent energy in accumulators. If the thermal storage apparatus is located on the consumer's premises instead of at the works then such a system of distributed storage will also bring about a certain reduction in the cost of distribution, and to that extent will be even more beneficial than the accumulator or gas holder. If the load can be switched off during the peak period, then the conditions will, indeed, be ideal.

The Baths Problem Solved.

Given the apparatus, we know we can supply the consumer with a definite daily quantum of hot water at the required temperature, and given this regular supply, the customer may be trusted to draw upon it more regularly than when he had to take his chance in the scramble for the weekly tub. From obvious motives of economy the fire is generally stoked up specially for the purpose of a general family ablution, and it is confusing cause and effect to urge that members of a family usually take their baths on the same day as a matter of choice and will be unwilling to spread them out over the week. The daily use of hot water in a household would probably be as regular as the consumption of bread, provided the supply were available in known quantity, and a fair average per person for all purposes, including cooking, washing up and baths, can be taken at not less than 4 gals. per day at 150°F. average temperature.

According to a recent well-authenticated statement, there are about 1 000 000 houses and flats already connected to electricity supply systems in the United Kingdom, and these houses and flats are probably each occupied by not less than an average of four, or a total of four million people, each requiring 4 gals. of hot water per day, *i.e.*, 16 million gals. at 150°F. Assuming an efficiency of 70 per cent., which can easily be attained in well-designed storage tanks, and assuming the average temperature of the feed water to be 60°F., then the heating of this quantity of water would consume about six million units daily, of an annual value at 0·5d. per unit of over 4½ million pounds, or an average of £4 10s. per house connection per annum.

Revenue from Hot Water.

This, then, is the additional revenue that might be secured by a determined development of the water heating load, and although electricity at any higher price than ½d. per unit would be more expensive than gas at 8d. per therm for water heating purposes, considerations of health, cleanliness and safety weigh heavily in its favour. Therefore, it may well be that the bulk of the business could be secured at a higher price than above assumed, and that the average of four gallons per person per diem is too low.

Taking these figures, however, an additional revenue of £4. 10s. per house connection per annum gained in this way would be most desirable if no extra capital expenditure were involved. Consumers would purchase or hire storage tanks, and the existing plant and mains capacity need not be increased if the water heating load can be arranged as an "off-peak" load, instead of on the 100 per cent. load factor basis.

Dealing with the Peak.

The very low price per unit necessary for popularising the use of thermal storage apparatus will not be justified in most districts if the extra load taken by this apparatus overlaps, and increases the peak beyond the capacity of the plant demanded for other purposes. The supply authority should have the right to switch off the thermal storage load during the peak period, even though it may not be necessary to exercise this right more than once or twice each year. This might be arranged by means of the Olipel system of distant control, or, perhaps, by means of a wireless impulse from the power house, either of which methods would be better and more practicable than the duplication of circuits or the employment of time switches.

A cheap "off peak rate" would greatly encourage the use of electricity for thermal storage generally, and this could be employed not only for water heating, but for other cooking operations and room heating. The possibilities are enormous, and have not apparently been realised or sufficiently considered by those responsible for laying out the new housing schemes.

The problem really is to fill up the valleys without increasing the maximum annual peak of the load curve, and that problem is not solved by the installation of apparatus demanding a 24 hour supply. That is one reason why Mr. Bell has not realised great success with his "Therol" tanks. Another reason is probably due to the fact that these were designed on too ambitious a plan. They were made to deliver not only hot water, but boiling water as well, and in most districts destructive furring was the result. The water in a thermal storage tank should never be allowed to rise to a higher temperature than about 170°F., which will more than suffice for most domestic purposes. The boiling of water from this temperature in comparatively small quantities should be the function of the boiling plate, from which the service required is halved if the cooking utensils and kettles are filled with this pre-heated water from the storage tanks. This will make possible the employment of boiling plates of lower capacity, and consequently longer life, and incidentally will contribute to a useful levelling down of the maximum demand of the cooking range.

Relative Costs.

We have mentioned one halfpenny as the price per unit to be aimed at for the "off-peak" rate, and this is suggested in consideration of the cost of heating water by gas on a similar thermal storage system, which gives a better average economy than is yielded by a geyser, because metal work and residual water have not to be heated at each operation. The efficiency of a geyser for a bath is high, but it is exceedingly low and a very inconvenient appliance for providing a cup or a kettle of hot water, or even for filling a hand basin and the numerous other purposes for which small quantities of hot water are continually required in a household.

Experiments with thermal storage tanks have shown that electricity and gas will cost about the same at ½d. per unit and 8d. per therm respectively. The possible competition of coke-fired boilers is not here considered, because these do not offer the same degree of convenience owing to difficulty of temperature control, dirt and requisite attention and labour involved. The comfort and convenience of having an adequate supply of hot water always available at any hour of the day or night immediately the tap is turned, and by means of apparatus requiring absolutely no attention, cannot be over-estimated. These results can only be attained by means of thermal storage tanks, and at present it would seem that gas is our only possible competitor in that field. To beat that competition we need a cheap "off-peak" rate, and the necessary means to make the application of such a rate possible with maximum benefit, such as the Olipel system of distant control.

Meanwhile, there is plenty to be done in that ever-increasing market that recognises the consequential advantages of electricity at their true worth, and the establishment of thermal storage sub-stations is a possibility that has yet to be explored, and more especially in connection with new housing schemes, and new blocks of industrial dwellings.

The Place of Thermostatic Control in Connection with Electric Heating.

By GEORGE WILKINSON.

In some industries where temperature plays an important part in manufacture, specialists recognise that the product is more uniform and of better quality when the heating medium is automatically controlled and the process carried on in a uniform temperature. The sooner this fundamental fact is recognised by every firm in the country employing heat treatment the better both for industry and for the nation as a whole. Improvement in the quality of materials produced under uniform heat treatment is, of course, one argument only for the introduction of automatic heat control; it is mentioned first as likely to arrest the attention of manufacturers who, at the present time, are suffering from trade depression and are up against keen competition. Manufacturers who, by reason of more scientific heat treatment, are able to offer a superior quality of goods have the winning card which places orders on their books rather than on those of their competitors.

The source of heat in this country, with minor exceptions, is found in our coal supply. Time was when coal was so cheap and trade competition by other countries so insignificant that economy in heat production and application was not considered of much importance. To-day all is changed; fuel is dear and competition both at home and abroad is severe.

The Ideal to be Aimed At.

The ideal to be aimed at is to provide sufficient heat to carry out the necessary process of manufacture and no more. To achieve this result automatic temperature control is essential. Doubtless the day will dawn before long when every stove, radiator, oven, furnace, and even our living rooms and offices, will be equipped with simple and reliable apparatus to effect this close control of temperature.

The gas industry has made greater advances in heat control than the electric industry, and the next year or two will see the application on a commercial scale of automatic control of gas fires and radiators which will go far towards neutralising the heavy increase in the cost of gas. This forecasts continued rivalry between gas and electricity for heating purposes, especially in the domestic domain where gas has already such a strong hold. All the advantages of automatic heat control for gas are equally and probably more advantageously applicable to electric heating, hence, granted reasonable enterprise, electricity has nothing to fear on this score.

The Advantages of Electric Heating.

Compared with coal, gas, and oil, electricity is innately an expensive method of heating, but its adaptability and efficiency of application in many cases outweigh this fundamental disadvantage and place it in advance of all its competitors. While, therefore, sound economic reasons obtain for the application of automatic temperature control in the case of coal, gas or oil, they have added forcefulness when applied to electric heating.

One advantage with electricity which does not obtain in the other heating methods named is its unvarying calorific value. There is at present no simple system available to compensate for the varying calorific value of the fuel consumed and therefore efficient heat regulation in the case of electricity is a more simple proposition.

In some cases electrical engineers are apt to allow their zeal to out-run their discretion and are bold enough to pit electricity against other methods for such purposes as the heating of water for domestic and other purposes. In special cases there are sound reasons for the electric heating of water, but these are not in the majority. On the other hand, coal, gas and oil are a long way behind electricity for numbers of industrial heating processes, the latter lending itself to direct and local heating quite impossible of attainment by other means.

A case in point is the hardening and tempering of steel wire and strip. Gas is often applied for this purpose, but is being gradually superseded by electricity. With the former the thermal efficiency is so low and the temperature of the room is raised to such a degree that fans have to be employed to get rid of the waste heat and the fumes given off in the process. In the case of electricity the external heating is negligible, and there are no products of combustion, therefore no artificial means of cooling and ventilation are required. The relative cost with gas at 3s. 8d. per 1 000 cub. ft. and with electricity at 2d. per unit is two to one in favour of electricity, while the operation in the case of electricity can be carried on successfully by a labourer of ordinary intelligence, as against highly skilled labour in the case of gas.

Radiator Size an Important Factor.

In earlier times for domestic use electric heating was frequently brought into disrepute, due to the fact that the radiator selected was too small for the apartment to be heated. Electric fires or heaters to be permanently satisfactory must be capable of quickly raising the atmosphere of the apartment to a comfortable temperature during the coldest day of winter and under the most unfavourable weather conditions. The crude regulation obtained by providing one or two switches for an electric fire, whereby its power can be reduced to two-thirds and one-third of its full output, does not in any case furnish the required control. First, because such switches are seldom used, or are not used at the right time and for the correct period; and, secondly, because the external temperature and the weather conditions are constantly varying at irregular intervals, so that no simple combination of hand-operated switches can meet the case or prevent considerable waste of current.

It follows, therefore, that all apartments heated by electric fires of adequate power are at the present time (except in the few instances where thermostatic control is employed) costing substantially more for electric current than they should do, while such apartments are not so comfortable as they might be, owing to the constant fluctuation of temperature ensuing on the unstable weather conditions.

The Benefits of Equable Temperature.

The advantages of electric heating need not be commented on at length as they are already recognised. From the health standpoint, heating by electricity is ideal, there being no vitiation of the atmosphere. There are no fumes, dirt, or smoke, the quantity of oxygen is undiminished, and the apartment does not get "stuffy."

The few disadvantages may be set out as follows :—

(*a*) With radiators of the correct power the apartment will, except on the coldest days, often become over-heated; and an overheated room is almost as uncomfortable as one which is too cold, and it is also more unhealthy. This objection is not confined to electric heating, but applies more seriously to all other forms of artificial heating, and often accounts for the frequent colds and minor illnesses which few people escape during the cold season of the year.

(*b*) This frequent overheating causes a great waste of the heating medium. Fortunately, in the case of electricity the way to prevent waste is obvious, provided inexpensive, simple, and reliable apparatus can be produced which will cut off or reduce the electric current when the desired temperature is reached, and which will re-establish the heating when a slight fall of temperature takes place.

Incidentally the author would call attention to the increased comfort which ensues on equable temperature. The benefits to both mind and body are by no means small, while the economy in cost of heating, its absolute cleanliness, and the prevention of waste of current by servants, bring electric heating, from a commercial standpoint, into line with other more crude and less healthy methods. It is essential to complete success that automatic temperature regulation should not be obtained at the expense of cheerfulness, especially in the case of living rooms.

The Electric Fire as an Equaliser.

A promising field open to electric heating with automatic temperature control is in the almost numberless cases where coal fires or hot-water radiators are in use. It is well known that both these methods of heating are subject to wide variations of temperature due to the vagaries of combustion. It is not possible to co-ordinate the rate of combustion with the constantly varying weather conditions, consequently the apartments are frequently too hot for comfort and at other times dangerously cool. If a thermographic chart is taken, the temperature line will show frequent and erratic depressions representing cool or cold periods. The application of temperature-controlled electric radiators as an auxiliary method of heating will automatically remove these cool periods at little expense for current and with no trouble or attention, thus producing the ideal condition for comfort and health.

It is well known that for long periods during the spring and autumn, and occasionally in the summer, there are days when the mornings and evenings are cold, while the rest of the day is warm and comfortable. During these seasons coal fires or hot-water radiators are inconvenient. If they are used the apartment is too hot for the greater part of the day and waste of fuel takes place; moreover, the occupants have either to suffer discomfort from overheat in the daytime, or to endure a chilly atmosphere during the earlier hours of the day and in the evening. The economical and effective way of dealing with the heating problem during these periods appears to be by means of thermostatically controlled electric heaters ready for duty at all times, for long or short periods, and requiring no attention.

Simple and reliable temperature control gear is available fully to comply with the requirements already indicated, and independent testimonies are procurable which demonstrate a saving in cost of electric heating equal to about a third of the bill, and this with improved conditions of healthfulness and comfort. It remains with the enterprising firms already supplying excellent types of electric fires and heaters to avail themselves of the additional advantages and increased business which the application of automatic temperature control will bring in its train.

One of the latest developments in this direction is the successful application of automatic heat regulation to electric furnaces working at high temperatures. This is accomplished by a thermostat of simple type to the radiant heat rays of the furnace, the instrument itself being located in a comparatively cool position outside the furnace.

Domestic Electricity Supply and Small Apparatus.

One of the real worries that the electricity supply engineer has to deal with at present is how to develop his business without over stressing his network. But there is evidence that the great part which small accessory electrical apparatus can play as "a consumption-raiser" is not realised so generally as it ought to be. Such domestic apparatus, however, brings in a revenue which in the aggregate is worth having, particularly as much of it is secured at lighting rates; it gives great satisfaction to its users, by providing them with conveniences which otherwise they would not enjoy, and, most important, it gradually leads them on to the full use of electricity in the home. Of the accessory apparatus now available it may be said that flat irons, kettles and fans are perhaps the best of all missionaries and canvassers for the domestic electric idea. For instance, assuming that 800 of such pieces of apparatus can be connected to a network, and this aggregate is made up of 100 fans, 100 irons, 100 table hotplates, 100 kettles, 100 milk heaters, 100 toasters, 100 vacuum cleaners and 100 washing machines, of which the milk heater is in use for, say, 50 hours per annum and the vacuum cleaner for over 300 hours, the other apparatus being employed for some periods between these figures, a consumption of somewhere in the neighbourhood of 26 000 units a year can be predicted, bringing in a revenue of about £327, if the price per unit is taken at 3d. These figures in themselves are sufficient to show that the idea is worth going into in the way we have outlined.

The Electrical Side of Housing Schemes.

Overhead Distribution as an Economical Factor in their Development.

By GEO. V. TWISS and S. G. LEECH.

THAT all new housing schemes, or, for that matter, new houses and buildings anywhere, should be equipped for the use of electricity and have a supply of electricity available is a premise which cannot be questioned if progress—in terms of health and social amenity—be considered. At the same time, having regard to the depleted state of the nation's financial resources, every regard must be had to considerations of economy, and in this connection the possibilities offered by the overhead system of electric distribution cannot be ignored and, indeed, demand considerable acknowledgment.

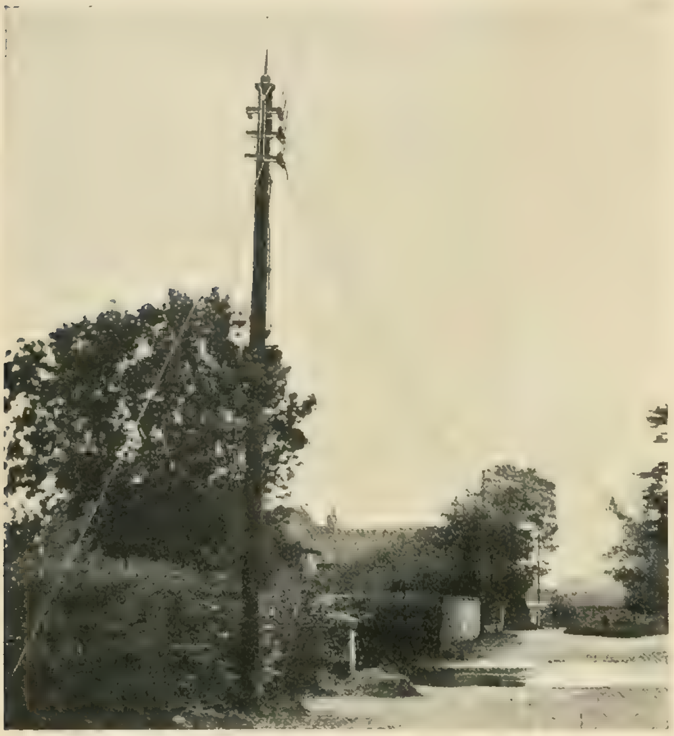


Fig. 1.—Bourton, Glos., Showing Two-wire 100 V D.C. Distribution System.

The use of overhead distribution is not new. There are many villages and rural districts in this country, as indicated by the accompanying illustrations (Figs. 1 to 4), where this system has been successfully employed. Incidentally, it can definitely be said that many of such schemes would have been financially impracticable but for the use of overhead distribution. Progress has, however, made available improvements in design, material and methods which permit of the employment in the future of this system to even greater advantage than hitherto.

The Advantages of the Overhead System.

The overhead system, when properly designed, has certain advantages, peculiar to itself, which include:—

(1) The ability to provide street lighting upon the same poles as are used for the distribution system.

(2) The electrical flexibility of the system as regards adjusting the size of mains to the growth and alteration of load.

(3) The simplicity of taking off services.

(4) The rareness of faults and the ease of rectification of the few which may occur, thus obviating the charge against revenue of the services of a permanent mains superintendent and/or jointer.

Let it be admitted straight away that an overhead distribution system *can* be unsightly, but, on the other hand, it *need* not be if handled with due regard to the æsthetic sense.

If, as it should be, street lighting is incorporated in the system, distribution poles then fulfil the function of lamp posts and thus obviate the use of independent lamp posts. If, in turn, the lay-out is properly designed, a maximum number of poles are naturally placed in the least conspicuous positions, and the appearance of these is capable of considerable improvement by the proper choice and balancing of the cross arms and gear and by the use of properly proportioned finials. The appearance of the poles can be still further improved by the painting or treatment of the pole itself to harmonise with surroundings and by the empanelling of the lower portion of the pole. Examples of how this can be done may be seen in the illustrations already referred to.

It is hoped that the above remarks and illustrations may serve to show that unsightliness can be reduced to a minimum and what little unsightliness may, in some people's opinion, still remain is but a small disadvantage to balance against the many tangible advantages, including the financial saving resulting from the overhead distribution system.

Lay-out Details.

To return, therefore, to the advantages. These are undoubtedly largely dependent upon design, and it is useful, therefore, to consider design from certain aspects dealt with below.

It becomes at once clear that from the point of view of economy, appearance and simplicity the chief object to be attained in designing any distributing network is to reduce to a minimum the number of wires running between poles and to consider carefully their arrangement relative to one another. This will, of course, be affected by the system of supply—whether alternating or direct current. In the case of the former, if the pressure exceeds 125 V, the two conductors forming a single circuit cannot be placed in the same horizontal plane, since existing regulations as to safety demand for the purpose of guarding that one wire shall run above the other with the lower split and cross-connected to form a cradle, or, alternatively, should the lower conductor be single, then a guard such as that of the "Trotter" type must be employed, necessitating the use of a cross arm in place of a bracket in order to secure sufficient spread (*see* Fig. 7). With direct-current supply (Fig. 7), however, and

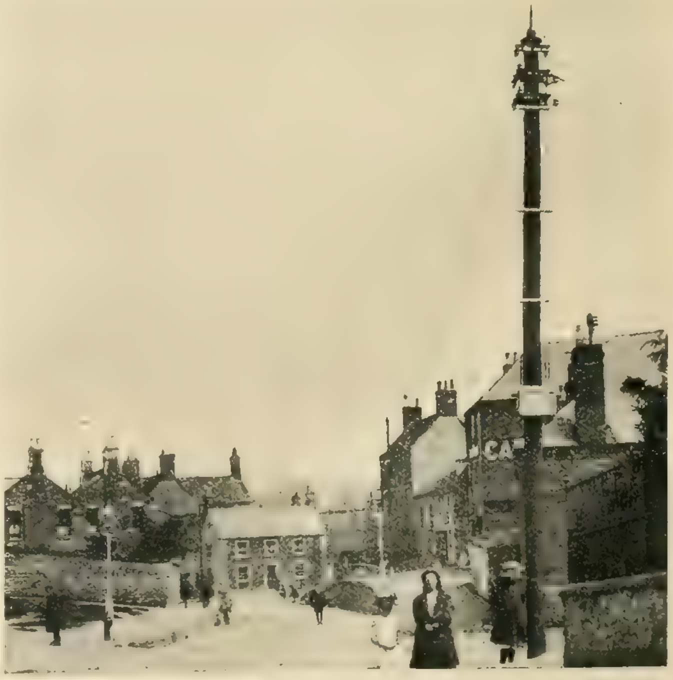


Fig. 2.—Farringdon, Berks. Another Example of a Two-wire 220 V D.C. Overhead System.

at a pressure suitable for any incandescent lamps in parallel, no such restriction obtains, and the two wires can be supported side by side, whereby a saving in pole height and strength is effected. With the simplest arrangement, therefore, comprising the use of a circuit of two conductors, construction becomes less costly if the supply is by means of direct current as opposed to alternating.

Let it now be considered how matters are affected by the addition of feeders, and for this purpose suppose a route along which will run a pair of feeders and the same number of distributors to give supply at a pressure in the neighbourhood of 200 to 250 V. With direct-current 2-wire (Fig. 8) the four conductors will lie in two horizontal planes, but alternating-current single-phase or direct-current 3-wire necessitates three (Figs. 8A and 8B).

To take full advantage of the economy offered by 3-phase supply the 3-phase wires of any distributing circuit must be run separately over different routes, and to give ease of service connection the arrangement would occupy three horizontal planes (Fig. 9).

The addition of a feeder circuit on the same pole necessitates an arrangement as shown in Figs. 10A and 10B.

Difficulties attending construction at crossings, &c., render arrangement shown in Fig. 10A almost impracticable, whilst that in Fig. 10B necessitates the use of a longer pole.

The Effect of the Number of Feeding Points.

Treating the matter on a broad basis, the authors have found that economy is best served and even pressure distribution secured by keeping the number of feeding points a maximum—cutting down the copper section in such feeders to give a comparatively large pressure drop at full load and treating the distributors with fair liberality in the way of metal. A given height of pole tends to secure these results in great measure with direct-current 2-wire—in a lesser measure with single-phase alternating current, but they disappear with 3-phase alternating current. If, then, the last named is in use in any case under consideration, current having been brought to site at high or extra-high tension and transformed locally, the position of the substation becomes a matter of the utmost importance. If, say, in the case of a small housing estate, it is situated near the centre of gravity of the load, satisfactory distribution can be obtained by using the substation as the sole feeding point, the distributors radiating therefrom. If, on the other hand, the substation lies near the edge of the area, it becomes a matter for calculation as to whether economy is best served by (1) running low-tension feeders from the substation to suitable points, or (2) increasing the number of substations. As regards (1), for reasons already shown, a distributor line of poles cannot in practice be utilised to carry even one set of feeders, and either a separate pole line must be erected for the purpose or underground mains used. If the area is reticulated with streets, the matter usually comes down to a choice between two lines of poles in any one street, or the distributor line above ground with the feeders underground by the most convenient route.

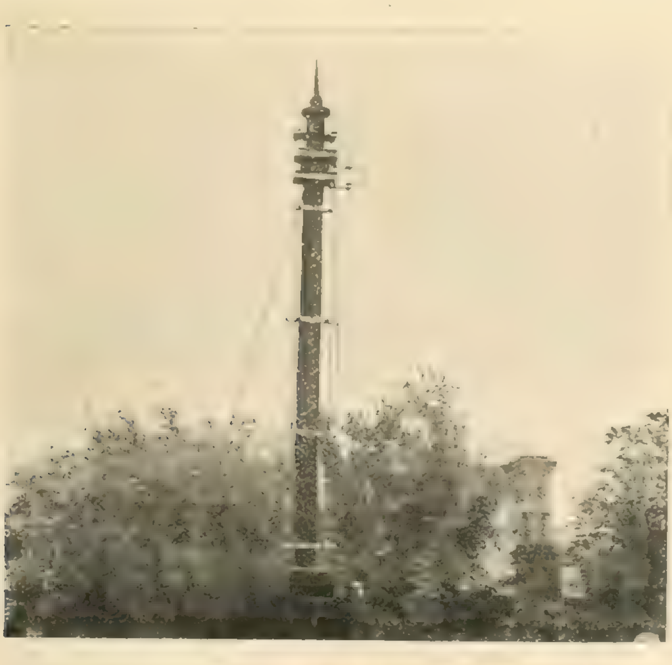


Fig. 3.—Woodbridge, Suffolk. A Two-wire 250 V. D.C. Terminal Pole.

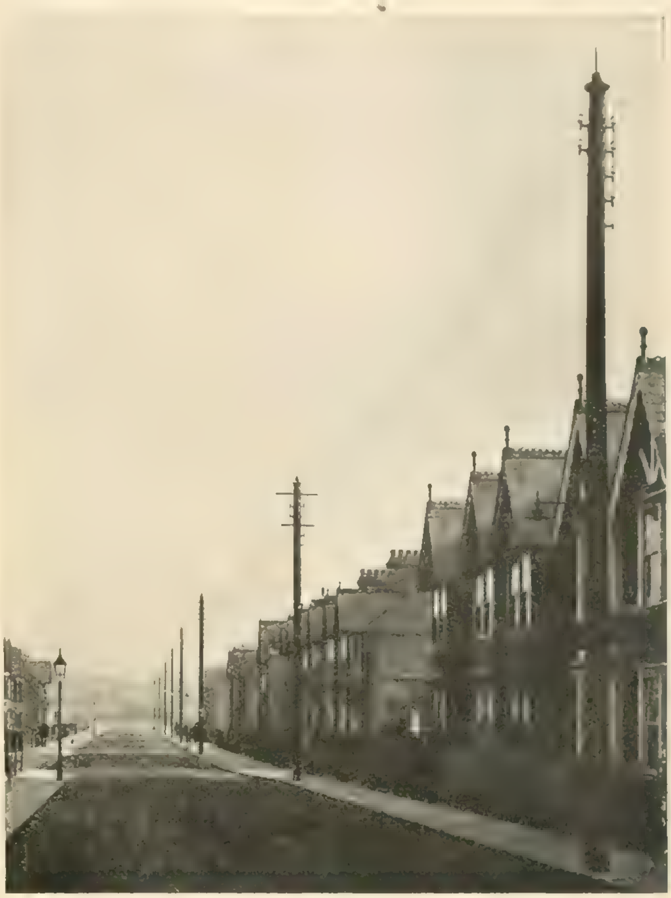


Fig. 4.—Whitstable, Kent. A Two-wire 230 V. D.C. Pole Line in a Villa Neighbourhood.

In the event of two conductors forming a distribution circuit, should these, to make matters easy for connecting services, be placed in the same horizontal plane one on either side of the pole, or is it preferable to place one above the other on the same side and increase cost by giving the pole another 12 in. to 15 in. of height? For some time the authors inclined to the latter arrangement, but practice has shown that with the horizontal position services can just as readily secure the necessary clearance. Figs. 11 and 11A illustrate this.

The subject of overhead distribution offers, it will be seen, endless opportunities to the designer in order that he may secure neat and workmanlike appearance in face of the necessity to arrange clearance of all wires where such cross or branch when following their respective routes.

Design of Material.

Owing to the fact that the first overhead wires used to any considerable extent were Post Office telegraph and telephone wires, the practice of the Post Office as regards insulator pins and shackles has naturally had its effect upon the design of such material for overhead power lines, often, unfortunately, with a lack of regard for the different circumstances and requirements involved.

A particular instance of this is the use of the Cordeaux screwed spindle. The Cordeaux screw, being a sharp thread in porcelain, is necessarily mechanically weak, and the sharp edges, together with a loose fit causing air spaces, are bad electrically. For Post Office wires, however, which are comparatively very small and at negligible electric pressure, this weakness is not material, and the Cordeaux screw is quite all right for such purposes. Power wires, however, are much larger; in fact, low-tension wires, as used for distribution, are often the largest wires used in overhead work, and the Cordeaux screw is, therefore, not sound for this purpose. A type of insulator and spindle which gives the necessary mechanical strength and electrical requirements is shown in Fig. 5. The screwing end of the spindle incorporates a resilient medium, enclosed in a collapsible, non-corrodible metallic sheath. By this means a snug fit is obtained, without air spaces or sharp edges, and differences of expansion between porcelain and metal work are taken up. At the same time, the mechanical strength is very great, and there is no liability of corrosion setting up bursting strain in the porcelain.

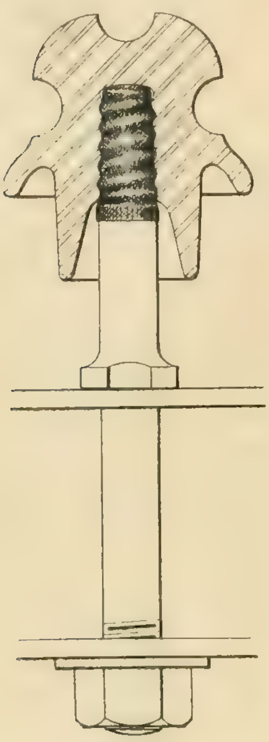


Fig. 5.

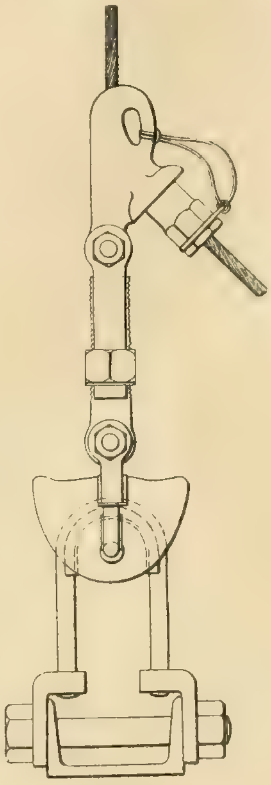


Fig. 6.

Another practice which is not considered good is that of the use of shackle insulators for ending off. Shackle insulators have in the past been used by the Post Office for telegraph and telephone wires, but even for this purpose their use is now largely discontinued; in fact, the Post Office themselves consider shackle insulators as obsolete. Power lines, however, involving as they do much heavier wires necessitates insulators of great strength and good electrical characteristics. which requirements are best met by insulators of the interlinked type, as shown in Fig. 6. In this insulator, the porcelain is in compression, and is capable of developing a strength of anything up to 4 tons, as opposed to about 3,000 lb. on a shackle insulator. Moreover, the electrical value is much greater than that of a shackle.

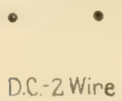


Fig. 7. D.C. 2-Wire.

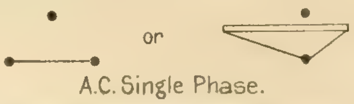


Fig. 7A.—A.C. Single Phase.

The ending-off of heavy power wires on to insulators presents a problem which may involve a large amount of labour. In this connection, the fitting as shown is of interest, as by its use a wire can be readily ended off in a manner which ensures that the wire will break before the gripping device will yield.

Questions of Cost.

The proper comparison of cost is that of an underground cable distribution system with house service, plus the cost of a separate street lighting equipment, as against the corresponding cost of an overhead distribution system, including services and incorporating street lighting. The latter invariably shows a substantial saving. With prices unstable as they are now, however, it is found impossible to convert this statement into one of a firm table of actual comparative costs, as even within a period of weeks there are considerable variations in price, and with some components, such as poles, the variations appear to be quite irregular. Consequently, comparison made at the time of writing this article might be quite wrong and even misleading by the time the article was published. Nevertheless, the amount of saving, although varying considerably from time to time, is always considerable, and, based upon calculations on jobs which have been carried out, has mounted up to about 50 per cent. on first cost. There are also subsequent savings, as, for instance, on every service added. Moreover, when it becomes necessary to adjust the size of conductors to an altered load, the saving is very considerable.

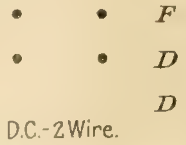


Fig. 8. -D.C. 2-Wire.

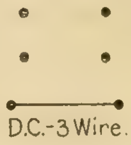


Fig. 8A.—D.C. 3 Wire.

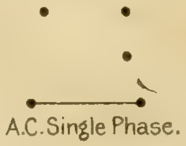


Fig. 8B.—A.C. Single Phase.

Conclusion.

It is hoped that the foregoing will serve to substantiate that the overhead system as applied to distribution has special advantages. Notwithstanding this, however, it is not suggested that the overhead system should be used everywhere. In fact, as shown above, the ideal arrangement is in some cases a combination of overhead systems for distribution and underground cable for feeders. In large towns and cities, however, the congestion is generally too great to permit of the overhead system being employed at all. In small towns and villages, however, and in suburban districts of large towns and cities, the use of overhead distribution is readily practicable and special opportunities for its adoption are afforded when new housing colonies are being erected.

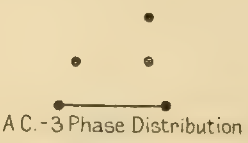
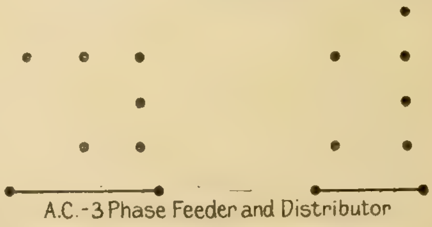


Fig. 9.—A.C. 3-phase Distribution.



Figs. 10a and b.—A.C. 3-phase Feeder and Distributor.

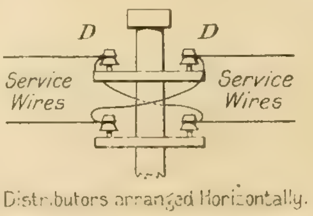


Fig. 11. -Distributors arranged Horizontally.

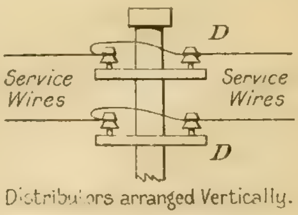


Fig. 11A. -Distributors arranged Vertically.

Calculations have shown that in order to provide by the overhead system electricity on a housing estate, together with all the necessary street lighting and house services, the cost is less than two per cent. of the expenditure on the buildings alone—a very trivial addition to the cost for so appreciable an advantage.

The Cheapness Fallacy in House Wiring.

By R. G. TYLER.

THE great changes of the last few years have produced a certain looseness in the way rules, otherwise generally accepted as necessary, are treated. On the one hand, housing schemes and the smaller middle-class houses call for lighting installations which to be possible must be "cheap," and, on the other hand, rules have been more or less allowed to lapse during the war. The result is a tendency to adopt a low standard of work. It will, no doubt, always be difficult to get the general public to come to a sound judgment on such questions as the point at which the cutting down of price means inevitable loss of efficiency. Rules such as those of the I.E.E. may be regarded in some quarters as counsels of perfection which are not for those who must study economy. Without laying down the law as to whether the Institution rules should be invariably respected, it would be well if architects and others who are in control of new building work were fully instructed as to the merits and demerits of the different classes of work from which they have to make a choice.

Some Arguments and Some Replies.

Nearly everyone admits that, for new buildings, screwed steel conduit wiring affords the best and most permanent job, but if one suggests it one is met by such arguments as these :—

(*a*) The cost is prohibitive.
(*b*) "Close-joint" conduit is "good enough."
(*c*) Screwed conduit work is sometimes bad as well as high in price.

As to (*a*), the price is now high—as is every other item of building operation—but it is "prohibitive" only if compared with something else which is assumed to be equally, or nearly equally, serviceable, and it will not do to turn it down in favour of a rival which is technically bad. As to (*b*), is "close joint" work "good enough" under any circumstances? The Rules Committee, after most exhaustive enquiry and for cogent reasons, practically turned it down finally and definitely as unfit for permanent work under any circumstances. War conditions, of course, made it necessary to use many inferior methods temporarily and it is a great pity that any such should be allowed to become habitual. The user, the architect, and others are apt to be misled by the fact that wiring work may be perfectly good when new and even for some years after execution, but those who have closer personal knowledge of the weak points and particularly those who have to rectify faults and to rewire old work, know that thin, close-joint tubing with unscrewed sockets will, in a longer or shorter time, invariably give trouble and, further, that such trouble as arises from these weak points is really dangerous. As to (*c*), it is, no doubt, true that there are instances of trouble arising with the screwed conduit system, but this is only another way of saying that bad work can be done on any system and there is no difficulty in finding out what are the proper steps to ensure that work is properly executed.

The I.E.E. Rules Must be Enforced.

It should be most strongly urged on those in control of new work, and especially upon fire insurance companies, that there is no reason whatever why the rules of the Institution of Electrical Engineers should not be rigidly enforced. The close-joint slip-socket system is the only one which has been condemned as inherently bad, and its use should be definitely and finally disallowed by all authorities. If cheaper systems are required, the Henley wiring system, Callender's "Kaleeco" system, or wood casing provide suitable alternatives. Grip continuity systems may also at times be suitable, but it is very doubtful whether any such system, when properly installed to give efficient continuity and facilities for drawing in the wires after completion of the tubing, will show any appreciable advantage in cost over ordinary screwed tube—and such a system is, after all, only an attempt at a cheap substitute for the best.

In view of the foregoing, it should be recognised that authentic rules do exist and that the indefinite practice of the last few years should be discontinued. Each case deserves special consideration, and though some may call for treatment with one of the cheaper systems, in no case is a bad system justifiable. In other words, though there may be financial difficulty in adopting the courageous course, the moderately cheap and good system must be preferred to the cheap and nasty, which, of course, is not really cheap at all.

High Efficiency and Economy.

Apart from the question of systems, there are now many ways by which the best efficiency may be obtained with economy in first cost. In this respect some useful lessons have been learnt in the execution of war work, such as the method of giving service from street mains to small houses. In cases where whole townships came into being great saving was effected by bringing the main distributor above ground at one point and fixing a joint box on the outer wall of one of a pair, or even a row, of cottages, one cable being run internally to a pair of fuses in each. This effects a great saving over the generally used system of bringing an underground service into the basement of every house. In many cases, of course, no basements existed. It is to be hoped that architects will allow their objections to such excrescences to be overcome in the interests of economy. An external box, neatly made and fixed about a foot or so from the ground line, should be, at any rate, not more unsightly than many modern appliances used in connection with open plumbing.

The service switches, fuses and distribution boards need only be of the plainest and simplest pattern, but here, again, it is the reverse of economical to put in a pair of cheap "tumbler" switches even in the smallest houses where only six or seven lights have to be served. An inexpensive combined switch and fuse in an iron case is cheapest in the long run, and no distribution board is necessary as one circuit only is sufficient. Where more than 12 lights are supplied, a distribution board with two, three or four ways is best placed on the first floor, as the branch circuits will be shorter than if it were on the ground floor. A word should be said about that part of the wiring which is concealed in the roofs and floors. It is undeniable that a large amount of work has been and is being done which is disgraceful, simply because it is unseen and because so many untrustworthy men have insinuated themselves into the trade. Wires are run partly uncovered, pipe joints are half made and earthing is entirely neglected. The evil effects may not appear for years and no one but an expert and one who specially seeks out such things is likely to detect them.

Adequate Earthing.

It should be remembered, again, that new and very necessary rules exist to ensure adequate earthing, which, of course, is of the first importance. As to lamp fittings, the need for extreme economy has been very apparent chiefly because prices have lately been absurdly high. Now, however, there is a distinct fall in prices and good glass bowls and shade pendants suitable for even the better-class houses are obtainable at more reasonable prices. Elaborate metal work is quite unnecessary in any case. Metal filament lamps, both of the vacuum and gasfilled types, are also lower in price.

To sum up, it cannot be too strongly urged that, to secure the most satisfactory installation, the right course is to regard the actual wiring work as of primary importance. No economy should be allowed on this section of the work that will impair its efficiency or its rigid compliance with I.E.E. rules. If economy is necessary, it should be effected in the merely ornamental sections of the installation. A good wiring job with plain fittings is far better value than a cheap and nasty job with comparatively expensive fittings.

Distribution and Wiring as Applied to Town Planning.

By G. C. BURNAND, A.M.I.E.E.

THE electrical engineer, when called upon to prepare a plan for the supply of electricity to a new garden suburb or housing scheme, has usually the advantage of knowing within fairly narrow limits the probable requirements in any given road or area, and is, therefore, able to calculate with considerable accuracy the most economical sizes of feeders and distributors to be employed. The chief problem, therefore, which arises, is the determination of the cheapest, most efficient and most reliable system to be employed, and here the choice lies between either the underground or overhead systems, or a combination of both. It is proposed in this article to deal briefly with one or two considerations which arise when preparing a scheme of this nature.

The Drawbacks of the Overhead System.

An overhead system of mains, distributors and services, while perhaps showing a saving in first cost, possesses in the author's opinion certain unsatisfactory characteristics. It is not calculated to improve the artistic effect which is aimed at by some town planning experts and objections may be raised by both the Housing Committees and prospective tenants. The cost of maintenance is by no means low, and interruption of supply due to gales, storms, &c., is always possible. Underground systems, on the other hand, although safer and more reliable, have a reputation for being expensive. It is the writer's intention to show that the latter system with certain modifications and under certain conditions can be considerably cheapened without any loss in either safety or reliability. It is a postulate in such a system, however, that the current supply be single or three-phase alternating, the service being carried out in accordance with usual practice with the modification that sections of the distribution network are permanently earthed at the feeding points, and throughout the entire section, including the wiring. In other words, the whole system of distribution as distinct from the feeders, should be run on the earthed concentric principle, individual transformers being inserted at feeding points between the earthed concentric distributors and the feeders.

Nevertheless, the nature of the supply may be such as to render the interposition of individual transformers unnecessary; for example, where the supply to the feeding points is low tension three-phase or single-phase four-wire from a local transformer substation with the neutral earthed at the substation, permission has been obtained from the Board of Trade to earth sections of the neutral or outer permanently provided that any such section does not carry a total load of more than 10 kW, and suitable provision is made for cutting out the earthed section when it is required to test the main distributors. Doubtless such permission would have now to be obtained from the Electricity Commissioners.

Transforming Arrangements.

Whether transformers are used or not, distribution and wiring are identical, and it is proposed herein to treat the subject upon the assumption that the supply is a high tension one delivered at various predetermined feeding points in the area to be served. At these feeding points small air-cooled transformers would be installed, each transformer being large enough to take the possible load from groups of twenty or more houses, as the case may be. The transformers can be placed either in pits, small transformer pillars—on the lines of a small feeder pillar—or even in one of the houses of the group. In the latter case the transformer must be enclosed in a suitable iron case properly secured and sealed. It should be installed in a dry part of the premises, and the author knows of many cases where small 2 000/100 V transformers have been installed under the floor boards in the hall of one house in a group with quite satisfactory results.

The branch distributors, consisting of V.I.R. insulated wire, sheathed with copper, the sheathing having a cross-sectional area at least equal to that of the core, are run from the secondary side of the transformer, the copper sheathing being left uninsulated, and permanently connected to earth. This sheathing serves as the outer of an earthed concentric circuit. In practice it has been found that, when, as is necessary, the outer sheath is made of sufficient strength to form a good mechanical protection for the V.I.R. insulated core, the cross sectional area of the sheath will exceed considerably the necessary area required to meet the electrical conditions. It follows therefore, that the ohmic drop in a given length of concentric wire is less than in a similar length of an ordinary twin cable.

Service Arrangements.

In the case of a low tension supply from a substation the transformers are replaced by suitable link disconnecting boxes arranged to take the concentric branch distributors on one side and the main distributor on the other, the earthed outer of the distributor being connected through the neutral link and efficiently earthed. From the transformer or link box the concentric distributors are run on the surface of the houses, preferably under the eaves, and a tapping is taken off for each service by means of a watertight tee-joint, or, alternatively, the distributor itself is looped into each house and connected direct to the main fuse board.

This latter method has been employed with great success in one of the new housing schemes in the Metropolitan area, and the writer is informed that in spite of the fact that the cost is somewhat higher owing to the greater quantity of wire employed, the method has proved far cheaper in practice than when using the tee-joints; the elimination of the joint box and saving in labour being set off against the cost of the extra wire to the advantage of the looping method.

Between houses the distributor is run under the side entrance path and, if the soil be suitable, the wire can be buried direct without any further protection. If, however, the soil consists of made-up ground—cinder, coke, slag, &c.—it is necessary to protect the outer sheath against chemical action, and this can best be done by laying the wire in a small wooden trough filled solid with compound. The house wiring is, of course, carried out on the concentric system throughout, each service being efficiently earthed on entering the house and the sections of the house wiring earthed wherever opportunity occurs.

The Importance of Earthing.

This question of earthing cannot be too strongly emphasised, as nearly every case of trouble in concentric wiring systems can be traced to faulty earthing. Another important point to be remembered in connection with this system is that the outer sheathing of the wire must be electrically continuous throughout, and therefore all outers must be efficiently bonded together at switch points, fuse boxes, &c. In all concentric wiring special fittings are provided by the manufacturers for this purpose, and it should be always borne in mind that the sheath of the concentric wire, whilst forming part of the circuit, also acts as a thoroughly sound mechanical protection to the inner conductor and insulation, no further protecting conduit or wood casing being necessary. A further saving in cost is obtained by reason of the fact that only single pole fuses and main switches are necessary; these, of course, are placed on the insulated side of the circuit. The wiring can be run on the surface, sunk in the plaster or between the floors as may be desired and the cost of wiring per point using any of the well-known and proved concentric wiring systems will be far cheaper than when using ordinary V.I.R. wiring, either in casing or conduit, and very little more expensive than the unsightly and unsatisfactory open cleat wiring. Concentric wiring, combined with an earthed distributor system as outlined is both cheap in first cost and in maintenance. Should a fault arise an event which is exceedingly improbable—the exposed distributors are easily accessible; moreover, new connections can be made at small trouble and expense. The distributor system is particularly flexible, and extensions can be made easily if and when desired.

The no load loss of the transformers, where these are employed, is not so great as might be anticipated, and once they are properly installed, they require no further attention. Current can be metered at each house, at each feeding point or group of houses, or not at all, as may be desired, but the method of charging for current is one which may be influenced by views held in the locality by governing bodies, consumers and others. It is a large question and one which has been and remains a subject of controversy. In any case it is not one which comes within the author's self-imposed limits when preparing this article.

"Foolproofedness" as a Domestic Asset.

By DOROTHEA SELBY, B.Sc. (Household and Social).

THE question of making apparatus 100 per cent. safe has not yet worried the makers of domestic electric appliances very much In spite of the rather clumsy robustness of much of the British work there is a lack of imagination and a carelessness of detail about its features which makes much of it unsuitable, if not actually dangerous, for the non-technical user. In testing irons and other domestic apparatus by means of a Megger it is surprising to find how low the insulation is even in many makes of good repute. If this subject were to receive more attention there is little doubt that there are endless improvements which could be made in this direction.

It is probable that manufacturers of domestic electrical appliances are already aware that their equipment has not yet reached the "foolproof" state, and even if they have not begun to travel towards the goal, half the battle is won if the position is realised. A comparison of the same number of advertisements dealing with electrical apparatus for use in the home and of, say, cooking with a patent preparation, would reveal that the "electrical" child is far outnumbered by the potential cook. Little as it is likely that any sane mother would allow a child of six or eight years old to make the Sunday pudding or cook Father's birthday cake, the fact in the advertisement world that she is allowed to do it so far oftener than she works a vacuum cleaner or a washing machine, is a true indication of the state of public opinion.

Is Foolproofedness a Necessity ?

The question then arises as to whether it is essential to have electric labour-saving devices so foolproof that a child can use them. The degree of safety considered necessary or desirable depends on the solution of three much wider problems. The first is the housing question; the second is the education of all classes of women, both mistress and maids, and the third the domestic servant problem. All three are of course intimately connected.

In spite of pessimistic reports, houses are being built both under housing schemes and by private enterprise. A very large number of these, even the artisan dwellings, are fitted with electric light and are wired for power. On the success of the owners of these new houses in coping with domestic work much depends. There are many women who are waiting to see whether houses can be run as successfully with mechanical apparatus as with human labour, and whether this new way is a better and a happier way. If the electrical industry does its part of the work efficiently the next few years will see an enormous change in the construction of new houses, and the re-construction of old homes.

Housing Conditions in England.

At the same time it has to be remembered that the domestic problem in this country is by no means on all fours with that in America. The average Englishwoman still insists on a house of her own, and a house to herself; the flats and service flats of London are mainly occupied by bachelor men and women, or by grandparents. Rare is the man or woman who honestly enjoys living with a mother-in-law The communal kitchen, which according to the bleatings of the pessimists was beginning a new era, where there would be nothing of the former splendour of the Englishman's home life, has succumbed long before that grand old institution.

During the war innumerable women had for the first time in their lives to run their homes without hired help. Many of them realised for the first time what an amount of futile work there was with the endless creation of dirt by employing coal fires, and by the continual stirring it up in the so-called cleaning. Now they have begun to think about it, and now that the cost of running a home is so high they are beginning a re-organisation of the house work.

Unladylike Treatment.

Early in 1921 an advertisement in an American paper ran thus: "Motorised household utilities though used mainly by women, receive treatment that is far from ladylike—motor carelessly left running hour after hour—clouds of scalding steam, current jammed on under full load, splashes of soapy water, neglected lubrication. These are just a few phases of the slugging, hammer-and-tongs sort of treatment your product can expect."

The salesmen of this firm would have to be adepts in applying this scathing criticism of woman's capabilities to the neighbour over the way rather than to the "prospect," but the fact that the firm had bravely faced the necessity for making their machine foolproof is exceedingly important. It is rather a depressing advertisement for a woman to read through, though no doubt it will appeal to the male reader; it suggests that woman is incorrigible. Has she really been given a fair trial yet? A great deal has to be done in the education of users or potential users of domestic electrical appliances in the showrooms of manufacturers, factors and supply companies. Very generally the salesman only cares to deal with customers who are serious buyers at the moment, and has neither the time nor the inclination to awaken the general interest. So long as salesmen are working mainly on a commission basis, a good enough system in many ways, this is likely to continue, but it is a very short-sighted policy for the manufacturer, the factory or the supply undertaking to neglect the formation of public opinion.

A Useful Policy.

At least one of the London Supply Companies has been working for some years with this end in view, with most satisfactory results. A lady demonstrator was appointed some years back who, besides cooking and talking about cooking in the showroom, is ready at any time to go and instruct new servants in the use of the electric range. Suppose Mrs. A. decides to hire or buy an electric cooking stove she can send her cook down to the showroom to watch the demonstrator cook, and to learn the general workings of the stove. As soon as the new stove is fixed at Mrs. A.'s house, the demonstrator calls and gives the cook a further lesson on her own stove. Wherever possible she arranges that the stove shall not be used before her call, as it is easier to form good habits than to eradicate bad. Should cook I. leave to get married (she is far less likely to leave for frivolous reasons when she has an electric range), Mrs. A. has only to drop a card to the supply company, and the demonstrator will call again, and teach cook II. the use of the stove. This is found to be more satisfactory than letting cook I. pass on the tale, uncensored, to cook II.

In this way this supply company has attacked the domestic load problem with marked success and has, incidentally, made the path easier for others as it has disseminated much accurate knowledge. They have taken every precaution to see that the user understands the apparatus so that she herself runs no risk of accident and so that the apparatus itself wears and works well Occasionally the demonstrator finds it is impossible to trust a cook with an electric stove: one chef-trained cook insisted on keeping the oven on all day, whether she used it or not. Some companies might have said, "All the better for us. What an excellent domestic load!" Fortunately, this company is more far-sighted and arranged to have the stove taken away so that Mrs. X. could not tell her friends how expensive electric cooking was! For the most part women very quickly learn to use the stoves well and economically and appreciate them thoroughly.

In districts where there is no system of this kind we have heard of many mysterious breakdowns which have in the end necessitated a careful enquiry by trained engineers. The reasons are often ludicrous; once recurrent breakdowns on hot-plates were found to be due to the heating of the maid's curling tongs in the resistance coils of the hot-plate!

The Furtherance of Education.

Education might be carried further by the interested parties. It is recognised that schools, so far as the domestic science and sewing classes are concerned, are still in the coal-gas and hand-power age, but much could be done by inviting visits of the staff and students of the domestic science training colleges to showrooms where domestic appliances can be carefully demonstrated. Many schools would welcome lantern lectures, particularly if these were given by persons of education who could emphasise the scientific side and correlate it with work done in the classes.

Recently a domestic servant tore the flex from the adaptor of an iron, and finding to her dismay that the iron was no longer heating, she reverted to the familiar method of heating the iron at the fire. When the flex was repaired it was found that the elements of the iron had been destroyed by heat!

To prevent disasters of this kind is probably impossible as long as the average woman is so ill educated about electricity. A change in the curriculum of girls' schools so that they are no longer copies of boys' schools, but allow for the fact that girls are likely to become wives and mothers, will help the situation. For example, physics as applied to domestic problems becomes a fascinating subject instead of a dry-as-dust study, and will be of real use to the girl in later life. She will be trained to observe and, for example, she will be aware of the danger of worn flex; at present the average feminine idea of economy is to go on using flex as long as it will wear, and it is only when there has been a "short," possible damage to the element of the appliance or to the motor of a machine and certain fright has been given to the user that the advice of an electrician is called for and the flex is replaced.

The development of the domestic servant situation is likely to have an influence on the degree of "fool-proofness" required. The feminist movement and the war probably account for the present situation. The former, and possibly the latter, too, are an outcome of the spirit of the age. To enter into a full discussion of this is beyond the scope of this article, but it must be appreciated that the movement for freedom, for shorter hours and better pay are just as real in the home as in the factory.

Some Aspects of the Servant Problem.

Briefly, the movement to-day is towards day servants. The cost of building is such that to allow room for the maids in a new house makes them almost prohibitive for professional people. Even if there is sleeping room, it is not easy to find satisfactory maids to live in. The married woman, of the younger generation particularly, is showing a tendency to become more businesslike and efficient and she is finding that to have in a "daily" and to supplant the second maid by labour-saving appliances is not only more economical but is also more satisfactory. The fascination of 100 per cent. efficiency is great and there is no doubt that "Mechanical Jane" is a great success, though she will never supplant "Ordinary Jane" entirely.

For that reason and allowing for the fact that more attractive conditions in domestic service and a shortage of industrial work is making far more women available than has been the case for some years, the electricity supply authorities and the manufacturer must see to it that they are quite ready for this mixed system where the maid will sooner or later handle the apparatus.

The Lines of Attack.

The lines of attack they should work at are two:—

(1) This education of potential users.

(2) Improvements of the appliances themselves.

The improvements may be looked at from two points of view, that of the user and that of the article used. The manufacturer needs to consider the most severe conditions under which his product may be used. There are few users of irons who have not left the electric iron "on" unintentionally for a longer or shorter period. At a woman's hostel attached to a university in this country a student's efforts at economising on laundry work were swamped by the price of a new leaf for an oak table which had been burnt through while she was at dinner! In another case "Mary" was so absent-minded that fire insurance had to be claimed twice within six months. Mary's master expected to have his premium raised if claims continued at this rate, so forbade electric ironing. In laundries a red signal light is sometimes put in to act as a danger signal, but even this simple method is not used as often as it might be. In this country there has been no serious effort to provide the iron with a "cut-out" switch in the connector indicating clearly whether the iron is "on" or "off." Unless such a connector was very well marketed its list price would probably be not less than 6s., which makes its cost rather heavy in proportion to the price of the iron, but it would certainly add to the convenience and make accidents less frequent.

Cut-outs for Irons.

In an American trade journal there was advertised recently an automatic cut-out fuse which was to be attached to an iron or other appliance and which would cut off the current when the appliance reached a certain temperature and yet could be reset without any replacement of wire. The author has not yet had an opportunity to examine this, but if it does all that is claimed for it, it will be a distinct advance over the cut-out which is inserted in certain American water boilers. These consist of plugs of readily fusible metal, placed in the base of the appliances, which are melted when the temperature reaches a certain point so that the current is cut off. Yet another device is fixed in the connector so that there is no necessity to dismantle parts of the heating apparatus.

A Criticism of Some Fires.

One British firm, at least, claims that its water boilers are so made that heating them dry even to a red heat does not buckle the bottoms or damage the elements. The worst that can happen is the melting of the solder. The same firm uses for its electric fires fireclay formers which are unbreakable. Another one of the youngest British firms claims that the elements of the fire are "practically unbreakable." There are still many fires on the market where the guard is unnecessarily easy to remove. Where the removable guard is intentional, to facilitate cleaning, directions should always accompany the fire emphasising the danger of leaving it off when the fire is in use.

Careful directions issued with apparatus may save many accidents, particularly with the more delicate machines, such as vacuum cleaners. It is interesting to find that a motor is usually treated with more respect than heating apparatus. There is something mysterious in the sight of motion produced by an unseen cause, whereas the production of heat being a more familiar process is not quite so awe-inspiring.

Motor Wrinkles.

The chief trouble with motors is no oiling, excessive oiling, and oiling in the wrong parts. It is remarkable how many makers of vacuum cleaners omit to indicate clearly on the machine which are the oil holes. There are generally directions supplied with the machine but in how many houses are these at hand when the whim to oil is abroad? The most obvious place to a woman are the slots through which the brushes are fixed!

A cleaner recently introduced over here from the Continent has a serious fault: it has a short handle with the flex leading straight out without a spring guard. In time the insulation of the flex will wear and the user is nearly sure, sooner or later, to get a burn on the hand. In an otherwise well constructed machine this is an exceedingly stupid omission.

This new type of machine draws the dust laden air through the bag first so that only filtered air passes through the fan-motor. It will be interesting to see if the older makers modify their machines so as to embrace this additional safeguard.

We in this country have been behind the States in the development of the electrical domestic industry, but although they are at present ahead of us in the 100 per cent. safety movement, they have not yet stepped so far along the road that it is impossible to overtake them. The British temperament inclines towards much greater safety than the American, but already the latter is waking up to the necessity of much greater care.

In a recent number of "Electrical Merchandising" there is a prominent place given to an appeal to the trade to work for the public in this direction by correcting individual cases as fast as possible without sending out a general alarm to the public. The advice is sound and might well be followed here. "The 110 V circuits," they say, "as every practical electrical man knows, are not ordinarily dangerous. We handle the 110 V circuit with impunity; we 'feel out' 110 V or 220 V circuits with our fingers, and when we get a 110 V or 220 V 'jolt' from arm to arm or from hand to foot, while standing on a wet or metal floor we chuckle to ourselves and consider it a good joke. But in the case of the layman (to whom electricity is mysterious anyhow) the surprise of such a shock coming unexpectedly may lead to serious accidents. Exposed line parts also set the stage for accidental short circuits through contact with metal objects which may cause serious flesh burns or blindness if the eyes are exposed. The uninsulated socket pull chain in the bathroom or basement which can be reached by a person standing on a wet floor or in the bath with the feet in water is another real menace."

If our English Press were to give the contractors and manufacturers a similar dressing down, modified to suit the conditions over here, much bad work in the new houses would be avoided and a tremendous impetus given to the development of the domestic load.

The Doctor's Dilemma.

A Medical Correspondent on How to Heat our Homes.

By "ELECTROCYNIC."

THE Medical Correspondent of the "Observer," in a recent article ventures into the gas-electric controversy armed only with a colossal ignorance of his subject and a certain ingenuity in the use of inappropriate adjectives. Forsaking his usual subjects eugenics, smoke abatement, pure milk and the like, in which his expertness is unquestionable, he suddenly assumes the mien, manner and methods of the gas propagandist, and, in the article referred to, attacks electric heating with all the vehemence and inaccuracy of the most practiced debater on the roster of the B.C.G.A. He is, of course, entitled to his own opinions on the subject of domestic heating, and the fact that they happen to be in accordance with the advertised tenets of the B.C.G.A. is, one may hope, purely a matter of luck for the gas interests.

Such articles as this are becoming increasingly common, and they may be taken as a rough indication of the ever-growing fear which the rivalry of electricity is engendering in the bosoms of our gaseous friends. In the ordinary way I should take no notice of such gas-inspired diatribes, but in this particular case the attack is developed on such extraordinary lines as to compel my attention.

An Amazing Argument.

Briefly the argument is this: Central heating, as practised in America, and in a few other places, is unhealthy because it warms the air. Electric heating is unhealthy for the same reason. The gas fire, on the other hand, is the *one* hygienic method, because, according to the "Observer's" Medical Correspondent, it gives forth radiant heat, and leaves the air in a state of refreshing iciness. Curiously enough, most people consider it an advantage that the air of a room should be warmed; indeed, it is difficult to see how any room can be heated without warming the air.

Radiant heat is, of course, a very delightful thing, but it is merely a transient and local condition. The heat is only radiant until it is absorbed by walls, furniture, &c., &c., and after that it proceeds to warm the air in the manner to which this observant medico so strongly objects. In any case, only those who are in a direct line with the fire can possibly receive any benefit from the *radiant* heat, and persons seated to the side of the fire, or who are screened therefrom by articles of furniture, and yet manage to keep warm, are either the victims of a fatuous illusion, or else are being warmed indirectly by convection.

A Curious Delusion.

I hold no brief for central heating as generally understood and applied, and I might even go so far as to agree with the doctor that it is physiologically incorrect—if he will not think such agreement impertinent in a layman. But in my opinion the chief objection to central heating is that it is too uniform in its results, and I do not think that uniform heating is either pleasant or healthy. To find fault with the system because it does not give radiant heat is simply silly. Presumably those foolish people who get so excited over the imaginary advantages of purely radiant warmth labour under the delusion that they are assisting to carry out the intentions of nature in the matter of heating. Poor deluded beings! I wonder what proportion of the sun's heat is available, even to the farm labourer, in radiant form.

The ordinary man who works within doors gets practically no radiant heat from the sun, and on those rare occasions when it does impertinently thrust its rays into our rooms we, or most of us, pull down the blinds in order that our delicate vision may not be damaged by glare.

Extraordinary Behaviour of an Electric Fire

The most amazing part of the doctor's argument is his denunciation of the electric fire for *its* lack of radiance. The kind of fire he used for his experiment (he *did* experiment, and in Kensington of all places) is thus described: "The current heats a number of filaments, which are not consumed, and the effect is to heat the air of the room, without producing any more than a very quiet light." And this type of fire is not radiant! Ye gods! Why, the common criticism is that it is radiant and little else. Can the study of eugenics have driven the doctor entirely off his head?

As to the physical effects of electric heating, he considers them precisely similar to those produced by central heating. This is what he paid 10d. an hour for: "The electric heater provides a comfortable, soothing, enervating ease, in the direction of Nirvana; and, thereafter, one is ready to shiver and succumb at the assaults of the air without. It is very pleasant in a way and for a time, but it is unhygienic in its action on nose and throat, lungs and skin." Doctor! you surprise me. For upwards of twenty years I have heard every sort of argument for and against electric heating, but never have I heard it described in such glowing terms as you employ. Indeed, your adjectives more than compensate for the dead non-radiance of the fire itself. There are many thousands of people who would be only too glad to find these qualities (disgusting perhaps to your hyper-sensitive organism, but exceedingly attractive to the majority of this sybaritic generation) in their heating systems—whether gas, electric or water.

The Perfect Heater.

Seriously, however, it seems inconceivable that anybody (let alone a doctor, who is supposed to have some scientific knowledge) should in earnest prose debit the electric fire with all the faults which by common consent of friend and foe it does not possess, and deny it the virtue of radiance which—in the opinion of many people, is its single physiological advantage.

Gas fires, of course, conform to all the principles of hygienic heating. "They provide radiant heat in a relatively cool air, and they continuously ventilate the room by carrying the products of combustion up the flue, and thus drawing in fresh air. Thus one gets moving air and radiant heat—after—even if a long way after, the natural ideal of an early morning summer sun and the wind on the heath." In my private opinion it is so far removed from the natural ideal as to be in closer accord with the lunatic condition of a midnight moon and water on the brain.

The "Observer" article bears every sign of having been inspired (quite innocently, of course) by the British Commercial Gas Association, and one can only admire the ingenious variety of the methods and instruments which this enterprising society employs for the furtherance of gas propaganda. In this particular case I think the writer has gone a good deal beyond his brief, but the bit about the chimney and the products of combustion sufficiently indicates the source of inspiration.

The Brutal Facts.

It pays the gas companies to make a virtue of necessity, but the brutal facts are these: The gas fire consumes the atmospheric oxygen and produces poisonous fumes which, if not evacuated would in time kill or render senseless the inhabitants of the room. As a rule, the fumes are not completely evacuated, and partial poisoning takes place, engendering headaches and, in the case of medical journalists, a habit of inaccurate statement and a temporary suspension of mental activity.

An electric fire has no deleterious effect upon the air, and its innocuousness in this respect is apparently an offence in the eyes of the gas-enthusiast. Ventilation and heating are two entirely separate and distinct functions; but if anybody really desires that his electric heater should both heat *and* ventilate, he has only to stand the fire underneath the chimney. Thus arranged it will induce an up-draught in the flue, the only difference between the electric and gas processes of evacuation being that in the former case *pure* air is evacuated.

A Warning.

I hope the "Observer's" correspondent will not take it in bad part if I most earnestly recommend him to stick to his eugenic last, and to refrain (as I do sometimes) from writing on subjects of which he is painfully ignorant. In matters of legitimate medical concern, such as the cure of colds and the effects of alcohol on the livers of immature frogs, I shall continue, as hitherto, to pay my tribute of respectful admiration to the scientific acumen of our literary Aesculapius. But I hereby warn him off all such subjects of practical domestic interest, because on these points I know a great deal more than he does, and it horrifies me to find errors of fact in the columns of the once omniscient "Observer." I am afraid, however, that my warning will be lost on a man who is not ashamed to admit that he has "never purchased an ounce of soft coal for his own use in his life." Let us hope that his future life will be equally free from all association with minerals of a bituminous nature.

Heating and Cooking Notes.

New Developments of Old Ideas.

Several years ago, at the time when the "Therol" heat storage system for electrically heating water first came into being, some experiments were made with the idea of applying similar principles to heat storage systems for room heating in domestic houses. The apparatus consisted of a stove enclosed and heavily lagged, a door being provided which was opened when the room needed heating. The internal or heater portion of the apparatus consisted of a number of electrodes in vessels containing "salts," the continuous passage of an electric current through which caused heat to be generated which was stored within the lagged chamber.

Now there is apparently to be a revival of interest in this type of appliance. Some experiments are being carried out on an electric oven of concrete or brick, which has a high heat storage efficiency. Similarly the idea has been considered of building hot cupboards in the structure of a house, for the purpose of either warming or drying clothes, or for haybox cookery. There is certainly room for development along such lines, and the introduction of apparatus which offers something approaching 100 per cent. load factor will provide a means of reducing the charges for electrical energy for heating and cooking purposes. At least it should do, but many supply authorities adopt a peculiar attitude on this point.

The Charge for "Heating and Cooking" Current.

In days gone by all supply engineers hung their troubles and tales of woe on the "Peak." The millenium of electrical progress and cheap electricity supply was to come when a demand had been created off the "Peak." Since then the valleys in the load curve have been filled in to a large extent by a power load, and also by the increasing use of electricity for heating and cooking. With regard to heating and cooking charges what do we find is the attitude of the supply engineer to-day? In the main two methods seem to be employed to turn away the demand of the public for electric heating and cooking. One method is for the engineer to throw up a barricade of charges for mains, services, &c., increasing the cost of the installation due to special requirements for double wiring, for the special rate meter, load balancing, &c. The other method savours more of direct action and consists in charging a lighting rate, or something like it, for heating and cooking.

The problem of charges for heating and cooking has got to be faced, and the future development of this section of the industry largely depends on its solution. At the moment the manufacturer of apparatus is liable to be discouraged over the retarding effect of supply conditions, the consumer is often disappointed, the only people who have any justification for content being the gas authorities. Some supply engineers may awaken one day to find that the demand created by B.E.D.A. has led to the public taking action on its own account, and that the chief engineer of a supply undertaking has been chased from his lair at the power station, caught in the High Street, and publicly hung from an arc lamp standard outside the electricity showrooms. A horrible fate!

New Apparatus.

The Overseas Engineering Company, Ltd., have placed on the market a series of domestic appliances comprising an iron, hot plate, and a combined grill and toaster. The toaster is illustrated in Fig. 1, and consists of a radiant spiral element supported in a nickel plated frame and stand, the operation of toasting or grilling being carried out beneath the element by means of a nickel plated tray pan. Three sizes are made, consuming 600 W in the first two sizes, and a 1 000 W in the largest size. The elements are guaranteed for a period of 12 months, and in the largest size three heat regulation is provided for. The apparatus would also serve as a hot plate of the radiant type for boiling water, milk, &c., in small quantities. The hot plate manufactured by the same firm is of the enclosed type, with a turned cast-iron top and pedestal feet. Two sizes are made, 6¾ in. and 9 in. in diameter respectively. The smaller size consumes 600 W, and the larger 1 000 W. In either size single or three heat regulation can be obtained according to the customer's preference. The irons (see Figs. 2) are 3, 4, 5 and 6 lb. weight respectively, the loading ranging from 300 to 500 W. They are supplied complete with flex, adaptor and stand, or without stand if desired. The iron is a well made article, nicely balanced, and attention has been paid to providing a handle which gives a comfortable and firm grip. A wire pan attachment at the back of the iron allows it to be stood on end thereby acting as a stand. All the articles are British made, and are particularly serviceable for the export market.

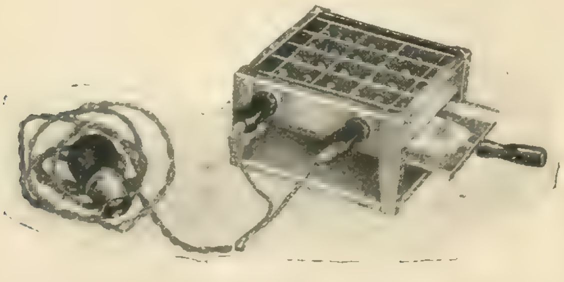


Fig. 1. Toaster by Overseas Engineering Company, Ltd.

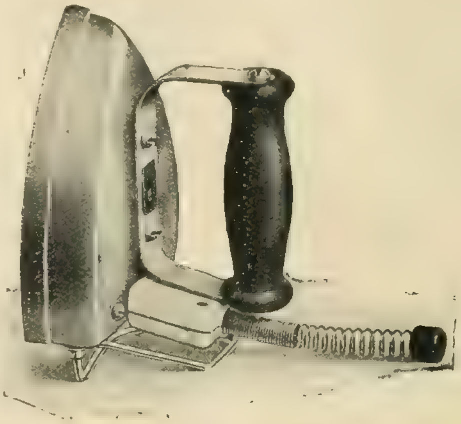


Fig. 2. Iron by Overseas Engineering Company, Ltd.

A New Thermaglo Fire.

A fire of particularly simple design has recently been produced by the Quain Electric Company, Ltd., and we illustrate this model in Fig. 3. It essentially consists of two end plates, kept in position by three connecting rods, between which is fixed a single radiant heater unit. Beneath the heater unit is fixed a semi-cylindrical reflector, the fixing being such that the ends of the reflector are held in grooves, thus permitting the reflector to be moved so that the heat may be reflected in any desired direction. The loading is 600 W, so that in most cases the heater can be used off the lighting circuit. The general appearance is quite pleasing, and, throughout, the fire is well made. It should prove very serviceable in cases where a small amount of local heating is required. It is suitable for wall or ceiling mounting, a property which is in its favour for use in heating ships cabins.

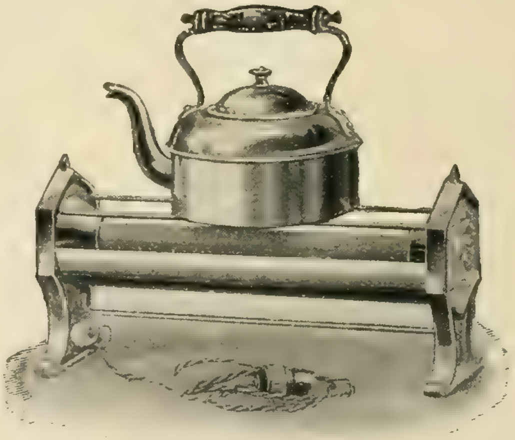


Fig. 3. –Single Bar Radiant Heater by Quain Electric Company Ltd.

Space Heater Units.

The Igranic Electric Company, Ltd., have developed a space heater unit which can be employed for a number of useful purposes. These units consume 500 W., and can be supplied suitable for circuits of 115 V, 230 V, and 250 V, respectively, a range which will cover most cases. They are steel cased, flat, small, and easily installed in any position. There is no cement, asbestos or moulded insulation employed, mica being relied upon throughout. Each unit is of standard dimensions, and 2 ft. in length. They form a ready means of providing electric heating in crane cabins, drying cupboards, store cupboards, footplates, instrument cabins, watchmen's huts, &c. One of these units is shown in Fig. 4.

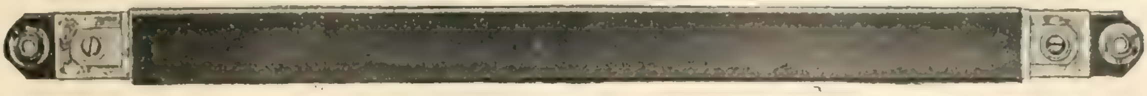


Fig. 4. Igranic Space Heater Unit.

A "Plexsim" Ship's Heater.

Electric fires are becoming increasingly popular for use on board ship, and a particularly pleasing design of this type of fire has been produced by Messrs. Simplex Conduits, Ltd. As shown in Fig. 5 it is a two-bar radiant fire, consuming 1 kW, having a cast-iron frame, finished matt black, control being provided for by means of a tumbler switch mounted at the base of the frame. The fire is, of course, equally suitable for use in small offices and rooms.

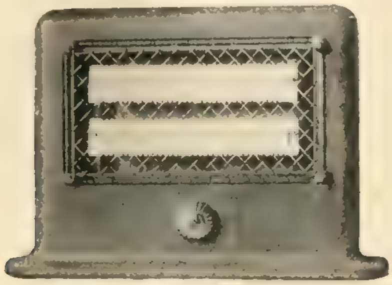


Fig. 5. Simplex "Plexsim" Ship's Heater.

A Belling Boiler.

To meet the demand for a boiler for household use, which can be used off a lampholder, Messrs. Belling & Company have brought out their No. 8 type of Radiant Boiler, which consumes 750 W. This loading, of course, limits the use of the boiler on lighting circuits to areas where the supply pressure is 200 V or over. The special feature of the appliance is the employment of a specially-designed top casting and internal mounting which permits the element being brought very close to the surface of the boiler, thus increasing the efficiency of the appliance. The top casting is nickel plated, and is supported by black finished wrought iron legs, a steel stamping providing a mount and support for the element. The diameter is 7½ in. and the weight complete 4¾ lb.

An Iron with a New Type Handle.

The "Dinkey" iron made by Messrs. Belling & Company is notable for the attempt that has been made to provide a handle which would combine comfort with the means of obtaining a firm grip. It will be noticed that the handle illustrated in Fig. 6 is specially shaped to fit the hand and fingers snugly when the iron is in use. The iron has also a serviceable point, which is an advantage for fine work, and the element has been specially designed to provide adequate heat at the point of the iron, where it is often most needed.

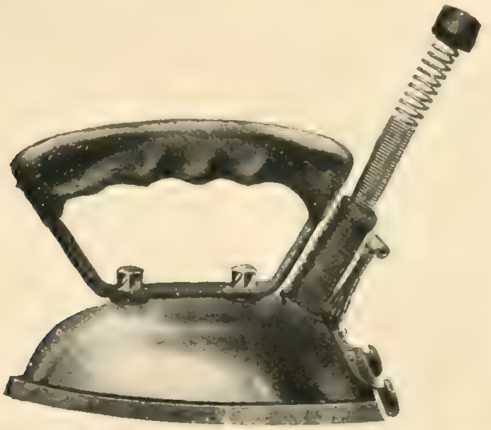


Fig. 6. The "Dinkey" Electric Iron by Belling & Company.

A metal strip attachment at the back, allows the iron to be stood on end when not in use. The appliance is really well finished and heavily nickel plated, presenting a very attractive appearance.

The "Sullivan" Workshop Fire.

The Pattern "K" fire, illustrated in Fig. 7, has been designed by Messrs. H. W. Sullivan for the purpose of meeting the demand for a workshop fire at a reasonable price. It consists of radiant type Sullivan fire bars, mounted in a black-finished sheet-metal frame, suitable plugs being provided to facilitate wall mounting. Heat control is provided for by means of rotary snap switches. Two sizes are made, two and three bar respectively, giving either 1·5 kW or 2·5 kW on full heat. Naturally such a fire does not call for beauty in design, but the general appearance is neat and serviceable. A point of note is the substantial wire guard that is provided in front of the elements, though we think in some workshops it would be necessary for a guard of smaller mesh to be employed.

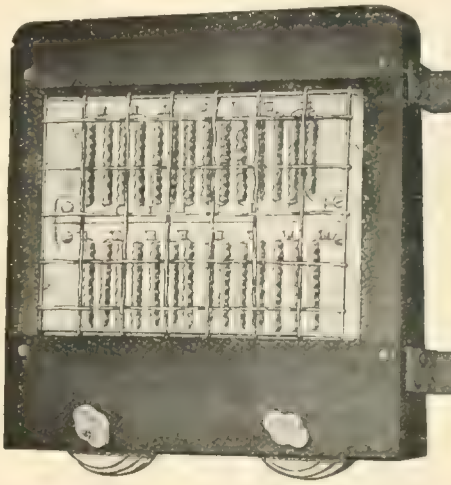


Fig. 7.—Sullivan "K" Type Workshop Fire.

Scientifically Designed Electric Domestic Appliances.

To all engaged in the electrical industry it is unnecessary to emphasise the many advantages and the superiority of electricity in its application to all domestic purposes. But this in itself is an argument for the use of scientifically designed and economical heating and cooking apparatus, and recognising this need the Metropolitan-Vickers Electrical Company has therefore made complete and exhaustive tests covering the whole range of such appliances at present on the market. In fact the company's research laboratory has been engaged for months on these tests, and as a result of the concerted attention given by a number of heating experts, a complete

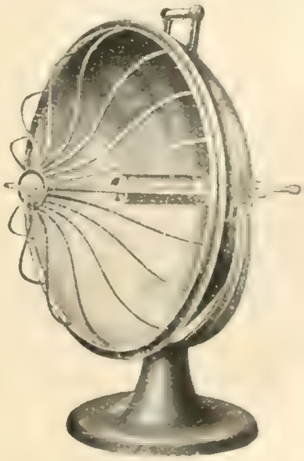


Fig. 1. "Cosmos" Radiant Fire.

Fig. 2. "Cosmos" Domestic Iron.

range of scientifically-designed domestic appliances has been evolved, and is now being placed on the market under the well-known name of "Cosmos."

The "Cosmos" domestic appliances are designed to give heat where heat is required and to minimise losses. They are without exception of sound construction, and thorough British workmanship, every unit being fully tested at the works before despatch. We give below a brief description of some of these appliances, which are made at the Company's Cosmos Works, Brimsdown, Middlesex.

The "Cosmos" Radiant Fire.

The first is the "Cosmos" Radiant fire, illustrated in Fig. 1. This consists of a copper bowl reflector 14 in. in diameter, and generally parabolic in section. The heating element which consists of nichrome wire wound on a cylinder so fixed that its centre coincides with the focus of the parabolic reflector, and the heat generated is radiated in parallel beams from the reflector similarly to the light beams from a searchlight. An important point to be noted is that a bright red heat is attained by the whole of the heating unit, not only by the resistance wire, but also by the special insulating paste in which it is embedded, and by the cylinder on which it is wound. This is the distinctive feature of the "Cosmos" Radiant fire, and is one of the results of exhaustive tests carried out in the research laboratory.

The reflector is hinged to a substantial trunnion, so that the heat rays can be readily projected in any desired direction. An ornamental guard protects the heating element from accidental contact, and the whole is made portable by the addition of a neat handle attached to the reflector. Electrical connection is made by means of the "Cosmos" standard connector which is described later on.

The "Cosmos" Domestic Iron.

The "Cosmos" iron, as shown in Fig. 2 is the embodiment of all features which the Company's research work has shown to be desirable. The heating element consists of three layers of mica or micanite generally conforming to the outline of the sole-plate. The centre layer has serrated edges and corresponding serrations in the centre slot through which the bolts pass. Nichrome wire crimped by a specially-designed machine, is wound about the serrations on one side of the micanite only, except at the point where it is wound on both sides to give the hot-point effect. The ends of the nichrome wire are brought to the main terminals by strip connections, and perfect and permanent contact is provided.

The soleplate consists of a cast-iron plate machined perfectly flat on both sides, heavily nickel plated and highly polished, all edges being slightly rounded and the extreme point ground away slightly to prevent creasing of light fabrics. The plate is of minimum thickness, and ironing temperature is obtained in three minutes from the time the switch is closed. The top plate is also of cast iron, its underside being machined perfectly flat. The heating element is thus clamped firmly and evenly between two perfectly flat surfaces giving excellent thermal contact, and a very short path for the heat to traverse. A black ebonised wood handle is provided and arranged to keep cool during use. A stand is mounted at the back enabling the iron to be stood on end when not in use. This saves continual lifting. "Cosmos" irons are designed to maintain an even temperature of about 150°C. which is ideal for average ironing, and by reason of the special construction of the element, the point of the soleplate is kept at an equivalent temperature. The iron can be used effectively for 10 minutes after switching off. All irons are suitable for use with the "Cosmos" standard connector.

The "Cosmos" Electric Kettle.

The "Cosmos" electric kettle illustrated in Fig. 3 is made in both 2 and 3-pint sizes and has a body of spun copper, pure tinned inside and finished either polished or nickel plate. An ebonised-wood handle is provided and the lid is fitted with an insulating knob. It is suitable for table use, being provided with three insulating ball feet.

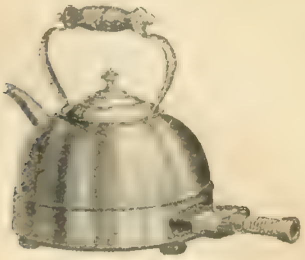


Fig. 3.—"Cosmos" Electric Kettle.

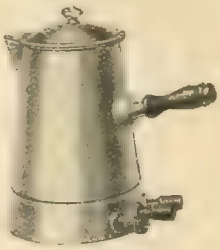


Fig. 4.—"Cosmos" Electric Jug.

The heating elements are substantially constructed of nichrome wire wound on mica and designed to give uniform heating. They are firmly clamped to the heat bottom of the kettle, giving perfect thermal contact and a very short path for the heat to traverse. A special feature is made of the studs for fixing, which are attached by a special process that makes it impossible for them to work loose, and, furthermore, entirely eliminates the possibility of leaking water. An asbestos pressure plate prevents the heat from escaping in a downward direction, and an easily detachable outer bottom facilitates inspection of the elements. Terminals suitable for use with the "Cosmos" standard connector are provided.

The "Cosmos" Electric Jug.

A typical "Cosmos" electric jug is shown in Fig. 4. It is substantially constructed of brass, with a heavily tinned interior, and finished either polished or nickel plated. "Cosmos" jugs are made with capacities of ½, 1 and 2 pints, and the 2-pint size is provided with three terminals to give heat regulation, while the smaller sizes have terminals suitable for the "Cosmos" standard plug. The heating elements are constructed and fixed exactly as described in the case of "Cosmos" kettles, giving uniform heating and a short heat path.

The "Cosmos" Combined Grill and Toaster.

The "Cosmos" combined grill and toaster is shown in Fig. 5 and is a very useful domestic appliance, especially suitable for breakfast cooking. It is constructed throughout of substantial sheet steel finished in nickel plate or stove black as desired. A drip pan with grid and a toast grid are provided, which slide easily on interior runners. The front of the grill is provided with a hinged door which, when closed, makes possible a high cooking temperature quickly obtained. Side handles, securely fixed, make the grill portable even when in use. The heating elements are fixed in the interior of the grill and protected by means of an expanded metal guard. When specially required, the grill can be made suitable for boiling liquids by the provision of a grill top having a circular aperture over which can be placed an ordinary kettle or saucepan. Suitably protected elements would in this case be fixed under the aperture.

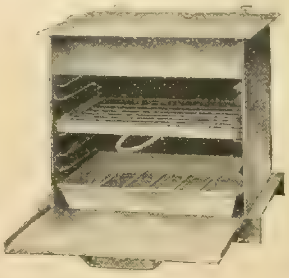


Fig. 5.—"Cosmos" Combined Grill and Toaster.

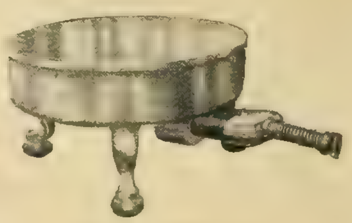


Fig. 6.—"Cosmos" Hot Plate.

All "Cosmos" grills are equipped with protected pin terminals for use with "Cosmos" standard connectors.

The "Cosmos" Hot Plate.

A typical "Cosmos" circular hot plate is shown in Fig. 6. This consists of a top plate of cast iron machined perfectly flat on both sides, with the heating element firmly clamped to the underside, providing good thermal contact and short heat path. The body is constructed of sheet steel, heavily nickel plated and highly polished —ornamental nickel-plated cast feet with ball heat insulators making the hot plate suitable for table use. The smaller size is provided with two pins for the "Cosmos" standard connector, while the larger size has three pins for heat regulation.

The "Cosmos" Standard Connector.

The "Cosmos" standard connector, of which frequent mention has been made, is suitable for use throughout the range of "Cosmos" domestic appliances. The body of the connector is composed of a black composition, which resists heat and gives perfect electrical insulation. Made in two halves and provided with grooves, it grips the flexible cable very securely. Excellent electrical contact is made in the sockets, which are loose in their grooves, and are thus self-aligning, but cannot rotate. The top of the connector is enclosed in a pressed-metal cap finished according to the finish of the article with which it is used, and equipped with a steel spring which protects the flexible cable. An insulating composition bush fixed at the connector end of the spring prevents fraying of the cable insulation.

The Home of 1921.

No housing number of an up-to-date electrical journal such as The Electrician would be complete without a reference to the work that is being done by the British Electrical Development Association in inspiring, cajoling and persuading all and sundry, electrical and non-electrical alike, of the advantages in many and various ways that can be obtained by using electricity for domestic purposes. "Literature" is not the least useful of B.E.D.A.'s methods, and not a bad way either, for those who domestically guide us cannot help being attracted by the contents of two pamphlets entitled "Woman's Work is Never Done ! ?" (note the pathos of the ! ?) and "The Home of 1921." But if the titles are alluring the contents are still more so and should, while causing a certain amount of anxiety to the so-called "head of the house" at the same time benefit the electrical industry and the cause we have at heart. Those interested should see that all their consumers and would-be consumers have copies.

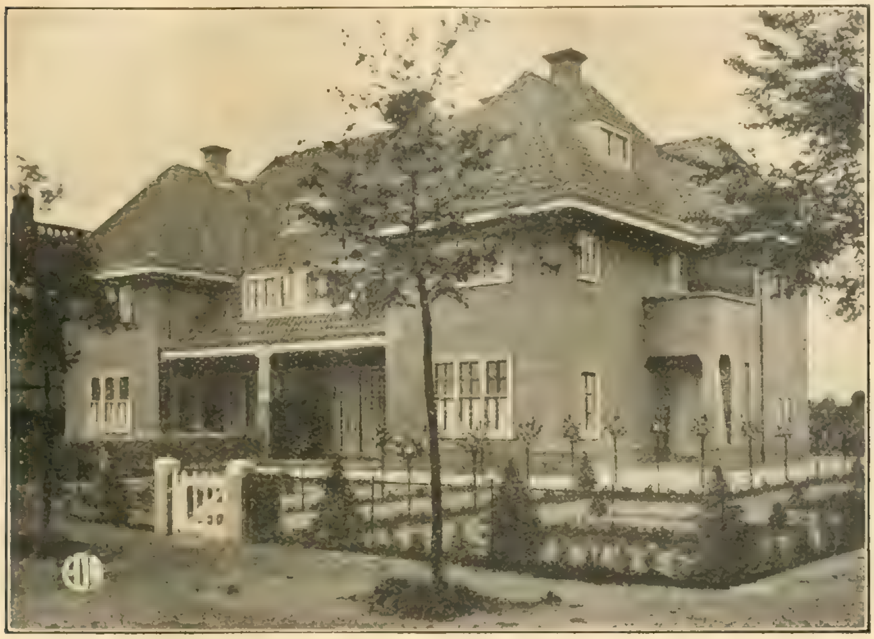


Fig. 1.—View of one of the Employees Houses (Larger Type).

"Philips' Village."

But the British Electrical Development Association not only diseminates propaganda it provides information. In a recent publication it gives some details of the use to which electricity is put in "Philips' Village," which has been built by Messrs. Philips' Glow Lamp Works, Ltd., for their employees at Eindhoven, Holland. The exterior of one house of a larger type of houses in this village is shown in Fig. 1 and of the interior of the kitchen in Fig. 2.

Electricity is of course used for lighting, heating (*e.g.*, water) and ironing. It is not, however, used for cooking; some tenants use gas cookers, others cooking stoves (coal). Electricity is supplied by the Municipal Authority at the rate of 7½d. by pre-payment meter. The consumer's demand is not limited by any instrument or otherwise. The owners supply lamps at much reduced prices; these lamps are stamped and may only be used in the houses of the workmen and the employees. If desired, the Philips' Co-operative Stores provide their customers with other electrical apparatus.

The wiring is run in a tubing system with single-pole box-switches, hotel-switches, wall-sockets and ceiling lamp holders. The cost of wiring amounts to 28s. 4d. per lighting point (August, 1920).

Each house is built for only one family and contains 6 to 7 rooms for which 9 to 11 lighting points are allowed. "1-Watt" and "Arga" lamps are used; the size of these lamps for drawing-room, bedroom and kitchen being 100, 50 and 32 candle-power respectively.

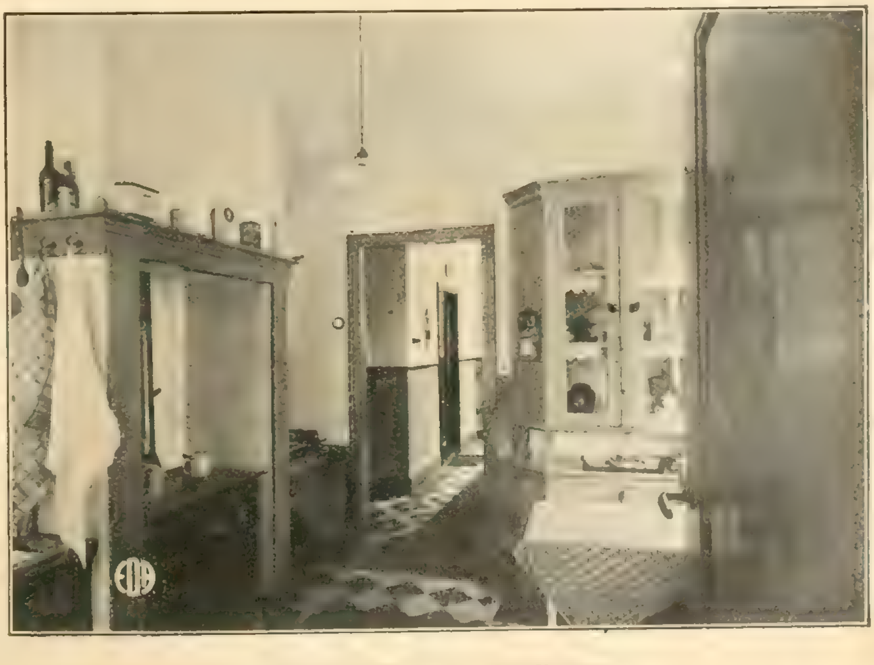


Fig. 2.—A Corner of the Kitchen.

The temporary wooden houses, built during war time, are provided with electric light, free of charge, from the factory's electric generating station. The lamps, supplied at very reduced prices, are stamped and may not be changed by the tenants. Too abundant use of electric light is checked by warning the tenants that the supply must be paid for if it exceeds the limit of 14 kWh per month (drawing-room, 2 or 3 bedrooms and a kitchen).

The "Universal" Electric Washer.

The "Universal" combined electric washer and wringer has a number of features which, considering the attention that is being given and the criticism that is being directed to this class of apparatus, makes it worthy of attention.

A general view of the apparatus is given in Fig. 1, while the arrangement of the drive is illustrated in Fig. 2.

The moving parts are all operated in oil, and further, are totally enclosed so that the womenfolk or children cannot in any way do damage to themselves or the machinery. As an additional precaution the patent "Universal" overload cut-out is fitted on these machines in a similar way as it has been successfully applied on the "Universal" coffee and meat grinders. Should for any unknown reason the machine be overloaded, instead of burning the motor out (which has been the main trouble on electric washers), the motor is automatically cut-out, and thus all trouble is obviated. The wringer

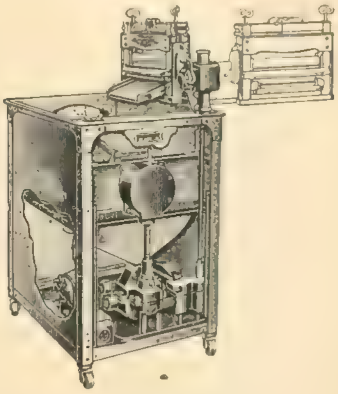


Fig. 1.—General View of the "Universal" Electric Washer.

is so made that it can be used in four different positions. A reverse action is conveniently arranged, and the simplicity of the whole thing can be explained in three or four minutes to the womenfolk. There is no need to interest them or frighten them by explaining the details of intricate workings. The wringer is fitted with a safety release which entirely obviates the possibility of serious damage to any person's hand which by chance may get clipped in the wringer.

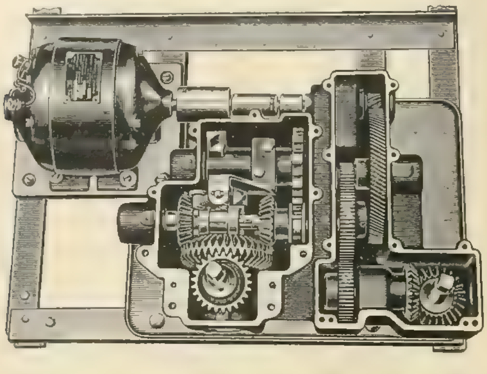


Fig. 2.—The Drive of the "Universal" Electric Washer.

It is made by Messrs. **Landers, Frary & Clark**, a firm of seventy years' standing, and is marketed by Messrs. **L. G. Hawkins & Company**.

The Institution of Electrical Engineers.

The following have been nominated by the Council for the vacancies which will occur in the offices of President, Vice-Presidents, Honorary Treasurer and Ordinary Members of Council on the Sept. 30, 1921 :—

President (one vacancy).—J. S. Highfield, Consulting Engineer.

Vice-Presidents (two vacancies).—Prof. E. W. Marchant, D.Sc., Professor of Electrical Engineering, The University, Liverpool ; C. C. Paterson, O.B.E., Director, Research Laboratories of the General Electric Company, Ltd.

Honorary Treasurer (one vacancy).—Sir James Devonshire, K.B.E., Managing Director, London & Suburban Traction Company, Ltd.

Ordinary Members of Council. Members (four vacancies).—S, Evershed, Director, Messrs. Evershed & Vignoles, Ltd. ; A. L. C. Fell, C.B.E., General Manager, London County Council Tramways ; H. E. O'Brien, D.S.O., Assistant Mechanical Engineer and Works Manager, Lancashire & Yorkshire Railway ; A. Page, Electricity Commissioner ; T. Roles, City Electrical Engineer and Manager, Bradford ; Capt. J. H. Round, M.C., Engineer, Marconi's Wireless Telegraph Company, Ltd.

Associates (two vacancies).—Sir Andrew M. Ogilvie, K.B.E., C.B., Retired Second Secretary, G.P.O., London ; A. W. Tait, C.B.E., Chairman, Metropolitan Electric Supply Company, &c., London.

Those retiring from the present Council and not put forward for re-election are Mr. Ll. B. Atkinson (President), Mr. W. A. Chamen (Vice-President), Mr. P. R. Allen, O.B.E., Mr. H. W. Clothier, Mr. D. N. Dunlop and Mr. J. Sayers, O.B.E. (Members of the Council). Of the remainder of the Council who would ordinarily retire on Sept. 30, 1920, Mr. J. S. Highfield, Prof. E. W. Marchant and Mr. C. C. Paterson, O.B.E., are put forward for higher office.

The branches of the profession represented by the new nominees and by those remaining on the Council are shown hereunder, the new nominees being indicated in italics :

Educational : Dr. W. H. Eccles, *Dr. E. W. Marchant*, Dr. A. Russell. Manufacturers and Contractors : (*a*) Traction, Light and Power, H. J. Cash, J. R. Cowie, *S. Evershed*, E. A. Gatehouse ; (*b*) Cables, P. V. Hunter, C.B.E., B. Welbourn ; (*c*) Telegraphs and Telephones, F. Gill, O.B.E. Traction, Light and Power : (*a*) Companies (excluding Railways), *Sir J. Devonshire* (Hon. Treasurer), A. H. W. Marshall, *A. W. Tait, C.B.E.*, P. D. Tuckett, C. Vernier ; (*b*) Local Authorities, S. E. Fedden, *A. L. C. Fell, C.B.E.*, *T. Roles* ; (*c*) Railways, *H. E. O'Brien, D.S.O.* Consultants : A. A. C. Swinton, F.R.S. Telegraphs and Telephones (excluding manufacturers) : Sir W. Noble, *Capt. H. J. Round, M.C.* Miscellaneous (*i.e.*, Law, Government Depts., other than Post Office, Electro-Chemistry, Research, &c.) : *Sir A. M. Ogilvie, K.B.E., C.B., A. Page, C. C. Paterson, O.B.E.*

Members are reminded that under Article 50 of the Articles of Association any ten full members may nominate a qualified person to fill a vacancy on the Council by delivering such nomination in writing together with the written consent of the person nominated before April 21st.

The new President, Mr. **John Somerville Highfield**, like his predecessor, comes of an engineering stock. His grandfather was engineer to various water, gas works and railways and his father was interested in scientific and amateur engineering work. Mr. Highfield was born in November, 1871, and was educated at King's College, London, of which College he is an associate. He then joined the Chloride Electrical Storage Company, Ltd., as an assistant to the late Mr. G. A. Grindle and, after some time in the service of this firm, became connected with the completion and starting up of the electricity undertaking of the Stafford Corporation. Subsequently he was appointed engineer and manager of the St. Helens (Lancs.) Corporation electricity and tramways department, and on the death of the late Dr. John Hopkinson, the consulting engineer to the Corporation, was entrusted with the design of the electricity supply and tramway systems of that town. In 1903 he was appointed chief engineer to the Metropolitan Electric Supply Company, Ltd., and on the retirement of the late Mr. John Conacher, the general manager of the Company in 1909 became engineer and manager to the Company, which office he held until his resignation in 1915 to commence private practice as a consulting engineer.

Mr. Highfield has been connected with the Institution since 1900 when he was elected a member. He served on the committee of the Manchester local section from 1901 to 1903, was a member of the Council from 1904 to 1907, and again from 1911 to 1914. He also served as Vice-President from 1914 to 1916, as a member of Council for a third time from 1917 to 1919, and for a second term as Vice-President last year. Some years ago he contributed a Paper on "Battery Boosters" and during his connection with the Institution has read no less than three Papers on "High-tension Direct-current and the Thury system," one in London, one in Paris and one in Glasgow. The one read in London will be memorable as the last time on which Lord Kelvin took part in a discussion on a Paper read before the body with which he was so long connected.

Obituary.

TOM ERNEST GATEHOUSE.

We greatly regret to record the death of Mr. **Tom Ernest Gatehouse**, editorial and technical director of the "Electrical Review," which occurred on March 31, after a short illness. In consequence of failing health Mr. Gatehouse had not for some years past taken a very active part in the production of the "Review," though in the capacity of editorial and technical director he had exercised consultative supervision. His interest in the paper, which was in the best sense of the word his monument, however, remained to the end, and he had been at his office a few hours before the attack which ended in his death.

Mr. Gatehouse was born in 1854 at Eye in Suffolk. He was the son of Mr. Tom Gatehouse, a mechanical engineer. It is therefore not unnatural that he turned to engineering as a profession and at an early age became a pupil of Robert Sabine. At that time the most important branch of the electrical industry was telegraphy, and as a result Mr. Gatehouse was soon associated with Sir Charles Wheatstone and Sir Samuel Canning, an association which led to an intimate friendship with many of the leaders of the cable manufacturing industry. He also early turned his attention to the development of electric lighting and was assisted in the lighting of Victoria Embankment with the Jabockhoff candle, for which lamp he devised an important improvement, and with the early lighting of Aldersgate Street Station with arc lamps.

In 1881 he became associated, as editor, with Mr. H. Alabaster and Mr. H. R. Kempe in the production of the "Telegraphic Journal and Electrical Review." During the 40 years of his connection with the paper, Mr. Gatehouse witnessed great developments in the electrical industry, the period including the advance from dynamos of the toy variety, which fed one arc lamp, to the 30 000 kW turbo-generator, from the primitive battery bus to the 1 000-h.p. electric train and from tentative meanderings in the demesne of wireless telegraphy to the opening of a world-wide intercommunication by this means.

No account of Mr. Gatehouse's life would be complete without some reference to his hobby. Perhaps wisely for a man of hi large interests he chose the all-absorbing pastime of music, and fron his early youth studied the practice of the violin so assiduously that he became an amateur of a very high class. As long ago as 1885 he was one of the founders of the Electro-Harmonic Society, which, from very small beginnings, has now reached a membership of 600. The appreciation of the electrical profession and industry of this work was indicated at the 21st anniversary of the Society in 1896 when a presentation was made to Mr. Gatehouse as well as to Mr. Alabaster and Mr. Izard of handsome silver bowls as a token of gratitude and esteem of the members.

Apart from journalism he assisted the electrical industry as juror at various exhibitions, including the Milan Exhibition of 1906. He was a member of the Executive Committee of the Electrical Trades' Benevolent Institution, a past master of the School Board of the London Lodge of Freemasons and a supporter of other charitable institutions. He was a member of the Institutions of Electrical and Mechanical Engineers, a Fellow of the Royal Society of Edinburgh and an Associate Member of the Institution of Civil Engineers.

Electricity Supply in West Lancashire.

Mr. F. C. Wilson, chairman of the LIVERPOOL Tramways and Electric Power and Lighting Committee has made an important statement on the present position of electricity supply in the Mersey and West Lancashire Electricity district, in the course of which he replies to recent criticism of the proposal to form a Joint Authority for the District.

OVERLOADED STATIONS.

Mr. Wilson points out that in every area in the district the demand for electricity has overtaken the resources of the electricity authority, and in order to enable the various authorities to carry out their statutory obligations, it is imperative that fresh plant for the generation of electricity should be installed. The cost of installing the plant required to meet the estimated demand in 1925 will amount to £3 600 000, and the question with which the supply authorities in the district are confronted is whether it is preferable that this money should be expended in installing generating plant in the existing stations or in the provision of a large super-generating station, which would be able, with the assistance of the more modern plant in the district, to supply the whole of the Merseyside and West Lancashire area at a cost considerably less than the cost at which electricity can be supplied from the existing stations.

SELECT COMMITTEE'S REPORT.

He recalls the fact that in 1917 the Government appointed a Select Committee to investigate the whole question of the supply of electric power in the country, and that the committee, after months of consideration, and after hearing a large number of witnesses, representing all classes of interests concerned, arrived unanimously at certain conclusions. In effect it was found that the present system of generating electricity in a number of comparatively small stations by separate electricity authorities was obsolete, and the establishment of capital generating stations for the generation of electricity on a comprehensive scale was recommended. If they accepted the findings of that committee they must come to the conclusion that the money which was now to be expended in providing plant should not be expended in perpetuating an out-of-date system, but the money must be spent in the way in which it would be most beneficial to the community. Their scheme did not involve the scrapping of all existing generating plant in the district, but it proposed to utilise to the uttermost all the modern economical plant available.

The scheme would provide a cheap and abundant supply of electric power, and the carrying out of it would be attended with untold benefits to that highly industrialised area. There was no area in the country more suitable for the promotion of such a scheme than the Mersey-side and West Lancashire area, and he thought they would have been failing in their duty to the public if they had not risen to the requirements of the case and put forward a scheme for the constitution of a joint electricity authority.

After quoting from the Select Committee's report, Mr. Wilson points out that the scheme had the support of the Mersey Docks and Harbour Board and other important bodies and associations representing trading interests, and he believes that if the scheme goes through a new period of increased prosperity in the district will be inaugurated, bringing in its train not only benefits to the commercial community, but also giving employment to the large industrial population inhabiting the area.

Imitation Homes.

The furnishing and equipment of a small house as it affects the worker was the subject of a lecture delivered to the Ipswich branch of the Workers' Educational Association by Mr. H. P. Shapland, A.R.I.B.A. According to a report given in "The Cabinet Maker and Complete House Furnisher," Mr. SHAPLAND said that he did not propose to apologise for insisting on practical details rather than on the aesthetic side of the question. Unless they turned their attention to the problems of diminishing housework and increasing leisure both the time and inclination to consider how the home might be beautified would be lacking. While quite a number of housewives took a pride and pleasure in burnishing and polishing all their household belongings, often they could not shut their eyes to the fact that in such a household there was little time for such work. He saw no pleasure in bare, comfortless rooms, but was convinced that the majority of houses would be more comfortable, more beautiful and more easily cleaned if a considerable portion of their contents were removed and never put back again. True art was never pretentious, it was governed by a regard for the appropriate. A cottage should be furnished as a cottage, not as a miniature mansion, and the customer whose outlay on furnishing was limited to £500 should accept that limitation and confine his purchases to well-made, plain things of good quality.

Protection of Key Industries.

The following financial resolutions, which will form the basis of the projected KEY INDUSTRIES BILL, are to be moved in the House of Commons:—

RESOLUTION 1.

That for a period of five years from the passing of an Act for giving effect to this resolution there shall be charged on any of the following articles imported into Great Britain or Ireland a Customs duty of an amount equal to 33 1-3 per cent. of the value. The articles include :—

Optical glass and optical elements, whether finished or not ; microscopes, field and opera glasses ; spectroscopes and other optical instruments.

Beakers, flasks, burettes, measuring cylinders, thermometers, tubing, and other scientific glassware and lampblown ware ; evaporating dishes, crucibles and other laboratory porcelain.

Galvanometers, pyrometers, electroscopes, barometers, analytical and other precision balances and other scientific instruments ; gauges and measuring instruments of precision of the types used in engineering machine shops and viewing-rooms, whether for use in such shops or rooms or not.

Wireless valves and similar rectifiers and vacuum tubes.

Ignition magnetos and permanent magnets.

Arc-lamp carbons.

Metallic tungsten, ferro-tungsten and manufactured products of metallic tungsten, and compounds (not including ores or minerals) of thorium, cerium and the other rare earth metals.

All synthetic organic chemicals (other than synthetic organic dyestuffs, colours, and colouring matters imported for use as such and organic intermediate products imported for their manufacture) ; analytical reagents ; all other fine chemicals and chemicals manufactured by fermentation processes.

Including any articles comprised in any list which may from time to time be issued by the Board of Trade for defining the articles which are to be taken as falling under of the above general descriptions.

RESOLUTION 2.

There shall be charged on any of the following articles in addition to any other duties of Customs chargable thereon, a Customs duty of an amount equal to 33⅓ per cent. of the value of the article :—

Articles of any class or description in respect of which an order by the Board of Trade has been made under any Act of the present session for giving effect to this resolution if manufactured in whole or in part in any of the countries specified in the order or deemed to be so manufactured. Any such order may be made on the ground that articles of the class or description in question are being sold or offered for sale in the United Kingdom—

(*a*) At prices below the cost of production thereof, or (*b*) At prices which by reason of depreciation in the value in relation to sterling of the currency of the country in which the goods are manufactured are below the prices at which similar goods can be profitably manufactured in the United Kingdom.

And that by reason thereof employment in any industry in the United Kingdom is being or is likely to be seriously affected.

"Cost of production" means the current sterling equivalent of—(*a*) The wholesale price at the works charged for goods of the class or description for consumption in the country of manufacture, or (*b*) If no such goods are sold for consumption in that country, the price which, having regard to the prices charged for goods as near as may be similar when so sold or when sold for exportation to other countries, would be so charged if the goods were sold in that country.

Industrial Conditions in America.

Mr. ERNEST J. P. BENN, the Managing Director of Benn Brothers, Ltd., is sailing for America in the "Aquitania" on April 23rd for the purpose of studying industrial conditions in the United States. He will devote particular attention to the problem of the readjustment of wages in view of falling prices, and the steps which are being taken to re-establish overseas trade. His tour will embrace most of the industrial cities between New York and Kansas, and Chicago and Quebec. As Treasurer of the Industrial League, he will visit many of the Trade Organisations, both of employers and employed, and he is also provided with special facilities for examining the industrial side of the leading Universities. One of the results of the tour will be a strengthening of those relations with technical publishers in America which is so needed in view of the ever-increasing demand for industrial technological books among the whole of the English-speaking people. With the intensive cultivation of German trade, which may be looked for in view of the financial situation of middle Europe, there is a greater need than ever for the exchange of ideas and co-operation between the English-speaking nations. Mr. Benn, as the Managing Director of the largest technical publishing house on this side of the Atlantic, will undoubtedly be able to help along this movement.

The State Electrical Department of URUGUAY recently received 19 tenders (varying from $175 000 to $456 000, Uruguayan gold), from foreign firms for the supply of a 10 000 kW turbo-generator. These figures at pre-war rate of exchange, are equivalent to about £37 100 and £96 900 respectively.

Electricity Companies' Officers.

The annual meeting of the Association of Officers and Staff Members of Electricity (Power and Supply) Companies of Gt. Britain was held on Monday, Sir A. B. W. Kennedy presiding. The annual report of the Executive Committee stated that there was little requiring their attention during 1920. Towards the end of the year the Electricity Commissioners began their enquiries into schemes for the formation of Joint Electricity Authorities and the Committee took action to safeguard the interests of members in connection with schemes for superannuation, &c. The Committee have pressed for uniformity throughout the country of any such schemes, and for terms not less favourable than those applicable to the Civil Service. When the enquiries are completed, and the formation of Joint Electricity Authorities takes place, conditions will, it is stated, necessarily arise in which the interests of members may be jeopardised, and the Committee will take steps to secure the protection afforded by Sec. 16 of the Act. of 1919.

Sir Alexander Kennedy moved the adoption of the Association's new constitution which provides (*inter alia*) that the abbreviated title shall be "The A.O.E.C.," that the object of the Association is to protect the interests of its members in connection with any proposals affecting the industry; that membership be confined to officers and staff members of power and supply companies of ten years' service and over; and the annual subscription shall be one guinea; that a President, Vice-Presidents, Auditors, Hon. Treasurer and Hon. Secretary shall be elected annually. The executive committee is to consist of not less than six and not more than 12 members, in addition to the Hon. Secretary and Hon. Treasurer, and four shall retire annually.

Mr. Charles Ellis seconded the motion, which was carried unanimously. The President, Vice-Presidents, Executive Council, Auditors, Hon. Secretary and Hon. Treasurer were re-elected.

As a token of appreciation of the work done for the Association, the Hon. Secretary (Mr. O. M. Andrews) was presented with a music cabinet and an inscribed silver cigarette box. In acknowledging the presentation, Mr. Andrews said he appreciated the gifts more as a token of the members' kindness than for their intrinsic value. He also urged members to get as many of their colleagues as possible to join. The work of an Association like that did not end with getting a clause in an Act. The testing time would come when all those Joint Electricity Authorities which were being inquired into actually took shape; there would then be an amalgamation of interests which had been foreseen when the Association was founded, and that would be the time when the members would be likely to be adversely affected.

Coal Crisis Regulations.

In view of the coal crisis the Board of Trade has issued directions under the Emergency Powers Act for the restriction of coal consumption and the conservation of supplies and for the use of electricity or gas. All sky signs, illuminated facias, advertisements and other lights used for advertisements shall be extinguished. Local authorities must reduce the consumption of electricity and gas for public lighting to the minimum.

Where electricity or gas is required for power, its supply and use shall be restricted so that not more than 50 per cent. of the weekly average, but the quantity may be increased where it is deemed to be in the public interest to do so. The person responsible for the management of an industry or business shall furnish to the local authority a complete return showing what quantities of electricity and gas were supplied or used for power during any period as to which information may be required.

The local authority may direct that any supply of electricity or gas, whether for light, heat, power or any other purpose, in any premises, whether industrial, domestic or of any other description, be diminished or cut off where there is reason to believe that the supply is being abused or used in excess.

Under the Emergency Regulations, the Minister of Transport, the Board of Trade and any other Department approved for the purpose, may take possession of any land, buildings or works (including works for the supply of gas, electricity or water), and any property (including plant, equipment and stores) used or intended to be used in connection therewith.

For the purpose of making the most efficient use of the materials or plant belonging to a tramway or light railway, the Minister of Transport may require the whole or any part of the rolling stock, materials and plant, including permanent way, to be placed at his disposal.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Office on receipt of published price, plus postage.]

"Continuous Wave Wireless Telegraphy." By Dr. W. H. Eccles Part I. (London: Wireless Press.) Pp. vii.+407.

"Die Berechnung Elektrischer Leitungsnetze in Theorie and Praxis." By J. Herzog and C. Feldman. (Berlin: Julius Springer.) Pp. xx.+731. Third Ed. M. 136.

"Théorie du Coup de Belier." By L. Allieir. (Paris: Dunod.) Pp. xv.+134.

"Electrical Installation Work." By J. Havelock. (London: Crosby, Lockwood & Son.) Pp. viii.+366. 15s. net.

Commercial Topics.

Trade Catalogues for Palestine.

The Controller of Government Stores, Russian Buildings, Jerusalem, desires to receive trade catalogues of any class of stores for placing in the catalogue reading room, which has been opened by his department for the convenience of the general public. Catalogues may be in English, Arabic, Hebrew or French, and should, if possible, be priced.

* * * *

Australian Tariff on Electrical Machinery.

The Tasmanian Government has succeeded in getting the Commonwealth Government to remit the Customs duties on machinery imported for the extension of the State hydro-electric scheme. It has been decided to permit, under item 174 of the tariff, the importation of all machinery which could not be reasonably manufactured in Australia. This decision will apply to the plant which the Tasmanian Government is now importing to extend its system.

* * * *

Telephone Material Required in Ceylon.

It is reported that there is a very serious shortage of telephone material in Ceylon, and in Colombo alone there are several hundreds of applications for telephones awaiting attention, and the out-stations are even worse in this respect. Of the material ordered in 1913, only a portion, including a switchboard capable of accommodating some 300 subscribers, was safely landed; the remainder being lost through the torpedoing of the steamer which was bringing them.

* * * *

Fibre Products for Canada.

H.M. Trade Commissioner at Winnipeg (Mr. L. B. Beale) has reported to the Department of Overseas Trade that a Winnipeg firm of manufacturers' agents are desirous of getting in touch with United Kingdom manufacturers of fibre products who wish to place their goods on the Canadian market, with a view to securing the representation of such firms in the Dominion on a commission basis. In connection with this enquiry Mr. Beale has forwarded a set of leaflets descriptive of the fibre goods produced by the Canadian branch of an American Company, together with a range of samples of the company's manufactures, comprising rods, sheet, tubing, discs, rings, gear and electrical parts. He has also transmitted copies of three price lists issued by the Company showing net wholesale prices f.o.b. Toronto, on January 1 last. The price lists, together with particulars of the Winnipeg firm referred to, will be furnished by the Department to United Kingdom manufacturers interested, while the samples and advertising matter may be seen at the Enquiry Room of the Department until the 26th inst., after which date they will be available for loan to manufacturers in the Provinces.

Electric Traction.

The new tramway route of the Halifax Corporation from West Vale to Stainland has been opened for traffic.

West Ham Tramways Committee proposes to purchase electric welding plant at an estimated cost of £270.

At a cost of £365 Swansea Public Health Committee is installing electric charging plant, capable of charging four vehicles.

The Bolton tramway workers have been given an increase of ¾d. per hour, or 3s. a week, in order to bring them into line with those in adjoining towns. The extra cost to the department will be £7 000 a year.

Bournemouth Corporation has introduced a revised scale of tramway fares. The alterations have taken the form of a reduction of the distances travelled for a penny and in some instances 1½d. fares have been introduced.

At midnight on Saturday last the Corporations of Middlesbrough, Stockton and Thornaby took over the Tees-side undertakings of the Imperial Tramways Company. Fares have been adjusted and new arrangements made in regard to workmen's tickets.

In a recent communication to the Stretford Urban Council the Ministry of Transport states that experience has shown that the life of a tramway track does not normally exceed fifteen to twenty years, and loans in respect thereof should generally be repayable in such period.

A report on the arrangements necessary while the local tramways are being converted to electric traction has been presented to the Edinburgh Tramways Committee by the tramways manager, Mr. R. S. Pilcher. The order in which the various routes are to be converted is set out, and it is estimated that the cost of electrifying all the routes and projected extensions will be £825 195.

Good progress appears to have been made in introducing electric traction on French railways. According to the "Railway Gazette," the Midi Company, which is operating about 93 miles of double-track electric line, is converting a further 1 300 miles of line and has placed orders for 50 new electric locomotives of the type used by the Chicago, Milwaukee & St. Paul Railroad. The reconstruction of two hydro-electric plants, which will furnish 150 000 h.p. each to the railway, is nearing completion. Sections of the Orleans and P.L.M. lines are also being electrified, in each case 1 860 miles having been taken in hand. Electric power for the Orleans will be furnished by the waterfalls on the Upper Dordogne and for the P.L.M. by the falls of the French Alps. The cost of electrifying these railways is estimated at 5 000 000 000 fr., the saving in coal will exceed 3 000 000 tons per annum, which, assuming the coal to be above or equal to 100 fr. per ton, will more than pay the interest on the electrification bonds issued.

Electricity Supply.

Southend Corporation has authorised the laying of additional feeders, and services at a cost of £3 350.

Great Grimsby Electricity Committee recommends an expenditure of £41 000 on extensions at the electricity works.

Taunton Corporation has applied for sanction to a loan of £1 000 for meters for 200 new houses which are being built.

Worcester Corporation has decided to adopt electric lighting for 150 new municipal houses.

Mansfield Council has increased the charge for electricity to 10d. per unit. The pre-war rate was 4d. per unit.

Bedford Corporation is able to reduce the charge for electric current for lighting and power by a halfpenny per unit.

Carlisle Electricity Committee has instructed the Electrical Engineer (Mr. C. W. Salt) to report on the cost of the proposed new electricity station.

Edinburgh Electricity Committee has been authorised to accept tenders for the erection of a sub-station at Cowgate at an estimated cost of £10,000.

In order to be able to supply electricity in Belper and Heage the Derbyshire and Nottinghamshire Electric Power Company has applied for a special order to the Electricity Commissioners.

Aylesbury Corporation has received sanction to a loan of £6 074 for the supply of electricity to the new houses which are being erected under the Council's housing scheme.

Stepney (London) Borough Council has taken up a loan of £25 000 for the electricity undertaking from the Hearts of Oak Benefit Society at 7 per cent. per annum, repayable within 20 years.

The Stalybridge, Hyde, Mossley and Dukinfield Joint Electricity Board have made a slight reduction in the cost of electrical current supplied to mills and other large consumers, and it is hoped to make a further reduction shortly.

Blackpool General Purposes Committee have rejected a recommendation to increase the salaries of heads of departments, including Mr. Chas. Furness, electrical engineer and the tramway manager, to £1 500 per annum, as it was felt that the present was an inopportune time to grant increases.

Accrington Corporation recently applied for sanction to borrow large sums of money for extensions of the electricity works, but on the advice of the Electricity Commissioners Blackburn Corporation is to be approached to see if a supply in bulk can be obtained on the completion of the whitekirk generating station.

Maidstone Corporation has increased the salary of the Electrical Engineer (Mr. E. E. Hoadley) from £791 to £835 per annum, the scale of the Associated Municipal Electrical Engineers. The Corporation proposes to extend and reorganise the supply mains in the Postley-road district at a cost of £1 543.

Islington (London) Borough Council has made a further increase in the price of electrical energy as follows: Units at 1d. or under, a further increase of 30 per cent., making 150 per cent. over pre-war prices; units above 1d. a further increase of 30 per cent., making 100 per cent.

Notice is given by the Electricity Commissioners that the date for making representations regarding the delimitation of the South-West Midlands Electricity District and for submitting schemes for the better organisation of electricity supply has been extended until the 30th June. The date for the East Midlands Electricity District has also been extended to July 30.

Proposals are under discussion for taking over the Queen's Ferry generating station by Chester Corporation and by Hawarden Urban Council from the War Office, and for the supply of electricity in bulk to Chester and in the industrial Deeside area between the city and Connah's Quay. The terms of the War Office include an agreement for two years, subject to twelve months' notice on either side, and all expenditure necessary to make the supply available must be borne by the local authorities. The cost of generating electricity has been estimated at 1.88d. per unit. Hawarden Council have applied for an extension of the area covered by their Provisional Order of 1914, and there is a prospect of co-operation between the Chester and Hawarden authorities in working the scheme.

An enquiry was held at Woking last week into the application of the Woking Electric Supply Company for authority to increase the maximum price of electric current from 9d. to 1s. 2d. per unit. In support of the application the secretary (Mr. E. G. Nicholson) said the cost of generation and distribution had increased greatly since 1914. This year the cost of coal per unit would be 1·73d., compared with 0·875d. in 1914. Oil, rates and insurances had all increased, and the installation of new plant would increase the item. The total cost per unit sold in 1914 was 2·617d., in 1920 3·075d., and in 1921 it would be 3·8d. The margin of receipts over expenditure in 1914 was 1·973d.; in 1920 it fell to 1·375d., and in 1921 it would be 0·870d. There had been a distinct falling off in output since last autumn. Since the beginning of the current year there had been a decrease of over 60,000 units in output. The average ordinary dividend paid since the inception of the company was 2¾ per cent. The company had always had power to charge up to 8d., but for many years only 6d. was charged. Under the temporary increased charges the maximum was raised to 9d., which they were now charging. Though they were now asking for a maximum of 1s. 2d. a unit they only intended to charge 10d. They merely desired the power to make a further increase in case of emergency.

Imperial and Foreign Notes.

A fire occurred recently at the Nhill (Victoria) electricity works, the plant being totally destroyed.

Port Cygnet (Tasmania) Council has decided to put down a steam-driven electric generating plant.

The annual report of the Ipswich Electric Supply Company (Queensland) shows a profit of £1 320.

Echuca (Victoria) Council has engaged Mr. G. W. Stewart to report on an electric supply scheme for the town.

A loan of £60 000 is to be raised for the erection of electric power transmission lines at Springs-Ellesmere (N. Z.).

Picton (N.S.W.) Council has decided to erect an electric supply station. It is hoped to supply energy at 11d. per unit.

Stawell (Victoria) Council has adopted a scheme of electric supply. The estimated cost of the plant and equipment is £14 300.

Benalla (Victoria) Shire Council has adopted a scheme of electric supply estimated to cost £12 525, and prepared by Messrs. Christie & Gardiner.

Auckland (N. Z.) City Council has been authorised to borrow £500 000 for extensions to the city electricity works and the erection of electric lines at Waiwera.

At the lead sulphate works established at Launceston last year, mainly in consequence of the cheap supply of electrical energy from the Tasmanian Government hydro-electric undertaking, an experiment was made recently in the production of metallic lead from Galena. The electric furnace used will not be adequate for the production of the metal on a large scale, but the manager of the works (Mr. Jas. Gitsham) states that the Galena can be treated by the electrical process at a cost of £3 per ton, whereas if it were sent to the mainland to be treated the cost would be about £11 a ton.

Reports on the Development of Hydro-electric Supply and the introduction of electric traction on the Government railway have been presented to the Jamaican Legislative Council, and will, it is stated, be considered this year. The first report is by Mr. H. Howard Humphreys, who estimates the cost of the hydro-electric works at £420 000; and the second by Messrs. Preece, Cardew and Rider, who recommend that, in the first instance, three power stations of 7 280 kW each should be erected. These would supply energy for industrial power and for lighting, as well as for pumping and irrigation. At present the locomotives consume about 20 000 tons of coal per annum, which costs about £145 000, and it is estimated that electric traction would mean a total saving of £162 000 a year. Messrs. Preece, Cardew & Rider are convinced that the rivers investigated will give sufficient power to operate the railways and leave a considerable margin for industrial power and lighting.

Marconi's Wireless Telegraph Company has increased the Rates for Press Telegrams to and from New York to 3½d. a word.

The United States Department of Commerce announces that the erection will shortly be begun of a Wireless Station at Shanghai by the American Federal Telegraph Company, and it is anticipated that the work will be completed within 18 months. It is also proposed to establish additional stations at Peking, Kharbin and Canton.

By agreement with the Peruvian Government, Marconi's Wireless Telegraph Company will take over on May 1 and operate for 25 years the Postal, Telegraphic and Wireless services of Peru, receiving as remuneration 5 per cent. of the gross receipts and 50 per cent. of the annual profits. Sir William Slingo, late Engineer-in-Chief of the British Post Office, who was commissioned by the Company to examine the Peruvian postal and telegraph situation, has accepted the position of Chief of the Department on behalf of the Marconi Company.

In Peru there are 9 000 miles of telegraph communications, some at a height of 16 000 ft., notably where crossings are made of the Andes, and of the 42 000 000 odd words telegraphed annually a considerable percentage has consisted in the past of traffic for Government Departments, which has been handled without payment. The concession includes the exclusive operation of all international wireless telegraph stations within the republic, the exclusive right to erect any further wireless station that the Company may think necessary and also the exclusive usufruct in all Peruvian telephone services, except the few local ones already existing. It is believed that the modernisation of the Peruvian Posts and Telegraphs and their operation by a commercial company will lead to a remunerative business, and that with the wider use of wireless telegraphy an immense increase in traffic will be recorded;

Institution Notes.

The Annual General Meeting of the Electrical Trades Benevolent Institution will be held at 2.30 p.m. on Monday, April 25th, at the offices of the Cable Makers' Association, Sardinia House, Sardinia Street, London, W.C.2, to receive the report of the Committee of Management, and to pass the accounts and balance sheet. A proposed alteration in the rules will also be discussed.

The Autumn Meeting of the Institute of Metals will be held in Birmingham from September 21 to 23, this being the first time since the formation of the Institute since 1908 that a return visit has been paid to a provincial city. The arrangements are in the hands of a committee of which Dr. H. W. Brownsdon is chairman, and the programme will include a reception by the Lord Mayor of Birmingham, visits to the University, works and other places of interest in the neighbourhood.

Miscellaneous.

Volunteers may be required for running small petrol-electric lighting sets. Those interested, and with the necessary experience, should apply to Mr. H. K. Reed, 46, Regency-street, London, S.W.

The memorial to the late Lord Rayleigh, F.R.S., which is being promoted by a committee of Fellows of the Royal Society and members of the University of Cambridge, will take the form of a plaque containing a medallion in Westminster Abbey. Up to present between £1 400 and £1 500 has been subscribed. The medallion will bear the head in profile of Lord Rayleigh, together with a suitable inscription.

A meeting has just been held at the works of Messrs. Waygood-Otis, Ltd., Falmouth-road, London, S.E., to wind up a fund started in the early days of the war, to provide assistance for employees and their families. The money raised by collections in the offices and works reached £1 014, which, with interest on investments, allowed of a distribution of £1 097 13s. Assistance was given to wounded men and to widows and orphans of those who fell in the war. The expenses of administration were only £2 1s. 4d. for postage, the whole of the work having been done voluntarily by the committee.

It is announced that the P.O. authorities will make an experiment in London next year with automatic switching. An additional exchange will be opened in the City, to which 3,000 new subscribers will be attached, and if the experiment proves successful it will be extended to all existing exchanges. Since 1914 automatic exchanges have been in operation at Epsom, Leeds, Portsmouth and Newport (Mon.), but the London experiment will be made on the Western Electric Company's system.

In Bulletin No. 3 of the Sixth International Printing, Paper, Stationery, &c., Exhibition, which is to be held at the Royal Agricultural Hall, London, from April 30 to May 14 inclusive, we notice that an electromagnetic reel brake will be exhibited by Messrs. Witton-James, Ltd., of Hendon. This appliance forms a synchronous interlock between the press-driving equipment and the reel, controlling the latter automatically and preventing it from overrunning. The Company also supplies electrical power plant and control apparatus for jobbing presses, stereo and other plant.

Last week conferences on wages took place between representatives of the Shipbuilding Employers' Federation and the Federation of Engineering and Shipbuilding Trades. On the first day the question under consideration was the notice given by the employers of the discontinuance of the special advances granted to piece-workers during the war. The conference was, however, adjourned for a fortnight to enable the workmen's representatives to review the serious situation with which the industry is faced. The men consider the reductions range from 40 to 60 per cent., but the employers contend that they only amount to from 16 to 20 per cent. On the 1st inst. there was a conference with the time-working trades, when a reduction of wages was also discussed. The men have now appealed to the Minister of Labour to set upon Inquiry Tribunal to investigate the matter.

The annual report of the Industrial League and Council is a record of useful work and of expanding activities. During the past twelve months all the great manufacturing centres in the United Kingdom were visited by representatives of the organisation. Active branches are in operation in Manchester, Leeds, Birmingham, Deptford, Eastbourne and Southwark, and committees are being formed in Leicester, Bristol, Portsmouth, Coventry, Glasgow, Hartlepool, Blackburn, Walsall, Halifax, Bedford and other places. The number of meetings held run into four figures, and a great variety of trade and industrial organisations have appealed to the League to provide lecturers on industrial subjects. At fifteen conferences of a national character the attendance included 700 employers, 60 employers' associations, 800 trade unionists, and 460 delegates from trade unions, representing a membership of one and a half millions. It is to be hoped that the Industrial League will be able to carry its work still further and will receive a steadily increasing volume of financial and active support.

The new telephone rates came into operation on the 1st inst., when about 2,000 past subscribers in London were affected. On various dates between now and the end of June the notices to terminate existing agreements will expire, and subscribers within the metropolitan area, numbering about 180,000, will have to decide whether they will cease to make use of the service or will continue on the new scale of charges. In future subscribers will pay a quarterly subscription of £2 2s. 6d. if their premises are within two miles of an exchange, and a fee of 1½d. for each local call. The late Postmaster-General, Mr. A. Illingworth, has admitted that the purpose of the new charges is to raise additional revenue. In order to raise the revenue required to meet expenses in 1921-22, an all-round increase of 67 per cent. would be needed, and if this principle were adopted more than half the existing subscribers would incur a heavier charge than that to which they will be liable under the new tariff. It is reported that up to the present few intimations of discontinuance have been given, and the number seems likely to be more than counterbalanced by fresh applications.

Bankruptcies.

The first meeting of creditors of Leslie Philip Howse and Geo. Harry Bertram Snell, electrical engineers, 6 and 8, Duke-street, Margate, will take place to-day (April 8), at 68a, Castle-street, Canterbury and the public examination on April 30, at the Guildhall, Canterbury.

A receiving order has been made against Robt. Chas. Jones,, lately trading as Elect-Ma Engineering Company, 10, Caledonia-street, King's Cross, London, N. The first meeting of creditors will take place on April 13, and the public examination on June 3, both at Bankruptcy-buildings, London, W.C.

Business Items, &c.

The offices of the Oxford Technical Publications have been removed to 1 and 2, Bedford-street, Strand, London, W.C.2. Telegrams: "Oxymoron, Westrand, London"; Telephone, Gerrard 4314.

The Sheffield branch office of Messrs. Herbert Morris, Ltd., has been removed to Montgomery-chambers, Hartshead, Sheffield. The telegraphic address remains "Comorris Sheffield," and the telephone number is 2400 Central. In their new offices the branch will be able to offer better service in the settlement of material handling problems.

Messrs. Alfred Herbert, Ltd., Coventry, announce that their tool-room has been kept on full time throughout the depression, being engaged on the manufacture of special tools, jigs and fixtures. Arrangements have been made whereby it will be possible for the firm to undertake such work on behalf of outside firms and where customers have drawings prepared they are in a position to quote short deliveries.

Messrs. Handcock & Dykes, consulting engineers, 11, Victoria-street, Westminster, S.W.1, announce that Mr. H. W. Handcock, who has for several years past taken little active part in the work of the firm, retired on March 31, thus terminating a partnership of over 27 years. The firm will be carried on as hitherto under the old name by Mr. A. H, Dykes, assisted by Engineer-Lieutenant W. T. Townend, R.N.. and the existing staff.

The Bilbao Works of the Spanish Company, which was formed about two years ago by Messrs. Babcock & Wilcox, Ltd., have now been completed to the designs of Sir James Kemnal, managing director of the parent company. Recently the King of Spain granted a private audience to Sir James, in order to obtain direct information concerning the new addition to the engineering resources of the country. His Majesty expressed great satisfaction at the rapid progress made in the completion of the works and on being able to count upon British technical advice and direction in such an important engineering enterprise.

Catalogues, Price Lists, &c.

A leaflet relating to Geekoduct Conduits and porcelain connecting blocks has been issued by the General Electric Company, Ltd.

We have received from the Metropolitan Vickers Electrical Company, Ltd., an artistic calendar consisting of monthly tear-off slips for 12 months from April 1, and surmounted by an attractive picture of a beautiful young lady.

The 1921 catalogue of tools recently issued by the Globe Pneumatic Engineering Company, 1, Victoria-street, Westminster, S.W.1, is a comprehensive publication, relating to tools and appliances operated by compressed air, which are being used in engineering operations. The catalogue, which consists of about 80 pages, is well illustrated, and an index facilitates reference.

A well-illustrated pamphlet of over 50 pages has been issued by the English Electric Company, Ltd., Queen's House, Kingsway, London, W.C., on their steam turbines. As our readers know, this Company controls and operates the Dick-Kerr, the Siemens, the Phœnix Dynamo and the Willans works, and from the point of view of equipment and experience they are in a position to meet all possible requirements in turbines and electrical machinery. The Company can supply either impulse or reaction types of turbine, and the present pamphlet commences with a short discussion of the principles of both types. This is followed by a general description of the design and construction of various types of machine. The pamphlet is nicely printed, and contains diagrams and sectional views, together with examples of standard machines supplied to electricity undertakings. A table of approximate dimensions and weights of standard sets is given, together with an enlarged and coloured view of the arrangement plan and elevation of a 20 000-kW power station which the Company is equipping for a municipality in this country. The station contains two 10 000-kW 1 500-r.p.m. turbo-alternator units, and is designed to work in parallel with a small existing station. The pamphlet also includes a long list of generating sets ranging from 18 750 kW downwards, supplied by the Company to various electricity works and industrial firms in this country, the British Dominions and foreign countries.

Personal and Appointments.

Mr. Walter Rutherford, whose resignation as joint managing director of the English Electric Company, Ltd., was recently announced, has been elected a director of the Calcutta Tramways Company, Ltd.

Important changes in the Government are announced, including the resignation of the position of Postmaster-General by Mr. A. Illingworth, who is succeeded by Mr. F. G. Kellaway, M.P. Mr. Stanley Baldwin, M.P., becomes President of the Board of Trade; Sir A. Mond, Bart., M.P., becomes Minister of Health, and is succeeded by the Earl of Crawford and Balcarres as First Commissioner of Works. Sir P. Lloyd-Greame, K.B.E., M.P., is to be Director of the Overseas Trade Department.

The Guernsey Telephone Council have appointed Mr. Ernest Henry Bennett, manager of the States Telephone Department, in place of the late Mr. R. McLean. Mr. Bennett has had 20 years' experience in telephone engineering. He was apprenticed to his uncle, Mr. A. R. Bennett the States Telephone Department's Engineer-in-Chief, and subsequently had three years with the Portsmouth Corporation Telephone Department as Inside Inspector, and then three years with the Brighton Corporation Telephone epartment as Test Room Inspector. Subsequently he was five years with the Post Office, and for the last seven years he has been Engineer to the Oriental Telephone Company at Singapore.

Tenders Invited and Accepted.

The municipality of Pretoria invite tenders for the supply and erection of switchgear. Tenders to Deputy Town Clerk, Municipal Offices, Pretoria, by 4.30 p.m., May 10.

The Commissioners of H.M. Works, &c., require tenders by April 12 for the supply of electrical accessories. Forms of tender, from the Controller of Supplies, King Charles-street, Westminster, S.W.1.

London County Council requires tenders by April 18 for about 5 500 tons of standard steel girder tram rails, lipless track rails and guard rails, &c. Form of tender from the Chief Engineer, County Hall, Spring Gardens, S.W.1.

The time for tendering for the telephone switchboards required by the Postmaster General's Department, Melbourne, (Schedule No. 1 670) has been extended from 19th April to 31st May. Specifications can be seen at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

The Victorian Government Railways invite tenders for the supply and delivery of 12 miles of 2-core, lead-sheathed, wire-armoured 2 200 V. cable (section of each core, 0·015 square in.). Tenders to the Victorian Railway Commissioners, Spencer-street, Melbourne, by May 4. Local representation is essential. Specification at the Department of Overseas Trade, 35, Old Queen-street (Room 59), S.W.1.

Tenders are invited for the supply and installation of the machinery for the electric power station for the low districts of the South Zone of the Argentine Federal Capital. Conditions may be seen in the Technical Director's office, Calle Charcas 1 840, Buenos Aires. Tenders to the secretary of the Direction General of Sanitary Works, Buenos Aires, June 3.

Belfast Corporation invite tenders for the manufacture and erection at the new Harbour power station of extra-high pressure and low pressure switchgear. Specifications from the consulting engineers, Messrs. Preece, Cardew & Rider, 8, Queen Anne's Gate, Westminster, S.W.1., or the city electrical engineer, Mr. T. W. Bloxam. Tenders to the Town Clerk's Office, City Hall, Belfast, by April 25.

In regard to the tenders required by the Victorian Government Railways for 12 miles of two-core lead-sheathed, wire armoured 2 200-V cable, H.M. Senior Trade Commissioner in Australia states that the Department is prepared to give consideration to alternative offers for cable with the section of each core 0·0145 sq. in. in lieu of 0·015 as originally specified. Tenders to the Victorian Railway Commissioners, Spencer-street, Melbourne, by May 4. Specifications are available at the Department of Overseas Trade, 35, Old Queen-street, S.W. 1.

Tenders are invited in connection with the electrification of the Cape Town–Simonstown and Durban–Pietermaritzburg Railways, for the supply of turbo-alternators, boilers, condensing plant, passenger and freight locomotives, motor coaches and underframes, motor bogies, electrical equipment of coaches, sub-station equipment and transformers. Specifications and forms of tender from the High Commissioner for the Union of South Africa, or the General Manager, Johannesburg. Further technical information can be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1. Tenders to the High Commissioner by May 3.

Tenders are also invited for the overhead equipment of permanent way and overhead transmission lines, switchgear and accessories and track bonds. Specifications and forms of tender from the High Commissioner, Trafalgar-square, London, W.C., or from the General Manager, Johannesburg, and further technical information may be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, S.W.1. Tenders to the High Commissioner by June 22.

London County Council has accepted the tender of the Commercial Telephone and Electrical Company, Ltd. (lowest tender received) at £356 10s. 0d. for wiring the Bethnal Green Weights and Measures Office and Coroner's Court. Thirty-two tenders were received, the amount of the highest being £946.

We learn from the "Manchester Guardian" Commercial Supplement that Auckland (N.Z.) Council has accepted the following tenders: British General Electric Company, generating plant, £94 000; British Thomson-Houston Company, remainder of machinery, £77 000; Babcock & Wilcox, boilers, £81 000.

Sydney (N.S.W.) Council has placed a contract with Messrs. Babcock & Wilcox for four boilers at actual cost, plus 15 per cent. The estimated cost (including the 15 per cent.) is £235 356, but for every ¼d. per hour increase in the basic wage, an addition will be made of 1 per cent. to the portion of the contract to which the increase applied. For increases in rates of material, freight, &c., an addition will be made representing the extra cost involved.

Stepney (London) Borough Council recently invited offers for the annual supply of cable, but only the following three firms submitted complete tenders:—W. T. Henley's Telegraph Works Company, £28 406; Siemens Bros. & Company, £29 629; Callender's Cable & Construction Company, £30 580. The tender of the Hackbridge Cable Company was informal, and those of the Mackintosh Cable Company and Western Electric Company and W. T. Glover & Company were incomplete. The British Insulated & Helsby Cables and the Enfield Ediswan Cable Works did not submit tenders; while the Pirelli-General Cable Works, St. Helen's Cable Company and the India Rubber, Gutta Percha & Telegraph Works Company were unable to tender. The contract has been secured by W. T. Henley's Company.

Companies' Reports, &c.

The Submarine Cables Trust gives notice that the coupon due on the 15th inst. will be paid by Messrs. Glyn, Mills & Company, 67, Lombard street, E.C.

The Mond Nickel Company, Ltd., is making an issue of £1 300 000 eight per cent. mortgage debenture at £98 per cent. Of the total amount £500 000 is to be offered to the holders of the 500 000 6 per cent. redeemable debenture stock in exchange for their present holdings.

The directors of the Isle of Wight Electric Light and Power Company, Ltd., have declared a dividend of five per cent. on the preference shares for the year ended April 30, 1918. A sum of £2 500 has been placed to reserve, £5 000 to renewal fund, and £558 carried forward.

For the quarter ended March 31, the Anglo-American Telegraph Company, Ltd. has declared an interim dividend of fifteen shillings per cent. on the ordinary and £1 10s. per cent. on the preferred stock, less tax.

The following companies will be struck off the Register of Joint Stock Companies unless cause to the contrary is shown before June 18. A. B. Vibro & Domestic Electrics, Derby Day & Night Sign Company, Feltham & District Electric Lighting Company, Snyder Electric Furnace Company, Wholesale Battery Company.

The 1920 accounts of the Llanelly & District Electric Lighting & Traction Company, Ltd., show a balance of £15 975. After providing for debenture charges and placing £2 500 to general reserve and renewals account, the board recommend a dividend of 7 per cent. for the year on the ordinary shares, carrying forward £1 341.

The profit of the Tyneside Electrical Development Company, Ltd, for the year ended Jan. 31 is £3 534, and with £849 brought in the total is £4 383. A further dividend at rate of 6 per cent. per annum on preferred ordinary shares, making 6 per cent. for year, is recommended, carrying forward £1 383. No return has been received on the company's investment in the Tyne Electric Steel Foundries, Ltd. Owing to the general fall in values of investments, the directors do not recommend any dividend on the deferred ordinary shares.

During 1920 the Bromley (Kent) Electric Light and Power Company, Ltd., report that the connections increased from 5 111 to 5 479 kW. The year's gross profit was £12 611 compared with £10 479 in the previous year; and after payment of debenture interest and trustees' fees, &c. (£3 012) and adding £1 446, brought forward the balance is £11 045. The directors recommend payment of a dividend at the rate of 6 per cent. for the year; that £1 230 10s. be placed to renewal reserve and £4 000 to general reserve, leaving £1 314 10s. 4d. to be carried forward to the next account.

At the recent meeting of the Newmarket Electric Light Company, Ltd., it was reported that during the past year the equivalent of 3 241 33-W lamps had been connected, making the total connections 38 933. The gross profit was £2 953 agaist £2 351. Deducting debenture interest (£710), and adding £303 brought forward, the balance was £2 546. The directors recommended a dividend of 3 per cent., that £1 500 be carried to reserve for renewal of plant and that the balance (£249) be carried forward. The chairman (Mr. J. C. Wigham) stated that last spring they were allowed to increase the charge from 8d. to 8½d. per unit, but since an increase of 11d. per unit had been sanctioned. If they had to lay down the plant at present it would be impossible to make the Company pay under 2s. per unit; and as it was, they ought to have another 2½d. per unit to make the concern a success.

Mr. P. C. N. Peddar, who presided over the annual meeting of the East Anglian Electricity, Ltd., last week, stated that the directors proposed to pay a dividend of 9 per cent. on the ordinary shares and 18 per cent. on the workmen's shares, less tax. That was the highest dividend so far proposed on the ordinary shares, but, as the ordinary shareholders had received a 25 per cent. bonus distribution, it really represented 11¼ per cent. The accounts for the last nine months' working enabled him to prophesy that a dividend of at least 9 per cent. would be advised by the directors out of the profits of the current year. Although in more speculative concerns even large dividends might be paid, in his opinion a moderate payment, such as that proposed, was ample for a business which was building up capital assets and developing the industrial value of East Anglia. They were now supplying electricity in seven towns, and their revenue had increased year by year. Their revenue for the twelve months ending December 31 last was 50 per cent. more than for the previous year. That rapid growth of the business was conclusive evidence that the efforts of the Company in the supply of cheap electricity in rural areas had been financially successful, and were appreciated by the inhabitants. In Braintree, where they had only recently organised a supply, the Council had given their support by entering into an agreement for increased facilities. The invitations from other towns to the Company to extend its beneficent influence to them warranted a further issue of capital. The Company's assets had recently been valued by Mr. W. H. Patchell, who spoke in very satisfactory terms of the condition of their plant and machinery. The workmen's shares had been appreciated by the employes, and all the shares authorised had been applied for, and were now being purchased at a premium. In view of the increase in the Company's business and the much wider area covered, the directors had created local advisory committees, who could advise the directors regarding extensions and alterations required for improved service. Committees had been formed for the Stour Valley and Gipping Valley, while Committees for Waveney Valley and the Braintree and Witham Area were in course of formation. The Directors were inviting subscriptions for a new issue of 50 000 shares.

New Companies.

The following list is compiled from information supplied to us by Messrs. Jordan & Sons, Ltd., Company Registration Agents, Chancery-lane, London, W.C.2 : -

AQUA ELECTRIC COMPANY, LTD. (173 740).—Reg. March 17, capital £8 000 in £1 shares, to carry on business of electrical, gas and water engineers. Directors : A. S. Dorsey, A. S. Haxton and E. F. Spencer. Reg. office : 168, Regent-street, W.

COX & GODSHAW, LTD. (173 791).—Reg. March 19, capital £1 000 in £1 ord. shares, to carry on business of woodworkers, builders, painters, electrical and mechanical engineers. Directors : W. B. Carter, S. M. Cox and L. C. Godshaw. Reg. office : 12, Sussex-place, South Kensington, S.W.

GILBERT GILKES & COMPANY, LTD. (173 768).—Reg. March 18, capital £36 200 in £1 shares, to acquire and carry on business of civil, mechanical and electrical engineers. Directors : N. F. Wilson, E. Crewdson, R. W. Pennington and W. M. Harris. Reg. office : Canal Iron Works, Kendal, Westmorland.

D. O. WILLIAMS & COMPANY, LTD. (173 806).—Reg. March 21, capital £2 000 in £1 shares, to acquire and carry on business of electrical engineers, installation and general contractors. Directors : J. T. Davies and W. M. Wilson. Reg. office : High-street, Clydach, Glamorgan.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Cabinet Maker" : "Furniture Exhibition" ; "Measured Drawings of Furniture at South Kensington" ; and "American Carpet Tariff."

"Chemical Age" : "British Dyestuffs Policy" ; "French Potash Plans for England" ; and "Chemical Interests in the Key Industries Bill."

"Farm and Home" : "Legal Aspects of the Agricultural Act" ; "Mechanical Potato Lifters" ; and "International Tractor Trials."

"Fruit-Grower" : "The Consumers' Fourteen Points," by E. J. P. Benn ; "Control of the Onion Fly" ; and "Synonyms in Potato Culture."

"Gardening Illustrated" : "Camellias" ; "Some Attractive Honeysuckles" ; and "Seasonable Chrysanthemum Notes."

"The Gas World" : "Valuation of Scottish Gas Undertakings for Local Rating Purposes" ; "British Commercial Gas Association Conferences at Tunbridge Wells and Truro" ; and Presidential Address before the Southern Association of Gas Engineers and Managers, by J. Wesley Whimster.

"Hardware Trade Journal" : "Holding Work in the Bench Vice" ; "The Cost of Light Castings (II.)" ; and "Apparatus for Hedge Clearing."

Prices of Metals, Chemicals, &c.

TUESDAY, April 5.

		Price.	Inc.	Dec..
Copper—				
Best selected…………	per ton	£69 10 0	—	£1 0 0
Electro Wirebars …	,,	£73 10 0	£0 10 0	—
H.C. wire, basis ……	per lb.	0s. $11\frac{7}{16}$d.	0s. $\frac{1}{16}$d.	—
Sheet …………………	,,	1s. $0\frac{1}{2}$d.	0s. $\frac{1}{4}$d.	—
Phosphor Bronze Wire (Telephone)—				
Phosphor-bronze wire, basis ………	,,	1s. $3\frac{7}{16}$d.	0s. $\frac{1}{16}$d.	—
Brass 60/40—				
Rod, basis …………	,,	0s. $8\frac{1}{2}$d.	—	—
Sheet, basis …………	,,	1s. $1\frac{1}{2}$d.	—	—
Wire, basis …………	,,	1s. $1\frac{1}{2}$d.	—	—
Pig Iron—				
Cleveland Warrants .	per ton	£7 15 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£29 0 0	—	—
Lead Pig—				
English ……………	,,	£20 15 0	—	£0 15 0
Foreign or Colonial …	,,	£19 7 6	—	£0 17 6
Tin—				
Ingot …………………	,,	£154 5 0	—	£11 10 0
Wire, basis …………	per lb.	2s. 2d.	—	0s. $1\frac{1}{2}$d.

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £13 10s.

,, (Roll-Brimstone).—Per ton £12 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £32 10s.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. $7\frac{1}{2}$d.

Sodium Chlorate.—Per lb. 5d.

Rubber.—Para fine, 11d.; plantation 1st latex, $11\frac{3}{4}$d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co., Ltd.

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Forty Years Ago.

(THE ELECTRICIAN, APRIL 9, 1881.)

MR. W. H. PREECE.—We are glad to be able to announce that Mr. W. H. Preece, M.I.C.E., Electrician of the Post Office Telegraphs Department, has been elected a Fellow of the Royal Society.

THE ELECTRIC RAILWAY AT BERLIN.—A telegram from Berlin, dated Wednesday night, says : "The trial trip on the Electric Railway from Lichterfelde to the Central Cadet Institution was successfully performed this morning. Messrs. Siemens & Halske have accomplished a complete triumph."

THE SOCIETY OF TELEGRAPH ENGINEERS AND OF ELECTRICIANS.—Invitations have been issued by the President and Council of this Society for a conversazione in honour of Professor Helmholtz, to be held on Monday evening, April 11th, at 9 o'clock, at University College, Gower-street. The library and entrance hall will be illuminated by the electric light.

ELECTRIC LIGHT FOR SUDBURY.—Is Sudbury to have the honour of introducing the electric light to Suffolk, as a means of lighting public streets ? At a recent meeting of the Town Council a committee reported that, after making careful inquiry, they found that the lighting of the streets of the town by electricity would cost £260, as against £360 for gas. As a consequence of this the gas company, who at present charge 4s. 9d. per 1,000 ft., are thinking of reducing the price to 4s. 1d.

Arrangements for the Week.

FRIDAY, April 8th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers on "A New Registering Microphotometer," by Dr. W. J. H. Moll ; "The Examination of the Structure of Crystals in the form of Powder by Means of the Ionisation Spectrometer," by Sir William Bragg, K.B.E., F.R.S. ; and "A Balance Method of Using the Quadrant Electrometer for the Measurement of Power," by Mr. H. Parry.

SATURDAY, April 9th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. At Grand Hotel, Colmore-row, Birmingham. Paper on "The Supply of Electrical Energy in Birmingham and District," by Mr. F. Forrest.

MONDAY, April 11th

INSTITUTION OF ELECTRICAL ENGINEERS.—INFORMAL MEETING.

7 p.m. At the Chartered Institute of Patent Agents, Holborn, London, W.C. Discussion on "Some Characteristics and Applications of Multispeed A.C. Motors," opened by Mr. F. Creedy.

ROYAL SOCIETY OF ARTS.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Recent Applications of the Spectroscope and the Spectrophotometer to Science and Industry," by Dr. S. J. Lewis. (Lecture I.)

TUESDAY, April 12th.

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH WESTERN CENTRE.

7 p.m. At Engineers' Club, Albert-square, Manchester. Paper on "Some Recent Developments in Steam Turbine Practice," by Mr. K. Baumann.

INSTITUTION OF ELECTRICAL ENGINEERS. N.-MIDLAND CENTRE.

7 p.m. At the Metropole, King-street, Leeds. Paper on "Some Developments in Multi-Speed Cascade Induction Motors," by Mr. F. Creedy.

INSTITUTION OF ELECTRICAL ENGINEERS.—SCOTTISH CENTRE.

7.30 p.m. At 207, Bath-street, Glasgow. Lecture on "Wireless," by Dr. J. Erskine-Murray.

WEDNESDAY, April 13th.

INSTITUTION OF RAILWAY SIGNAL ENGINEERS.

3 p.m. At Midland Grand Hotel, London, N.W. Resumed discussion on "Some Problems of Track Circuit Lay-Out," by Mr. W. C. Acfield.

INSTITUTE OF COSTS AND WORKS ACCOUNTANTS.

7 p.m. At the Institute of Chartered Patent Agents, Holborn, London, W.C. Discussion on "The Practice of Including Interest on Capital in Costs," by Mr. D. L. Moran and Mr. R. J. H. Ryall.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

7.30 p.m. At St. Bride's Institute, Bride-lane, Fleet-street, London, E.C. 4. Paper on "Oil and Colloidal Fuel," by Mr. A. Arnold.

LIVERPOOL ENGINEERING SOCIETY.

8 p.m. At Colquitt-street, Liverpool. Lecture on "Salvage Work in Connection with the Late War," by Commodore Sir Frederick W. Young.

THURSDAY, April 14th

INSTITUTION OF ELECTRICAL ENGINEERS.

6 p.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Paper on "Magnetos for Ignition Purposes in Internal Combustion Engines," by Mr. E. A. Watson.

FRIDAY, April 15th.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.

7 p.m. At the Holborn Restaurant, London, W.C. Annual Dinner.

INSTITUTE OF METALS.—SHEFFIELD LOCAL SECTION.

7 30 p.m. At the University, St. George's-square, Sheffield. Paper on "A New Non-ferrous Electric Furnace," by Mr. H. A. Greaves.

THE ELECTRICIAN

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Notes.

Words and Deeds.

IF by the time these notes are published a settlement has been achieved in the miners' dispute it will be in spite of and not because of the speeches and writings that have been circulated during the past few days. Many of these outpourings have been fathered by those who, while expressing their intention of doing all they can to bring about agreement, have certainly not allowed their words to emphasise unduly this excellent policy. In general these pronouncements have exhibited a tactlessness which in this period of stress is greatly to be deplored. On the one hand, we have men like Mr. FRANK HODGES and Mr. ROBERT WILLIAMS stating that they are only prepared to negotiate unconditionally and openly rejoicing in the chance of depriving the nation of its food which the dispute has given them; and on the other hand, Sir FREDERICK HALL asking provocative questions in the House of Commons about matters which are not only delicate but *sub judice*, and Mr. EVAN WILLIAMS protesting that this and that suggestion for settlement is impossible. But most surprising of all are the twin views of Mr. J. H. THOMAS, pleading for peace in a well-reasoned speech at Rugby and putting his name to a "proclamation" whose contents and tone render its issue a piece of all but criminal foolishness. It is no wonder that moderate men are both anxious and disgusted at the state of things and are beginning to wonder whether either side has any real desire for peace.

About It and About.

IT would be a thankless and unprofitable task to drag our readers through the mass of assertion and contra-assertion, statistics, suggestions, rumours and contradictions which have been made public during the last few days. They only help to obscure the real points at issue: that at the present rate of wages the coal industry of this country cannot be made to pay because it can find no market for its products, and that to subsidise, control or nationalise it will only increase its essential economic weakness and bring no real solution of its difficulties. There is much to be said for a subsidy (as a temporary expedient only), for the suggested wages cuts are severe and the cost of living is still high. But any permanent assistance of this kind must be ruled out. To employ it would only encourage that lack of enterprise which follows in the wake of all State interference with trade, and would be the preliminary to similar claims from workers in other industries, many of whom are worse off than the miners. The demands for a national rate of wages and the methods suggested for making this possible are open to the same criticism. Indeed, the differences of opinion between these two schools of thought are so radical as to make settlement seem well nigh impossible. We hope, however, that a full and frank discussion with nothing kept back by either side and no secret qualifications as to what is meant by this and that statement will lead to the desired result. In the meantime those who cannot contribute usefully to this end would be well advised to resist the temptation to make inflammatory speeches and to brandish the blunderbuss of a general strike in the public's face. Neither are ways to bring peace.

The Work of the B.E.A.M.A.

PROBLEMS connected with wages are now so much in the thoughts of everyone who has to do with industry that we may be forgiven for failing to remember that trade combinations may be successfully developed without concerning themselves with that particular matter. This applies especially to employers' organisations where the co-operation of firms working with similar interests undoubtedly tends to the removal of common annoyances and the shaping of a systematic policy for the general good. Among such organisations the British Electrical and Allied Manufacturers' Association may well be placed, and, in spite of the fact that criticisms are justly levelled against some of this body's activities, a glance at the latest annual report of its Council, which will be found summarised on another page of this issue, indicates that it is doing much useful work for the industry. The two outstanding examples of this are, in our view, education and research. These are closely interconnected, and are both equally important for the proper development of the industry.

The endowment of scholarships to encourage technically trained men to fit themselves for posts on the higher staffs of engineering concerns and the support which is being given to the newly formed Electrical Research Association are therefore worthy of commendation, and not less praiseworthy is the work which has been done towards standardisation of electrical equipment and in preparing specifications dealing with its production. At the present time, when it is essential that we should make the best use possible of the knowledge existing and potential in the electrical industry and employ our material resources in the most efficient manner, the B.E.A.M.A. may rest assured of general support of electrical engineers in the work it is doing in these two fields.

A Comparison and a Distinction.

It is significant that almost all the Papers that have been read before the Institution of Electrical Engineers this session have been concerned with the important problem of how to improve the operation of the equipment we are now employing. This is equally true whether we consider Mr. K. Baumann's Paper on "Some Recent Developments in Large Steam Turbine Practice," read last week, or Sir William Noble's Paper on "The Long Distance Telephone System of the United Kingdom," two Papers which represent the meridian and the nadir of electrical enterprise. It is also true of the equatorial Papers of Mr. W. B. Woodhouse and Mr. R. O. Kapp, and it is certainly true of the Presidential address.

Steam Turbine Developments.

All the same there is an important difference between Mr. Baumann's Paper and the others which have been read. For while cable makers and turbo-alternator designers are considering whether the working stresses to which their equipment is now subjected cannot be increased with economic advantage, turbine makers are as seriously considering whether the stresses at present employed should not be reduced in view of the epidemic of accidents which has lately been occurring. As Mr. Baumann points out, the general trend of development in steam turbine practice is towards the maximum possible output at the highest possible speed, but it is equally true that if this advance can only be made by sacrificing reliability, it is not worth making. Indeed, as Mr. Chattock pointed out in the discussion, while to obtain an increase in thermal economy is very desirable, if to obtain it means reduced reliability it is not worth the price, in the broadest sense of the term, that the user would be called upon to pay. The point is so important that we regret that the time at Mr. Patchell's disposal was so fully taken up with his experiences of the ills that large turbines in America are heir to that he was left with no time to draw the moral from these failures. It would seem, however, that this must be that there is at present a limit to the size to which turbines can safely be built, and that before this limit can be much increased more attention must be paid to details of design and construction. And while on the question of morals the moral of Mr. Baumann's own Paper would seem to be contained in a table towards the end to which no reference was made in the discussion. This table shows that of the total cost of a power station with an initial capacity of 100 000 kW, and a steam consumption of 10 lbs. per kW, over 30 per cent. goes in such items as land, building, roads and railway sidings, as against 17 per cent. in the boiler house plant, 8 per cent. in the condensing plant, 8 per cent. in the alternators, 11 per cent. in transformers and switchgear, 7 per cent. in converting plant, and 9 per cent. in the turbine plant. If, therefore, we take advantage of all the economies which theory has shown to be necessary and practice has shown to be possible, there remains a very large proportion of the total cost which is still unaffected, and that cost can only be reduced by revolutionising our system of housing the plant. A Paper on this subject would, therefore, be very opportune.

International Telephony.

The Washington correspondent of "The Times" announces that he exchanged telephonic greetings from the Pan-American Union building in that city with an acquaintance in Havana and with a wireless operator in Catalina, an island in the Pacific, off Los Angeles. He also listened to Havana speaking to Catalina. The latter conversation took place over 115 miles of submarine cable between Havana and Key West, in Florida, thence over land lines connecting the chief towns of the Atlantic seaboard with New York, Chicago, Omaha, Salt Lake City, Sacramento, San Francisco, Fresno and Los Angeles, and from Los Angeles by wireless to Catalina, 29 miles from the mainland, a total distance of 5 056 miles. Had land wires, weighing 435 lb. per mile, alone been used, it is estimated that conversation could have taken place over a distance of 10 000 miles. This enormous increase in telephonic range is due, as Col. Carty, of the American Telegraph & Telephone Company, pointed out, to the development of the thermionic valve. The adoption and development of this apparatus has indeed translated speech between the Mother Country and the Dominions and between the Dominions and the Mother Country from a possibility into an occurrence which may take place any day. Combined with the other developments which we discuss in our Leading article, this apparatus is opening up a new era in telephonic practice, which can only tend to improved conditions of existence by the removal of the misunderstandings which better international inter-communication will occasion.

The Rating of Motors for Intermittent Working.

In a recent issue we called attention to some suggestions for rating motors employed on intermittent loads, especially traction motors. And it is therefore interesting to find that the recent regulations of the Association of German Engineers for the rating of intermittently-loaded electrical motors compromise between the two methods there mentioned by being based on calculations from heating and cooling curves of the exponential type. These curves endeavour to connect the continuous and intermittent ratings of a motor in such a way that it shall be possible to predict what steady load on any machine would produce the same final temperature rise as a given intermittent load. For instance, if τ_m be the maximum temperature reached at a given steady load, τ_2 the maximum temperature reached at the same load during a period a followed by a no load period b in constantly recurring cycles and of a total duration p, then the thermal-overload capacity factor p is given by the ratio τ_m/τ_2 and is expressed as a function of a, b and T, the thermal-time constant of the motor. As regards the time H for which the motor must be run at the intermittent load in order to reach the temperature τ_2 for the first time this is calculated from curves which are a function of the same function P/T for various ratios of a/P. The rules therefore seem a fairly successful attempt to introduce science into what has up to now been mainly an empirical question. But it is, of course, impossible to lay down intermittent ratings for each particular case, and the most that can be done under the best possible circumstances is to strike an average which shall apply fairly to the usual conditions of operation.

A Standard Form of Contract.

From time to time questions arise as to the most suitable form of contract to be adopted for work performed by private concerns for Government departments and municipal corporations. In the past many branches of the electrical industry have adopted certain forms of contract designed to meet this end. For instance, the Institution of Electrical Engineers has a model form of contract for the supply of electrical plant, mains and apparatus; the Cable Makers' Association has a similar form and so, also, has the B.E.A.M.A. These forms deal with all questions which are likely to arise out of the performance of contracts, such as the time of delivery, making good defective work, taking over, time and methods of payment, quantities and arbitration in case of disputes. But they, in spite of the widespreading changes which have taken place, have undergone no recent revision, and it has, therefore, occurred to the Executive Committee of the Federation of British Industries that it would be advisable if a standard type of Government and municipal contract and form of tender were adopted. With this laudable object in view a Committee of Inquiry has been appointed, with power to approach Government departments and municipalities on the subject. This Committee contains representatives of electrical and general engineers, cable manufacturers, and of the machine tool, tube, iron and steel, motor, wagon, and of over a dozen other industries.

Difficulty of the Subject.

THE subject, it will be agreed, is an important one. The attempt to prepare a uniform contract for such a variety of industries should certainly be made, but it will be almost impossible of achievement. Useful work may, however, be done in preparing model clauses for insertion in contracts for particular industries, or groups of industries. As an example of what we mean we may instance a recent Australian contract for boilers, in which there were clauses providing for a variation in the contract price, if there was an alteration in wages or in the prices of coal or in the raw materials used by the manufacturers or any of their sub-contractors. There were also provisions dealing with delays caused by strikes or lock-outs. No doubt a good many of these clauses could be standardised and applied to any contract. On the other hand each industry has its peculiarities and its trade customs which must be suitably dealt with in each particular case.

Standardisation of Customs Declarations.

NOT content, however, with the standardisation of contracts the Federation of British Industries is also tackling the question of introducing a standard form of customs declaration for use within the Empire. There can be no doubt that if a uniform declaration could be agreed upon it would mean a great economy of both time and money. A representative Committee has devoted a good deal of attention to the question of preparing a standard certificate of origin and value, and it has now approached the Comptroller General of the Department of Overseas Trade with a suggestion that there should be a conference between representatives of the Empire Customs Conference and of the Federation in order to discuss this point as well as matters affecting commercial travellers, samples, and other similar questions. Whatever the outcome may be the thanks of all trading and commercial interests are due to the Federation for the efforts they are making to expand the trade of the Empire, a problem which is becoming of greater importance every day.

The Education Estimates.

NOTWITHSTANDING the urgent need of economy in public and private affairs at the present time, education is one of the few public services upon which money, when judiciously spent, would not be wasted. It is interesting that even extreme Labour interests also take this view. Such expenditure is indeed essential to the future welfare of this country, and of the Empire as a whole. Efficiency in all branches of education must be maintained, and progress in industrial and scientific research must be encouraged. We are glad therefore to see that in this year's Estimates £216 931 is allocated for scientific investigation, compared with £211 396 in the past year. This small increase of £5 535 will, however, be probably mainly absorbed by increased salaries, and, therefore, it does not imply any additional work will be undertaken. Still, it might be worse.

False Economy.

WE regret, however, to notice that there is a serious drop in the amount allocated for scientific and industrial research—from £556 868 to £416 023—and that the special grants of £196 000 to universities and similar institutions are not to be renewed this year, though the sum reserved for universities, colleges and intermediate education in Wales is £1 446 200, an increase of £500 500 over the past year's amount. Hitherto the position of professors and teachers in universities and university colleges in regard to superannuation has been very unsatisfactory, and the inclusion of a new item of £500 000 for superannuation grants to professors and teachers in these institutions will, therefore, please all who are interested in educational progress. We hope that this increase means a genuine attempt to provide a suitable retiring allowance for a most deserving section of public servants.

Carrier Current Telephony and Telegraphy.

IN the course of our comments on the Paper which Sir WILLIAM NOBLE read recently before the Institution of Electrical Engineers we called attention to the fact that there was no stagnation in telephonic science, and that a great deal of suggestive work was being done, not only in this country but in the United States, to increase our knowledge of certain problems now awaiting a solution. There will not be wanting those who would controvert our optimism. But we would draw the attention of these and, indeed, of all our readers, optimists and pessimists alike, who are interested in electrical developments, to a Paper on "Carrier Current Telephony and Telegraphy," which was recently read before the American Institute of Electrical Engineers by Messrs. E. H. COLPITTS and O. B. BLACKWELL. The former is Assistant Chief Engineer of the Western Electric Company, and the latter Transmission Development Engineer of the American Telephone & Telegraph Company. The first part of our abstract of the Paper appears on another page of this issue.

WHAT THE SYSTEM IS.

The subject matter of the Paper is of the greatest importance to telephone men. It is one which has engaged the attention of scientists and investigators ever since the telephone was invented. Briefly stated, carrier current telephone and telegraph operation means the simultaneous transmission of several telephone and telegraph messages over one pair of wires. The ordinary telephone conversation is intelligibly transmitted by voice currents, ranging in frequency between 300 and 2 000 cycles per second. Telegraph signals usually employ frequencies sufficiently below 300 cycles per second to permit their dispatch over the same wires as the telephone, without disturbance, well-known means being provided at the sending and receiving ends, to separate the two groups of frequencies into their proper channels. In these commonly used methods of communication the desired impulses or voice currents may be regarded as modulating the amplitude of a direct current supplied at the sending end.

In carrier systems, on the other hand, a source of power, having a higher frequency than those employed in the telephone range, has its output similarly modulated in magnitude by the voice or signalling frequencies. The resultant group of frequencies is then sent out over the line along with a number of similar groups. At the far end these groups are sorted out, and sent into separate receiving channels, where they are demodulated, or translated back, into the original telephone (or telegraph) frequencies. The frequency range which at present proves economically suited to carrier systems is said to lie between 3 000 and 30 000 cycles per second. The higher frequencies act as "carriers" of the lower ones; hence the name carrier current telephony, which really is a more descriptive term than multiplex telephony, a term sometimes applied to this system.

Three Outstanding Features.

The Paper gives a very clear and comprehensive outline of the origin and development of the carrier current systems, now in actual operation in the long-distance system in America. While several multiplex telephone systems of one type or another have been suggested, from time to time—and the authors give full credit to the work done by early inventors—none appears to have been put into commercial operation, until the present system came into being. The three outstanding features which make the latter a practical and workable scheme are:- The development of the three electrode thermionic tube into a dependable instrument for generating, amplifying or modulating, at will, high frequency currents; the invention of the electrical filter, which, in an efficient manner, makes possible the separation of electrical currents of different frequencies; the development of testing instruments, enabling rapid and accurate measurements to be made on lines and apparatus at ultra-audio frequencies. For it is certain that it was not until these devices had been perfected that it was practicable to introduce carrier current telephone and telegraph operation on a commerical scale. This is then another triumph for the thermionic tube, of which it may truly be said that it has revolutionised the whole art of communication, whether it be "wired" or "wireless."

The Possibilities for Long Distance Telephony.

In his inaugural address in November of last year, Mr. Ll. B. Atkinson referred to multiplex telephony as one of the problems which to-day confronts the telephone engineers of this country, and pointed out the possibilities of this system in its application to long-distance circuits, while in his Paper on "The Long Distance Telephone System of the United Kingdom," which he recently read before the Institution, Sir William Noble stated that the economical value of this system for use in the United Kingdom lay in its application to underground cables. He further stated that there are a few cases where the system could be applied economically to aerial lines, but that these were now being dealt with, and would be brought into commercial service, and linked up with the trunk system during the coming year.

Some Economic Advantages.

This is good news, for it is evident from the facts, brought out by Messrs. Colpitts & Blackwell, that the carrier current system offers many economical advantages when used in its proper field. Here, in fact, we have a system, which provides more circuit facilities without incurring the heavy expenditure of additional outside plant. By its means a two-wire circuit can be converted into a circuit capable of carrying simultaneously five telephone or one telephone messages and as many as ten duplex telegraph messages. If the line is of considerable length, carrier current repeaters must be inserted in the line at appropriate intervals. When the annual costs of carrier apparatus are less than the corresponding costs of the additional lines otherwise required between two trunk centres, it is clear that the carrier system should be adopted.

A striking illustration of the great economic value of the system is the case where the existing poles are already filled with wires to their carrying capacity and it would therefore be necessary to erect a second pole line in order to provide more circuits. The cost of the latter, particularly over long distances, would undoubtedly be greater than that of the apparatus required to utilise one or more of the existing circuits on the carrier current principle.

The Operation of the System.

So far as the operation of the system is concerned, it is interesting to note that no changes are required in the existing exchange equipment or in trunk traffic methods and that carrier current circuits can be operated and maintained by the regular telephone plant personnel. In fact, it appears that the carrier current system fits in so well with existing systems that the operators use the carrier channels indiscriminately with ordinary circuits without being conscious of the fact.

Freedom from Disturbance.

One notable feature, inherent in the carrier current system is its relative immunity against noise disturbance, caused by induction from neighbouring power circuits. The reason for this resides in the great difference in frequency involved and the means provided in the filters to exclude all undesirable frequencies. The usual precautions must of course be observed for preventing the introduction of such potentials on the telephone wires as would be dangerous to life or equipment, but residual voltages, which would cause noise on ordinary telephone lines, are diminished where carrier currents are used. The use of such high frequencies in telephone transmission would naturally give cause for anxiety as to mutual interference, *i.e.*, crosstalk, between two adjacent circuits, operated on the carrier principle since, generally speaking, crosstalk increases with the frequency. The authors give some graphic proofs, which show how this phase of the problem has been solved by means of suitable transpositions.

Points for the User.

One of the most important things to be noted, a thing which greatly concerns the telephone user, is the fact that a high grade of speech transmission is obtainable and can be maintained in carrier current operation, without serious effect on the ordinary voice current transmission over the same circuit. The signalling is done by single frequency current of 135 cycles per second, which is passed through the carrier channel just like the voice frequency currents.

It is not to be supposed that the carrier current system can in any sense replace the underground cable system, now in operation in the United Kingdom. The latter has its proper function in providing sufficient circuits for efficient operation of the long distance trunk system. It is rather to be looked upon as a supplemental means of securing additional circuit facilities in cases where economy dictates its use. In spite of the vast number of trunk cables at present in use in the United States, the carrier current system has found an extensive field of application. At the moment of writing there is, we are told, in actual use in the Bell System on a total of 3 500 miles of circuit over 19 000 miles of extra channels—telephone and telegraph. This is made possible by virtue of the carrier current system of operation.

The system is in theory and practice so full of interesting points that it may well be said to mark a definite step in the development of our knowledge of telephonic matters. That the Post Office Engineering Department are definitely adopting it should be a feather in the cap of that much-abused organisation.

The West Yorkshire Inquiry.

On Tuesday, April 12th, the Electricity Commissioners were to have commenced the third of their public inquiries into the existing organisation of electricity supply and into schemes for its improvement, but owing to the Industrial crisis the inquiry has been postponed for a few days. The area at present affected is that known as the West Yorkshire (Aire and Calder) District, and is one of the most important in the country. It is highly industralised, and includes such progressive local authorities as Leeds, Bradford, Halifax, Huddersfield and Barnsley, together with a number of urban and rural Councils. The Commissioners have been asked to investigate three schemes—viz., two prepared by local authorities, both of which contemplate the creation of a Joint Electricity Authority, and the purchase of the Yorkshire Electric Power Company, while the third is submitted by the Power Company themselves.

Proposals of a municipal tinge are put forward by Leeds and Bradford Corporations respectively, the main points of difference between them being that Bradford is willing, but Leeds is not, to make good out of the local rates any deficiency there may be in working. Bradford's policy is supported by the majority of the local authorities in the district, while Leeds, which proposes to purchase the power company at the end of 42 years, is ploughing a lonely furrow. This is a sign of regeneration which we are glad to put on record.

A Bruised Reed Foundation.

A weak feature of both schemes is that they apparently expect the Government to advance the money required during the first five years of operation for the erection of new electricity works and for building main transmission lines. In the present state of the finances of the country it is, we think, hopeless to look to the Treasury or to the Ministry of Transport for monetary aid. If one district were given financial assistance, all would demand it, and the total amount required is therefore so considerable that some suitable alternative must be devised. However, we confidently believe that if the Electric Supply (No. 2) Bill were passed it would not be difficult to discover as the necessary capital could easily be found. There cannot be the slightest doubt in fact that the business of supplying electric energy for power and lighting in the district would be a very remunerative one, and investors would get a good return on their money.

The doubt and delay caused by the present uncertainty as to the legal position of local authorities are highly prejudicial, and fresh legislation is urgently needed. We are glad, therefore, to see that the Bill has now been introduced in an amended form, and was read a first time in the House of Commons on Tuesday. We hope to deal fully with this new measure in our next issue, but its introduction is evidence of the desire of the Ministry of Transport to clarify the situation and to remove the present obstacles to progress.

A Delimitation Difficulty.

Another difficulty in the way of settlement is that the Yorkshire Electric Power Company's area does not coincide with that of the Electricity District; in fact, it extends into the areas of three such districts, and, assuming the acquisition of the company's undertaking were a feasible proposition, it seems to us that the three districts affected should co-operate in carrying out the purchase of the company's property. As local inquiries into the position in the other two districts will not be held for two or three months the position is unfortunately uncertain, and we cannot say what attitude will be taken up by the local authorities concerned. However, the company's powers can only be acquired by agreement, and we have no doubt that the directors will not consent to the piecemeal purchase of their undertaking. Though the majority of the West Yorkshire Councils have declared in favour of the municipal control of electricity we cannot see how co-operation with the company would militate against this principle, or why a Joint Electricity Authority, on which the company and all other interests affected would have proportional representation, should not be formed. It would be much the best solution of an awkward problem.

The Progress of the Yorkshire Company.

The Yorkshire Electric Power Company, which has made rapid progress in recent years, has an area of about 1 800 square miles. It has two generating stations, at Thornhill and Barugh, and considerable extensions of plant are in progress. In addition, proposals are on foot for erecting a large station at Ferry Bridge, which will have an ultimate capacity of 135 000 kW. Out of the 62 authorised distributors in the company's area 40 are taking, or have agreed to take, a supply in bulk from it, so that it will be seen that it is a concern which occupies a strongly entrenched position. The company's engineer, Mr. W. B. Woodhouse, estimates that during the next ten years £2 000 000 will be required for meeting the demands for electricity in the Aire and Calder district, and naturally the suggestion to expend such a large sum of public money is causing commercial men and ratepayers to examine the various proposals put forward with a critical eye. Any prospect, however remote, of an addition to the present heavy burden of the rates is looked upon with great suspicion, and consequently there are many, including some of the Urban Councils and the Leeds Chamber of Commerce, who favour the company's scheme.

A Joint Electricity Authority and the Rates.

We do not believe that a Joint Electricity Authority, if its business is undertaken and expanded in a proper business-like way, need involve any charge upon the district rates. All the existing undertakings are in urgent need of additional generating plant, and the aggregate cost of these extensions would be more than that required for erecting a few modern power stations and main transmission lines. It seems to us that it comes to this, is it better to perpetuate and aggravate the existing antiquated system of generation and supply rather than face the realities of the position and put our house in order now? Put in this form there can surely be but one answer, and that being so, either Joint Electricity authorities or big power companies, like the Yorkshire Company, should be entrusted with the important question of reorganising the supply industry without further delay.

The Electricity Bill.

Apparently the Government still adhere to the principles enunciated in the Electricity Supply Act of 1919, for Mr. Neal denied, in answer to questions in the House of Commons last week, that the legislative scheme of that Act had been abandoned, while he stated that the Government fully realised the necessity of the Electricity Supply (No. 2) Bill. Re-introduction by itself is not, however, sufficient, and we therefore desire to urge upon the Ministry of Transport the necessity for an early decision upon this vital matter. Extensions of plant and most of the generating stations are urgently required, and the present uncertainty as to the fate of the projected Bill is having a most disastrous effect upon the supply industry. If it is not intended to proceed with the measure, then we should be informed, in order that alternative proposals for the development of the industry may be prepared.

The Theory of the Three-Phase Variable Speed Shunt Commutator Motor.

By J. L. D. RIDSDALE, M.Sc.

LIST OF SYMBOLS.

b_1=breadth factor of stator windings; b_2=breadth factor of rotor windings; E=supply or line E.M.F. (star value); E_c=compensating E.M.F.; E_1=E.M.F. impressed on stator terminals (star value); E_2=E.M.F. impressed on rotor brushes (star value); e_1=transformer E.M.F. induced in stator; e_2=transformer E.M.F. induced in rotor; e_r=resultant of E.M.F.'s induced and generated in rotor; e_u=E.M.F. of rotation generated in rotor; F=flux per pole of rotating field; $F'_x . F'_y$=instantaneous values of component oscillating fluxes; $F_x . F_y$=maximum values of component oscillating fluxes; f_1=frequency of supply E.M.F. (cycles per second); f_u=frequency of rotation (cycles per second); I=current taken by motor from supply mains; I_1=current in stator coils; I_2=current in rotor coils; I_0=magnetising current; I'_s=short circuit current; k=factor of proportionality between flux and current; K=constant of motor$=r_1/x_0+\tan\alpha(1+x_1/x_0)$; n_1=number of turns in series per phase in stator winding; n_2=number of turns in series per phase in rotor winding; $Q=R_c/R_m$; $R=R_t/R_m$; $R_c=E_c/E$; R_m=ratio of transformation in motor$=b_2 . n_2/b_1 . n_1$; $R_t=E_2/E_1$ when E_c is zero; r_1=resistance per phase of stator windings; r_2=resistance per phase of rotor windings; S=slip; S_0=slip at no load; T_q=torque per phase in *Kg.* metres; t=time in seconds; u=speed of motor in revs. per second; u_1=synchronous speed in revs. per second; u_0=no load speed of motor in revs. per second; x_1=reactance per phase of stator winding; x_2=reactance per phase of rotor winding; x_0=exciting reactance per phase; Z_1=impedance per phase of stator windings; Z_2=impedance per phase of rotor windings; Z_0=exciting impedance per phase; α=angle whose tangent is the ratio of rotor reactance per phase to rotor resistance per phase; γ=phase angle between the flux and current components of the torque; θ=angle of brush displacement λ=phase angle in supply circuit.

Although there have from time to time been published in the technical press Papers dealing with the theory of the three-phase series commutator motor, there appears to be no publication in the English language containing any very full account of the theory of the variable speed three-phase shunt commutator motor. In the following contribution the theory of this latter type of motor is developed, and its principal operating characteristics are briefly discussed.

In order to bring out the relation between these motors and the three-phase induction motor, a short space is devoted to the study of the three-phase constant speed motor having the rotor winding connected to a commutator instead of the usual slip-rings. With a view to simplification, it will be assumed that the induction in the air-gap of the motor is distributed in space according to a sine law, that the permeability of the magnetic circuit is constant, and that the iron losses are negligible. Further, the effect of the current in the rotor coils short-circuited by the brushes will be neglected.

Fig. 1 is a diagram of a two-pole three-phase star-connected stator of the type used in the ordinary induction motor; for the present, the rotor is assumed to be a simple cylinder of laminated iron. As is well-known if such a stator is connected to a three-phase supply, a field is produced in the air-gap which is constant in magnitude, but rotates at a speed proportional to the frequency of the impressed E.M.F. If the phases come up in the sequence a, b, c the direction of rotation of the field will be that indicated by the arrow.

STUDY OF THE MOTOR FIELD.

For the purpose of studying the theory of the three-phase commutator motor, it is convenient to resolve the rotating field into two component fields along axes displaced from each other by half a pole pitch. As is well known these two component fields are in quadrature in time, and consist of oscillating fluxes of amplitude equal to the value of the flux of the rotating field, and oscillating with a frequency equal to the frequency of the impressed E.M.F. The position with reference to the stator winding of the axes of the two component fields may be chosen quite arbitrarily. It is convenient, however, to select as the axes of reference, axes parallel to and at right angles to the axis of the stator coils of one phase.

In Fig. 1 the axes of reference are OX and OY; the direction of rotation of the field being that indicated by the arrow—namely, counter clockwise—and the positive direction of the fluxes that indicated by the arrows F'_x and F'_y; it follows that the instantaneous values of the fluxes along these axes are respectively

$$F'_x=F_x \sin 2\pi f_1 t,$$

and

$$F'_y=F_y \cos 2\pi f_1 t,$$

where F'_x and F'_y are the instantaneous values, and F_x and F_y are the maximum values of the component fluxes per pole, f_1 is the frequency of the impressed E.M.F., and t represents the time in seconds, reckoned from the instant at which the flux F'_x passes through zero from a negative to a positive value. Further, $F_x=F_y=F$, where F is the flux per pole of the rotating field.

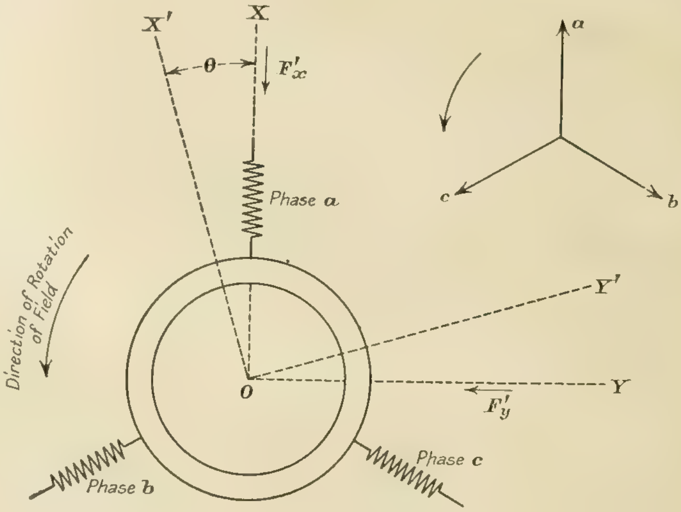

FIG. 1.

If a second pair of axes OX' and OY' be taken inclined at an angle θ deg. to the axes of reference OX and OY, it can easily be proved that the components of the rotating field, when the latter is resolved along the axes OX' and OY', are θ deg. out of time phase with the components when the rotating field is resolved along OX and OY. If the axes OX' and OY' are θ deg. in advance of, *i.e.*, displaced forward in the direction of rotation of the field θ deg. with reference to, the axes OX and OY, the component fluxes along OX' and OY' lag θ deg. in time behind the component fluxes along OX and OY. Similarly, if the axes OX' and OY' are displaced backwards through θ deg. with reference to the axes OX and OY, then the component fluxes along OX' and OY' lead by θ deg. in time the component fluxes along OX and OY.

Further, it is easily proved that, neglecting iron losses, the component flux along the axis OX is in time phase with the current in the stator coils whose axis coincides with OX, *i.e.*, the stator coils of phase a in Fig. 1, and is 50 per cent. greater than the flux which would be produced by that current acting alone, thus

$$F'_x=\frac{3}{2}kI_0 \sin 2\pi f_1 t,$$

where k is the factor of proportionality between the flux and current and I_0 is the current in the stator coils.

It follows therefore that the component flux along OX' (Fig. 1) lags θ deg. behind the current in the coils of phase a of the stator, or

$$F'_{x'}=\frac{3}{2}kI_0 \sin (2\pi f_1 t-\theta),$$

and

$$F'_{y'}=\frac{3}{2}kI_0 \cos (2\pi f_1 t-\theta),$$

where $F'_{x'}$ and $F'_{y'}$ are the instantaneous values of the components of the flux F, when the latter is resolved along the axes OX' and OY'.

The vector diagram (Fig. 2) shows the time relations between the current in the coils of phase a and the component fluxes along the axes OX OY OX' and OY'.

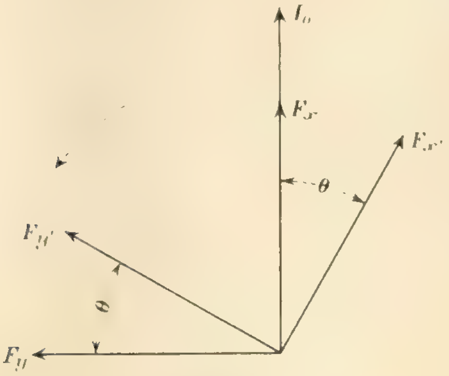

Fig. 2.

If now the laminated iron core of Fig. 1 be replaced by an ordinary two-pole drum armature and commutator on which press three brushes equally spaced round the commutator, and the brushes are short-circuited, there will be induced in the armature windings E.M.F.s which will cause currents to circulate in the armature windings and short-circuiting connections. The field of the motor will now be produced by the resultant of the stator and armature, or rotor, ampere-turns. For the sake of simplicity it is assumed that the mesh connected armature winding is replaced by an equivalent star-connected winding having $\sqrt{\frac{1}{3}}$ of the number of turns and $\frac{1}{3}$ of the resistance and reactance of the actual winding, and in what follows, when the number of turns in the rotor and the rotor resistance, reactance, and impedance are mentioned, it will be the turns, the resistance, reactance and impedance of the equivalent winding to which reference is made.

Vector Diagram of the Motor.

In Fig. 3 is shown in diagrammatic form a two-pole stator and rotor, and for greater generality the brushes are shown displaced from the axes of the stator coils. It is assumed throughout that the stator and rotor are both wound in the same sense, and are so wound that a current passing through any coil tends to produce a flux directed from the end of the coil at which the current enters, and to the point at which the current leaves the coil. The operation of the motor can conveniently be studied by the aid of a vector diagram. In order to draw such a diagram for one phase of the motor—*e.g.*, phase a—the rotating field must be resolved along and at right angles to the axis of the stator coils of phase a—*i.e.*, along the axes OX and OY (Fig. 3). Let OA (Fig. 4) represent the maximum value of the flux F_x along OX. The flux F_x induces in the stator coils of phase a an E.M.F. e_1 lagging 90 deg. behind F_x and equal to

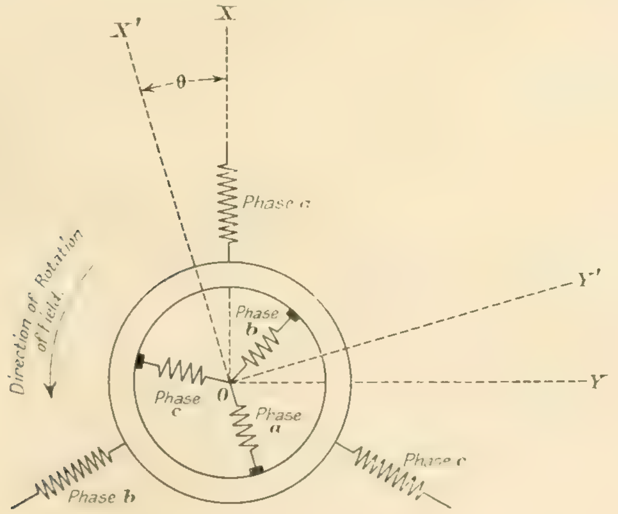

Fig. 3.

$$4{\cdot}44\, b_1 n_1 F_x f_1 10^{-8} \text{ volts},$$

where b_1 is the breadth factor of the stator winding and n_1 is the number of turns in series in each phase of the stator winding. In Fig. 4, OB represents e_1. The flux F_y will not induce any E.M.F. in the stator coils of phase a, as the coils and flux are at right angles in space.

When considering the phase relation between the E.M.F. induced in the stator and that induced in the rotor it will be found convenient to adopt the convention that E.M.F.s acting towards the neutral are positive and from the neutral negative, both in the case of the stator and rotor.

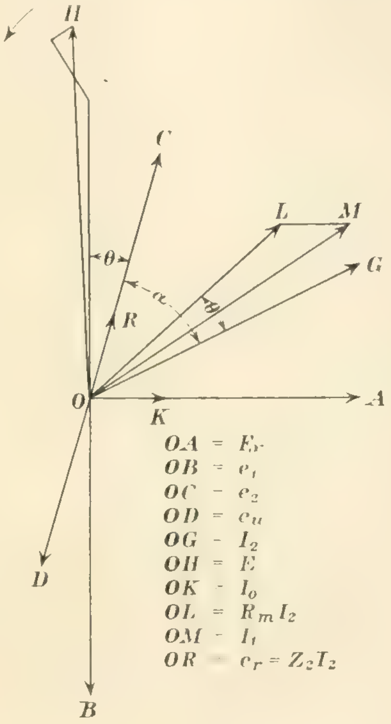

Fig. 4.

Rotor E.M.F.s.

In order to determine the E.M.F.s in the rotor, resolve the rotating flux into two components, $F_{x'}$ and $F_{y'}$, along and at right angles to the axis of the rotor coils of phase a—*i.e.*, along OX' and OY' in the diagram (Fig. 3).

As has already been stated, these component fluxes will lag θ deg. behind the components of the rotating field when the latter is resolved along OX and OY. Thus, the flux along OX' will induce an E.M.F. e_2 in the rotor equal to

$$4{\cdot}44\, b_2 n_2 F_{x'} f_1 10^{-8} \text{ volts},$$

where b_2 and n_2 are respectively the breadth factor and number of turns in series per phase of the rotor winding, and this E.M.F. will lag θ deg. behind the E.M.F. which would be induced in the rotor if there were no brush shift—*i.e.*, if θ were zero. e_2 is therefore represented by OC in the diagram (Fig. 4). The transformation ratio of the motor R_m is equal to

$$\frac{b_2 n_2}{b_1 n_1}.$$

The flux $F_{y'}$ cannot induce any E.M.F. in the rotor; if, however, the rotor is revolving at a speed of U revolutions per second, there will be generated in the rotor an E.M.F. of rotation e_u equal to

$$4{\cdot}44\, b_2 n_2 F_{y'} f_u 10^{-8} \text{ volts},$$

where f_u is the frequency of rotation, *i.e.*, revs. per sec. × number of pole pairs.

If the rotor is revolving in the same direction as the rotating field, the E.M.F. e_u is opposed to the E.M.F. e_2, whereas if the rotor is revolving in the opposite direction to the field, the E.M.F.s e_2 and e_u are in phase. In the diagram the E.M.F. e_u is represented by *OD*. It should further be noted that, in accordance with the conventions which have been adopted, the flux $F_{y'}$ is in phase with the E.M.F. e_2.

The resultant E.M.F. in the rotor, therefore, is the difference between e_2 and e_u and is represented by *OR* in the diagram (Fig. 4). If e_r is the resultant rotor E.M.F.,

$$e_r = e_2 - e_u\ ;$$

or, since $F_{x'} = F_{y'} = F$

$$\begin{aligned} e_r &= 4{\cdot}44\, b_2 n_2 F\,(f_1 - f_u)\,10^{-8} \text{ volts} \\ &= e_2 S, \end{aligned}$$

where S is the "slip." It should be observed that, as a result of the action of the commutator, the frequency of the E.M.F. e_r is the same as that of the impressed E.M.F.

The E.M.F. e_r gives rise to a current I_2 in the rotor windings lagging behind e_r by an angle, α, whose tangent is equal to the ratio of the reactance to the resistance of the rotor winding. The current I_2 is represented by the vector *OG* in the diagram (Fig. 4), lagging by an angle α behind the vector *OR*. The current I_2, in conjunction with the flux $F_{y'}$, give rise to a torque acting on the rotor bars of phase *a*, and tending to turn the rotor in the direction in which the field revolves.

As has already been shown, the magnetising current in phase *a* of the stator will be in phase with the component flux F_x, and is therefore represented by *OK* in the diagram (Fig. 4). The magnetising current required to produce the component flux F_y is supplied by phases *b* and *c* and hence does not appear in the vector diagram which relates to phase *a* alone.

Total Stator Current.

In order to determine the total stator current, the effect of the rotor ampere turns along the axis *OX* must be determined. The axis *OX* is θ degrees behind the axis of the rotor coils of phase *a*, and hence, as has already been shown, the M.M.F. of the rotor windings along the axis *OX* will lead by θ degrees the M.M.F. of the rotor windings along the axis *OX'*; the latter M.M.F. is in phase with the current in the rotor coils of phase *a*; hence it follows that the M.M.F. of the rotor windings along the axis *OX* will lead by θ degrees the current in the rotor coils of phase *a*. Thus for the purposes of determining the stator current, the vector for the rotor current assumes the position *OL* in the diagram (Fig. 4) θ degrees in advance of the vector *OG*, *i.e.*, it assumes the position it would have occupied if the brushes had not been displaced. The stator current I_1 and the impressed or supply E.M.F. *E* (star value) can now be determined in the usual manner and are represented by *OM* and *OH* respectively in the vector diagram (Fig. 4). It will be observed that the displacement of the brushes does not affect the power factor or speed of the motor.

In drawing the vector diagram it has been assumed that the rotor reactance is constant, in reality, however, it appears that the reactance decreases as the speed increases.* It will be seen that if it be assumed that the rotor reactance is proportional to the slip, the characteristics of the commutator motor with short circuited brushes are the same as those of the induction motor having a wound rotor short circuited through slip rings.

The Three-Phase Variable Speed Shunt Commutator Motor.

The fact that the E.M.F. at the brushes of the alternating current commutator machine has a frequency equal to the frequency of the impressed E.M.F. makes it possible to connect the brushes to the supply mains and thus to regulate economically the speed of the motor above or below the synchronous speed, by allowing the rotor to take energy from or return energy to the mains.

In the three phase variable speed shunt commutator motor the rotor brushes, instead of being short circuited as in the case last considered, are connected through a variable ratio transformer or auto-transformer to the supply mains, when by varying the E.M.F. impressed on the rotor brushes the speed of the motor can be varied. In order to obtain speeds both above and below synchronism, it is necessary that arrangements should be provided to enable the secondaries of the transformer to be reversed with respect to the brushes. This can conveniently be done by continuing the winding of the secondary beyond the star point. Further, in order to "compensate" the reactance of the rotor circuit and render it possible for the motor to attain unity power factor, a "compensating E.M.F." is introduced into the rotor circuit, which should lead the E.M.F. induced in the rotor by an angle as nearly equal to 90 deg. as is practicable.

The compensating E.M.F. may be derived from a small auxiliary transformer connected to the supply main. In Fig. 5 is shown in diagrammatic form a two-pole three phase commutator shunt motor; in order not to complicate the diagram, the connections for one phase only are shown.* The diagram is drawn for the case of the motor running at a speed below synchronous speed; in this case the E.M.F. impressed on the rotor must be in phase opposition to the E.M.F. induced in the rotor, and hence will be in phase opposition to the E.M.F. impressed on the stator. In order to obtain hypersynchronous speeds, the rotor brush must be connected to one of the tappings above the star point, when the E.M.F. impressed on the rotor will be in phase with the E.M.F. induced in the rotor.

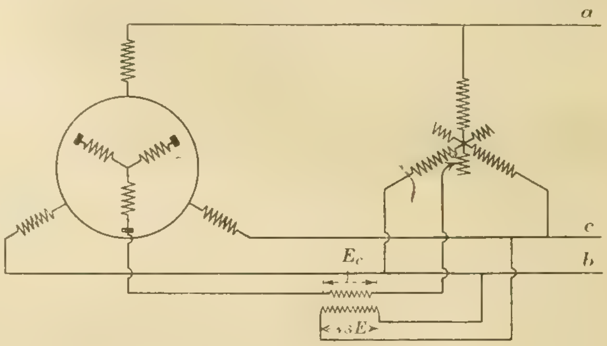

Fig. 5.

(*To be continued.*)

Books Received.

[Copies of the undermentioned works can be had from The Electrician Office on receipt of published price, plus postage.]

"Lehrgang der Schaltungschemata elektrischer Starkstrom-Anlagen." By Prof. Dr. J. Teichmüller. (Berlin: R. Oldenbourg.) Pp. vii.+131 M. 68.

"Freileitungsbau-Ortsnetzbau." By F. Kapper. (Berlin: R. Oldenbourg.) Pp. viii.+367. M. 65.

"Connecting Induction Motors." By A. M. Dudley. (London: Hill Publishing Company.) Pp. xi.+252. 15s.

"Artificial Light: Its Influence on Civilisation." By M. Luckiesh. (London: Hodder & Stoughton.) Pp. xiv.+366. 12s. 6d. net.

"Electric Bells, Alarms and Signalling Systems." By H. G. White. (London: S. Rentell & Co., Ltd.) Pp. 113. 3s. 6d. net.

"High Tension Switchgear." By H. E. Poole. (London: Sir Isaac Pitman & Sons.) Pp. ix+118. 2s. 6d. net.

"Year Book of Wireless Telegraphy and Telephony. 1921." (London: Wireless Press.) Pp. lxxxiv+1 355.

"Radiographic Technique." By T. Thorne Baker. (London: Constable & Company.) Pp. xii.+196. 15s. net.

"Coil Ignition for Motor Cars." By C. Sylvester, (London: Sir Isaac Pitman & Sons.) Pp. xi.+228. 10s. 6d. net.

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* *See* "General Electric Review" (1913), Vol. XVI., p. 976, "Elektrotechnik und Maschinenbau" (1913), Vol. XXXI., p. 1109, and "Journal" of the Inst. of Electrical Engineers (1907), Vol. XL., p. 208.

* For the form of motor due to Eichberg, *see* "Electrotechnische Zeitschrift" (1910), Vol. XXXI., pp. 749 and 785: also British Patent Specifications 14 024 of 1910, 26 685 of 1910 and 27 993 of 1910.

Carrier Current Telephony and Telegraphy.*

By E. H. COLPITTS and O. B. BLACKWELL.

Introductory.

The Paper deals with the history and development of the carrier system of multiplex telephony and telegraphy, with the principles on which it operates and with the factors which have to be considered on applying these principles to commercial service. Special reference is made to its employment in the Bell telephone system. Installations are in service furnishing four telephone conversations or ten duplex telegraph connections over each circuit in addition to the normal telegraph and telephone facilities. The additional circuits have much the same degree of practicability and flexibility of operation as the more usual form of circuits and are so designed that they fit in with the usual circuit facilities of the system. The equipment required is, however, expensive and its use, at present, is economical only over relatively long lines.

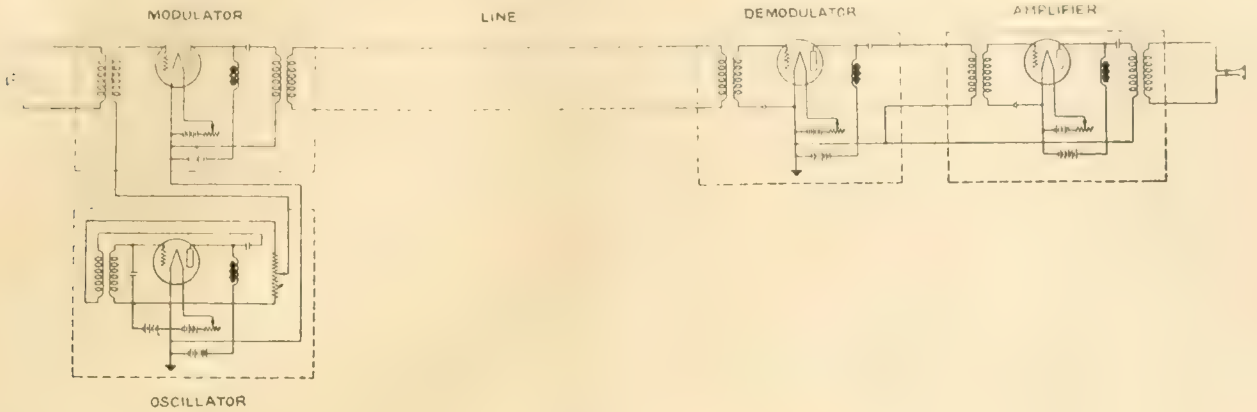

Fig. 1.

Historical.

The authors trace the history of the idea of carrier current multiplex working and discuss briefly the contributions of Gray, Bell Van Rysselberghe, Edison, Mercadier, Pupin, Hutin, Leblanc, Stone, Ruhmer and Squire, extending from 1886 to 1912, when the advent of the thermionic tube enabled the development of a practicable commercial system to be taken in hand. They outline the progress made by the Bell engineers and deal briefly with the trial equipments first put into commercial operation.

Principles of Operation.

The underlying principles of the carrier system are first described in their application to telephony. Fig. 1 shows schematically the fundamental circuits involved in a single one-way channel.

Modulation. It will be noted in the circuit shown that the potentials of carrier and voice frequencies are applied in series in the grid circuit of a thermionic tube known as the modulating tube, together with a steady voltage from a battery. Owing to the non-linear relation which exists between the plate current and the grid voltage the output current is not simply a reproduction of the alternating voltages applied to the grid. In fact, the modulating properties of the tube result from the inter-actions between applied voltages which this non-linear relation introduces.

The mechanism of this interaction is shown graphically in Fig. 2. It is evident that while the output current includes both the modulating current (here a sinusoid) and the carrier current, the amplitude of the latter varies in accordance with the instantaneous value of the former. Hence even though the relatively low modulating frequency itself be removed by a selective circuit, its variations are preserved in the wave form of the higher carrier frequency. The form of this modulated carrier wave is shown in Fig. 3. Here curve *A* shows a modulating wave of irregular form representing the voice current, curve *B* the carrier wave, and curve *C* the modulated carrier wave, whose envelope has the form of the modulating wave.

Component Frequencies.

It is not at once obvious from an inspection of this modulated carrier wave what component frequencies are present and which of these are essential. Assume for the moment the complex voice wave to be replaced by a sinusoidal current of a frequency $\frac{q}{2\pi}$ lying somewhere in the voice range. The envelope of the modulated wave will approach closely a sine curve and we may assume the value of the current at any instant to be given by the equation:

$$i = P\,(l + k \cos q\,t) \cos pt.$$

This equation represents a carrier current of frequency $\frac{p}{2\pi}$ whose amplitude varies sinusoidally between the values $(l-k)P$ and $(l+k)\,P$; k being proportional to the amplitude of the modulating wave. By simple transformation this may be resolved into its components, giving

$$i = P \cos\, p\,t + P\,\frac{k}{2}\,[\cos\,(p+q)\,t + \cos\,(p-q)\,t].$$

The first term represents a component of carrier frequency whose amplitude, P, is altogether independent of q and of k; and therefore it has no part in conveying the characteristics of the modulating wave to the distant station. These characteristics are preserved by the remaining two terms, whose frequencies are respectively the sum and difference of the carrier and modulating frequencies, and whose amplitudes are proportional to the product of the carrier and modulating waves.

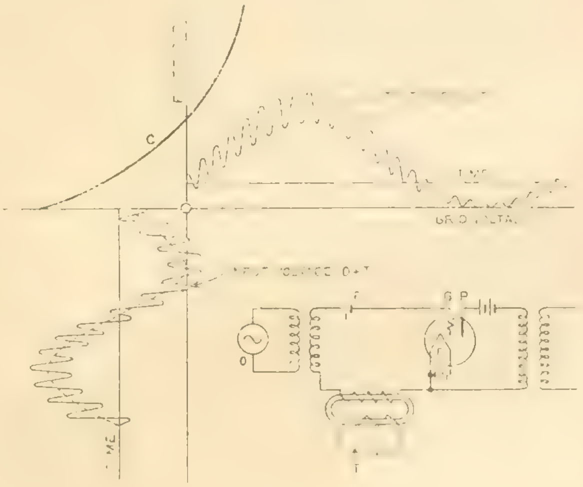

Fig. 2.

From this it follows that every component frequency of a modulating voice wave is represented in the corresponding modulated carrier wave by two components, one of which is greater in frequency than the carrier wave by the frequency of the voice component, and the other of which is less by the same amount. We may therefore be certain that all the essential components of the voice wave will be preserved if those components of the modulated wave are transmitted whose frequencies lie within two frequency bands, one of which extends from the carrier frequency plus 200 upwards to the carrier frequency plus 2 000 and the other from the carrier frequency minus 200 down to the carrier frequency minus 2 000. These are known as the upper and lower side bands respectively.

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*Abstract of a Paper presented at the 1921 Midwinter Convention of the American Institute of Electrical Engineers.

Demodulation.

By the term "demodulation" is meant the process of reproducing the original low frequency modulating wave from the carrier wave upon which it has been impressed. This is also effected by the use of the thermionic tube. Reference may be made to Fig. 1, where at the receiving station a modulated wave is shown applied to the input circuit of a vacuum tube. This figure also shows a low frequency amplifier in the output circuit of the demodulating tube.

The operation of the demodulating tube is exactly similar to that of the modulating tube, in that if voltages of two different frequencies are applied to its input circuit, there appears in its output circuit a complex current wave. When the output current wave is resolved into its components, we find currents identical with the two frequencies which had been applied at the input, one component whose frequency is the sum of the applied frequencies, one component whose frequency is the difference of the applied frequencies, and a large number of harmonics and sum and difference frequencies. The amplitudes of the two currents whose frequencies are the sum and difference of the applied frequencies are proportional to the product of the amplitudes of the applied voltages. When, therefore, the received modulated wave is applied to the demodulating tube, we may determine the frequencies and relative amplitudes of the components of voice frequency in the output circuit of the demodulator by considering the interaction of the various pairs of frequencies in the modulated wave.

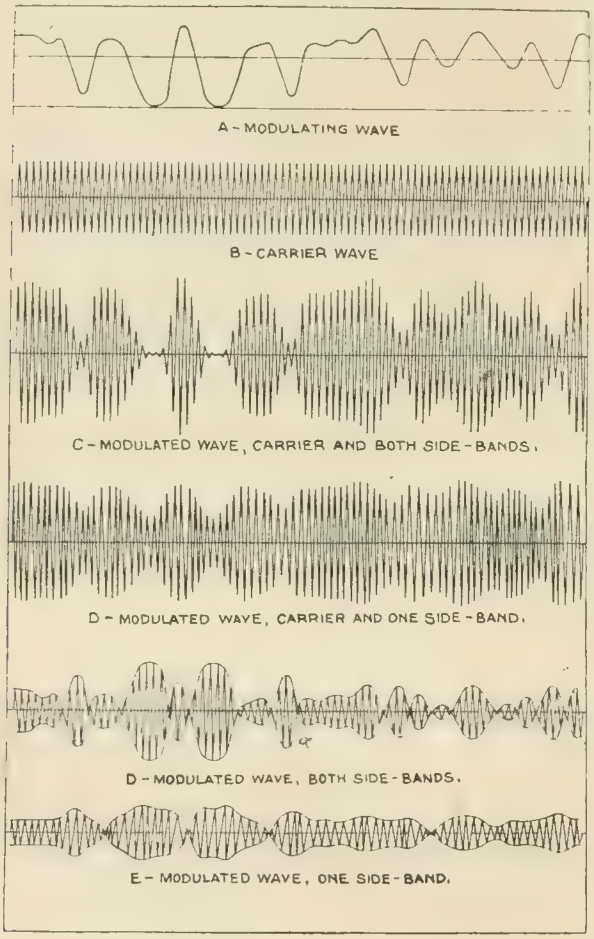

Fig. 3.

Obviously frequencies in the voice range can occur in the demodulator output only as the difference of two components of the modulated wave. If we substract the carrier frequency from any component of the upper side band, the result is the original speech frequency which produced that component. The interaction of the carrier and the entire upper side band therefore reproduces all the components of the voice wave with their proper relative amplitudes, since the amplitudes of the side band components are proportional to those of the original voice components, and that of the carrier is the same for all of them. The reproduction of the original voice wave also results from the interaction of the carrier with the lower side band.

It is evident that since speech can be reproduced from either side band alone, there is no necessity for transmitting both. Accordingly the selective circuits to be described later may be so designed as to transmit only one side band. As this effectively halves the range of frequencies assigned to each channel, its great importance is at once obvious. The effect on the wave form of suppressing the upper side band is shown by curve D, Fig. 3. It is seen that in addition to the form of the envelope being changed, the times at which the current passes through zero are no longer equally spaced.

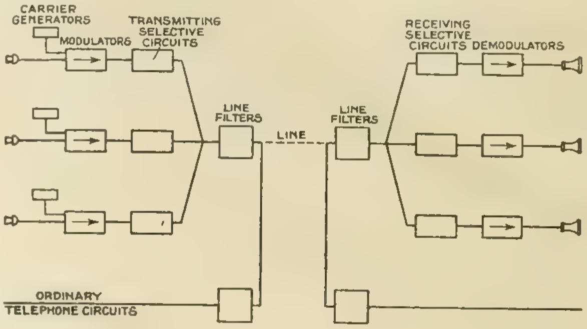
CARRIER GENERATORS
MODULATORS
TRANSMITTING SELECTIVE CIRCUITS
LINE FILTERS
LINE
LINE FILTERS
RECEIVING SELECTIVE CIRCUITS
DEMODULATORS
ORDINARY TELEPHONE CIRCUITS

Fig. 4.

Interaction of Frequency Components.

It is necessary to consider the interactions between the frequency components of the side band itself, for if, in the case of telephony, the voice wave includes components of more than one frequency, each will be represented by a corresponding component in the side band. The interaction of two of these component frequencies, simultaneously present in the side band, gives rise to a component in the output circuit of the demodulator, the frequency of which is the difference between those of the corresponding two components of the original voice wave. Such currents will have a serious effect on the quality of the reproduced speech, if their amplitude is comparable with that of the reproduced voice currents. The amplitude of this distorting component is proportional to the product of the amplitudes of the two side band components, whereas the amplitude of each of the two components of the desired voice current is proportional to the product of the amplitudes of its corresponding side band component and the carrier. The reproduced voice current can be made large compared with the distorting current only by insuring that the carrier is large compared with every component of the side band. As a result of this, it follows that in order to secure good

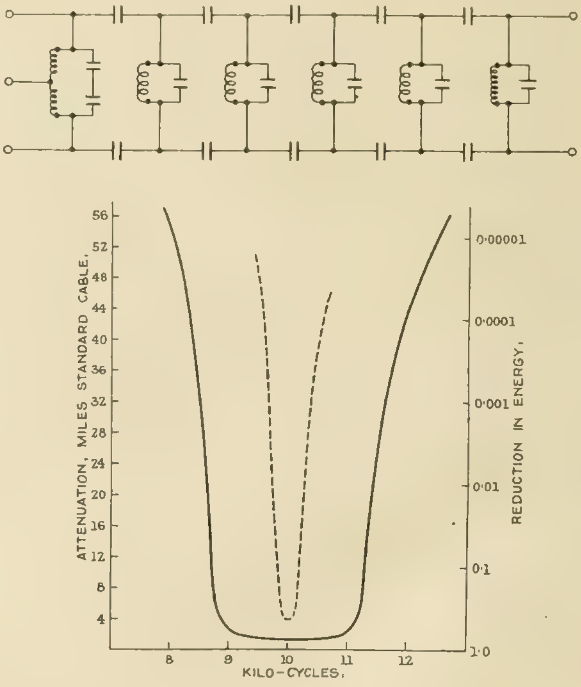

Fig. 5.

quality it is necessary that the greater portion of the energy applied to the demodulator consist of unmodulated carrier frequency.

The authors show further that consideration must be given to the effects of interfering currents due to extraneous disturbances.

Selection Electrical Filters.

When a number of one-way channels of the type schematially shown in Fig. 1, each employing a different carrier frequency, are operated by superposition on a common line, each channel must be connected with the line through selective circuits which transmit only the range of frequency assigned to that particular channel. The general position of the selective circuits in such a one-way multiplex system is indicated in Fig. 4.

The ideal selective circuit would transmit efficiently the side band, having a frequency range of 2 000 cycles, and would absolutely block off frequencies outside of this band. The nearest approach to this ideal, particularly for carrier operation, is secured by the use of what has come to be known as an "electrical filter," invented by Dr. G. A. Campbell. Fig. 5 shows a type of filter which has been used to great advantage in carrier telephony. As this filter transmits a band of frequencies, it has, for convenience, been termed a "band-pass" filter. The transmission characteristics of this filter are also shown in Fig. 5, where the attenuation introduced into a circuit by the insertion of this filter is plotted against the frequency of the applied current. For comparison the attenuation characteristic of a pair of loosely coupled resonant circuits is shown in the dotted curve of Fig. 5. The advantage of the Campbell filter in giving almost uniformly small attenuation over the frequency range included in the band with sharp discrimination against frequencies outside this range, is obvious. In the design of such filters the main problem has been to provide reactance elements of high time-constant, accuracy and stability. Coils with toroidal cores formed of finely divided iron and having time constants superior to those of air-core coils are used. A description of this type of core material and of its use in telephone plant is shortly to be published.

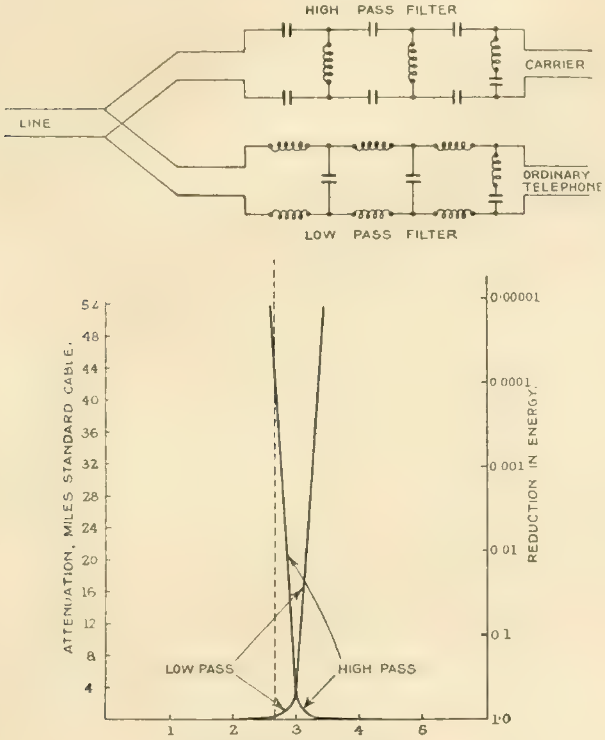

Fig. 6.

It has been found practicable to design filters which permit of operating with an interval of about 1 000 cycles between adjacent telephone channels; that is, 3 000 cycles between adjacent carrier frequencies.

Separation of Carrier Frequencies.

In addition to separating the various carrier channels from each other it is found convenient from an operating standpoint to separate within the toll offices the carrier frequencies as a group from the frequencies used for ordinary telephony and telegraphy. For this purpose the portion of the line which is used in common is connected with the carrier apparatus through a "high-pass" filter, which transmits all frequencies above a predetermined value (in this case above about 3 000 cycles), and suppresses all frequencies below this value (in this case below 3 000 cycles). Similarly connection is made with the ordinary telephone and telegraph circuits through a "low-pass" filter, which, in this instance, passes frequencies below 3 000 cycles and suppresses those above. This combination of carrier line filters, sometimes called a "high-frequency composite set," is shown in Fig. 6, together with the attenuation curves of the two filters. Referring to this figure, it will be seen that currents in the multiplex line divide between the low-pass and high-pass filters shown at the top of the figure. The division is determined at any particular frequency by the relative input impedances of these two branches. Accordingly, the high-pass filter is designed to offer a high input impedance to currents of ordinary telephone frequency, and to have an impedance equal to that of the line for currents within the carrier frequency range. Correspondingly, the low-pass filter is designed to offer a high input impedance to currents of the carrier frequency range, and to have an impedance equal to that of the line for currents of ordinary voice frequencies. The attenuation of the high-pass filter is small for carrier frequencies and large for voice frequencies, while the reverse is true for the low-pass filter.

The location of these line filters in a carrier system is indicated in Fig. 4.

Arrangements for Two-way Transmission.

For two-way transmission balancing circuits similar to those used with repeaters* are employed. Otherwise "local singing" or "end to end singing" may be set up. "End to end singing" may be avoided by the use of different carrier frequencies for transmission in the two directions. In this case it will only occur if the attenuation of the carrier line is more than compensated for by the amplification introduced at the terminal or at intermediate stations. By the use of balancing circuits for the carrier line itself "end to end singing" may be avoided without the use of different carrier frequencies for the two directions of the same channel. The Paper contains diagrams showing the location of the balancing transformers and networks in the system.

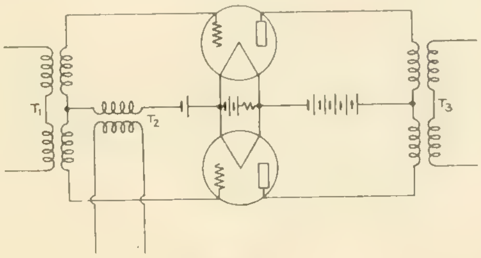

Fig. 7.

Carrier Suppression.

The relatively large amount of unmodulated current of carrier frequency required for the proper demodulation of the side band currents may be transmitted from the modulator or may be supplied to the demodulator from a local source. The latter system has the advantage that the amount of line current transmitted per channel is very materially reduced. Curve *E*, Fig. 3, shows the wave form with the carrier suppressed and both side bands present. Curve *F*, Fig. 3, shows the carrier suppressed and only one side band present.

Elimination of the carrier frequency at the sending end can be accomplished by what is known as a "balanced modulator," a schematic circuit of which is shown in Fig. 7. In this arrangement two tubes are connected in a manner somewhat similar to the "push-pull" repeater circuit which is described later. The voice frequency potential is applied differentially to the grids of the two tubes by the transformer T_1. The carrier potential is applied through the transformer, T_2, to the common portion of the input circuit in such a manner that the carrier frequency potentials of the two grids with respect to the filament are at any instant the same. The resultant carrier frequency currents in the plate circuits of the two tubes are then equal, and the fluxes which they set up in the core of the differential transformer, T_3, are equal and opposite; hence no voltage of the frequency of the unmodulated carrier is induced in the output circuit. By a more detailed analysis it can be shown that the side-band currents resulting from the interaction of the carrier and speech-frequency currents are not balanced out, but are reproduced in the output circuit. It should be noted that under these conditions high-frequency current appears in the output circuit only when low-frequency telephone currents are being applied to the input circuit of the modulator.

(To be continued.)

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* Gherardi & Jewett, A. I. E. E. Trans., pp. 1287-1345, 1919; The Electrician, Vol. LXXXIV., pp. 517, 543, 571, 618.

Some Recent Developments in Large Steam Turbine Practice.*

By K. BAUMANN.

General Trend of Developments.

The trend of development in turbines towards the maximum possible output at the highest possible speed is justified by the improvement in reliability, thermal economy and first cost. This step is conditional on a corresponding development of the driven machine with which the turbine is directly connected, or, alternatively, of the gear used for transmitting the power to the driven machine. The only machine coming under the first category is the turbo-alternator. From a purely electrical point of view, the development of the high-speed alternator is not justified, as it is less efficient than the low-speed alternator, and its first cost is practically the same. Nevertheless, other advantages fully justify endeavours in this direction.

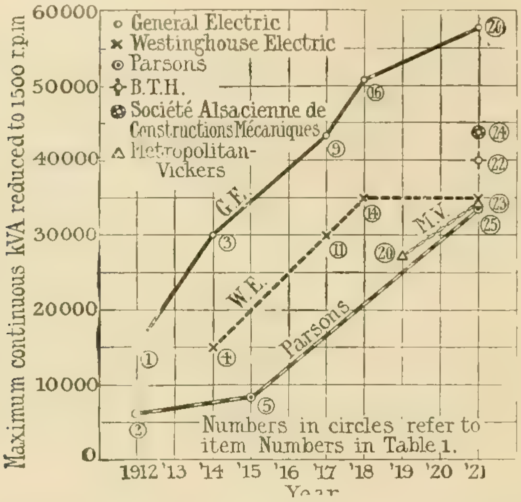

Fig. 1. Growth of Maximum Continuous kVA Rating of Large Alternators Reduced to 1 500 revs. per. min.

In the original Paper the author presents two valuable and comprehensive tables, containing lists of turbo-alternators built by various makers during the last 10 years. Some of these data are summarised in Figs. 1 and 2. The largest alternator, with a speed of 1 000 revs. per min., was built by the A.E.G. in 1918. This set was expensive. Future progress will be towards increasing the output of 1 500 revs. per min. machines, rather than 1 000 revs. per min. sets. The largest machine (presumably 1 500 revs. per min.) at present in operation has a capacity of 35 000 kVA (maximum continuous rating). Most manufacturers are willing to build an alternator of this size. A 35 000 kVA alternator has also been built for a speed of 1 800 revs. per min. Many turbo-alternators running at 2 400 revs. per min. and above have been built during the last 10 years. The capacity has increased in this country from about 3 000 kVA in 1912 to 17 200 kVA maximum continuous rating in 1921. (*See* Fig. 2.)

The direct-current generator driven directly from the turbine has recently given place to the moderately low-speed generator driven by mechanical reduction gear, up to units of 4 000 kW, and for larger units by turbo-alternators used with rotary converters. Development in reduction gear has also led to the disappearance of the direct-driven 25-period alternator running at 1 500 revs. per min. up to capacities of 4 000 kW. Mechanical reduction gear has completely revolutionised turbine practice for small outputs. Eventually even the 1 000 kW turbo-alternator running at 3 000 revs. per min. will be replaced by a high-speed turbine driving the alternator through gears.

Gear Development.

Gear is still in an early stage of development. For a given speed of the low-speed shaft the cost of gearing increases with increasing pinion speed, though it leads to a higher efficiency. In the original Paper a diagram is given showing the progressive increase in maximum kilowatts per pinion from 1912 to 1920. Apart from increased speed, the size of turbines has notably advanced, a fact which is illustrated in the tables referred to above. Generally, rating varies (*a*) as the square root of the back pressure and (*b*) inversely as the square of the speed. Particulars of the G.E.C., Zoelly and Metropolitan-Vickers multi-exhaust types of turbines operating at 32 400, 29 200 and 26 400 kW respectively (reduced rating), the speeds being 1 800 revs. per min. in the first case and 1 500 revs. per min. in the two last, are given in detail. The absolute vacua values are respectively 1, 1·05 and 0·9 in. respectively.

In the next part of the Paper sectional drawings and data relating to a variety of modern turbines are given, and the developments of (*a*) reaction turbines, (*b*) impulse turbines and (*c*) turbines for special purposes are sketched.

Impulse Turbines.

In regard to impulse turbines, the increase in size has been a conspicuous feature. The first 30 000 kW turbine, built in 1914, was of the two-cylinder type. Subsequently a 35 000 kW one-cylinder type was developed, the necessary leaving area being obtained by increasing the diameters of the last stages and the length of the blades. The two-cylinder type involves additional cost, a feature being the great difference in overall length. However, there are drawbacks in single-cylinder turbines, such as disc and blade vibration. Other details of construction discussed in the original Paper include stream-line exhaust, internal feed water, construction of exhaust casing and nozzle box and steam chest design. A table is presented summarising orders in Great Britain for turbines in 1914, 1916 and 1919. The total for the three years are respectively 143, 167 and 189. In 1919 143 of the orders were for impulse turbines, and in the three years the proportion, after rising in 1916, has slightly decreased. The proportion of reaction turbines, on the other hand, has risen from 21·6 per cent. in 1914 and 1916 to 24·3 per cent. in 1919. The total output capacity in 1919 was 523 975 kW, of which 112 407 kW was in the form of reaction turbines, and 411 568 kW impulse machines.

Reaction Turbines.

The development of reaction turbines in this country has involved standardised two-cylinder types for large capacities, high and low cylinder elements being arranged in separate cylinders in tandem for driving a single generator. In America the turbine has been subdivided into separate cylinders, and some units have been evolved for driving more than one generator, involving a multi-shaft arrangement. A feature has been the development of the Ljungström turbine, of which a 30 000 kW specimen is now under construction by the G.E.C. of America.

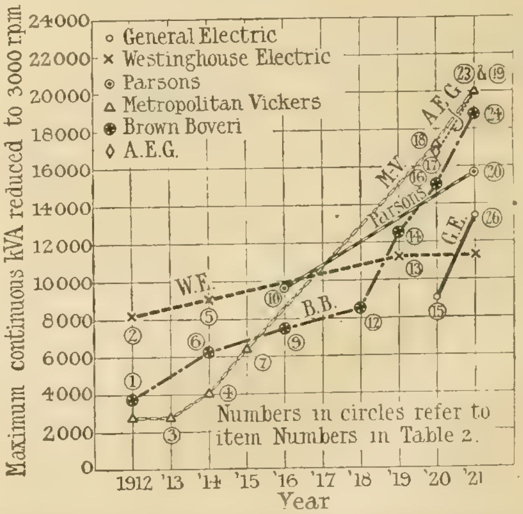

Fig. 2.—Growth of Maximum Continuous kVA Rating of Large High-Speed Alternators Reduced to 3 000 revs. per min.

Among turbines for special purposes, the author mentions (*a*) low-pressure and mixed-pressure turbines, and (*b*) back-pressure and reducing turbines, no very notable developments in method of construction being recorded.

Important Factors in Large Turbine Development.

The chief factors governing turbine design are (1) reliability, (2) working conditions, (3) thermodynamic efficiency, and (4) over all dimensions, weights and costs.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

Reliability is of primary importance, and largely limits the size of a turbine that can be used in power stations. Reliability depends on (*a*) the stress to which the material is subjected, (*b*) magnitude and type of vibration to which parts are subjected, (*c*) stresses due to uneven distribution of temperature, (*d*) reliability of material, (*e*) care during manufacture and erection.

It is suggested that the mean of the factors of safety referred to elastic limit and tensile strength should not be less than 4 when running at normal speed, an emergency speed of 15 per cent. above normal being permissible. The homogeneity of large pieces is naturally less perfect than in small masses.

Vibration refers chiefly to parts that rotate. The critical speed of the shaft should be appreciably above the running speed of the turbine. Vibration of discs presents difficulties. Those of large diameter must be very massive if excessive vibration is to be avoided. Cases have also occurred where the vibration of blades has been such as to cause fatigue of the material.

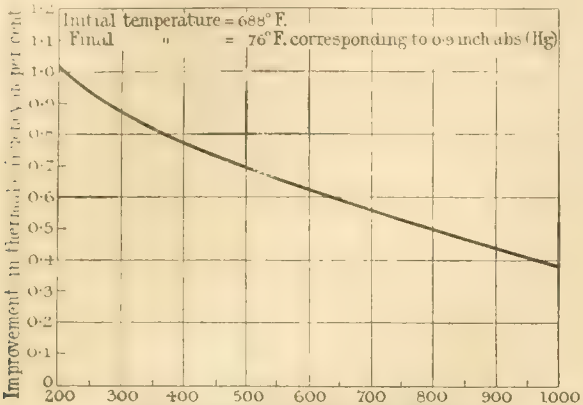


Fig. 3.—Total Improvement in Thermal Efficiency for 10 per cent. Increase in Absolute Pressure.

Stresses due to uneven distribution of temperature also increase with the size of the discs, and, besides increasing stress, tends to lower the natural frequency of vibration. Discs which run without vibration on a steady load may vibrate greatly during changes of load, since the latter sets up momentary uneven temperature distribution.

As regards *materials*, standard properties should be utilised. Designs requiring metal of high tensile strength, only obtainable by using special alloy-steels, should preferably be avoided, as such steels require more careful attention in manufacture and the treating of very large masses presents difficulties. Special alloy steels may be suitable for relatively small turbines running at 3 000 revs. per min., but cannot be recommended for the larger dimensions involved in speeds of 1 500 revs. per min.

Care during manufacture is specially important in turbine design, but construction should be such as to limit the amount of skill and supervision needed so far as possible Manufacturing facilities also play an important part. A rotor that can be completely assembled and shipped is preferable to one shipped in sections and assembled on site. In the latter case adequate facilities for assembly are frequently difficult to obtain, and work cannot be supervised as efficiently as in the workshop. Parts should be so designed as to be capable of being shipped without special precautions.

Working Conditions.

Working conditions with modern turbine plant may be divided into (1) those under the control of the power station designer, and (2) those under the control of the turbine designer.

In the original Paper the author presents a table showing the progress made in steam conditions, illustrated by details of machines installed from 1910 to 1921. The most notable points are increases, at boiler, from 200 lb. to 375 lb. per square inch in steam pressure; at the turbine, from 190 lb. pressure to 355 lb., from 506°F. temp. to 752°F., and from 100°F. superheat to 314°F. The vacua at economical rating vary from 0·9 to 2·0 in Hg, the cooling water temperature from 55°F. to 75°F., the turbine heat drop per lb. from 407·2 B.Th.U. to 492·8 B.Th.U.

At the present time steam pressures as high as 350 lb. per square inch and temperatures as high as 750°F. are being adopted for new stations. The heat drop, as shown by the above figures, has increased nearly 20 per cent., the ratio of expansion nearly in the ratio of 1 : 2.

The author next discusses the basis of calculations for improvement in heat consumption possible with improved steam conditions. It is pointed out that (*a*) the efficiency of a stage decreases with the amount of wetness in steam, (*b*) the reheat factor varies a great deal with the pressure, superheat and vacuum, (*c*) with a given turbine the ratio between the mean peripheral speed, u, and the theoretical steam velocity, c_o, varies with the total heat drop, (*d*) leakage and disc-friction losses increase with higher pressures, and leaving losses with lower back pressures. In the subsequent calculations heat content and heat drop are calculated from Prof. Callendar's formulæ and the method of correcting thermodynamic efficiency, applying the wetness correction and calculating reheat factors are explained.

Effect of Pressure on Economy.

The author has previously estimated that for every 10 per cent increase in pressure the overall economy is improved by 1 per cent. In the original Paper some accurate calculations are given for steam pressures up to 1,000 lb. per square inch, the total temperature and vacuum being constant, at 688°F. and 29·1 in. (Hg) respectively. Graphs of variation in heat consumptions with increase in pressure and improvement in thermal efficiency for 10 per cent. increase in absolute pressure (*see* Fig. 3) are also presented. Actually, with a given turbine, these calculated improvements are not realised owing to increased leakage losses at higher pressures and other causes.

For improvement due to the higher steam temperatures the author has previously formed the conclusion that the consumption is decreased 3 per cent. for an increase in temperature of 100°F. for total temperatures between 600°F. and 750°F., and for steam pressures between 200 lb. and 400 lb. per square inch. A more detailed calculation submitted in the present Paper shows the substantial accuracy of this estimate. Dealing with improvements due to higher vacua, the author presents a table divided into three sections giving (1) heat drops for various steam conditions for 28 in. vacuum, (2) consequent improvement in steam consumption in percentage of consumption at 28 in., and (3) decrease in exhaust steam temperature to obtain 1 per cent. improvement in heat or steam consumption at various steam conditions and back pressures. Improvements due to reheating and feed-water heating are also briefly discussed.

Thermodynamic efficiency, discussed in the last portion of Part II. of the Paper, depends on blading efficiency and losses outside the blading. These losses, however, vary vastly in different types of turbines. Losses outside the blading are summarised in tabular form and are also illustrated here in Fig. 4. Two divisions of losses, with respective totals of 2·89 per cent. and 4·45 per cent., are tabulated, giving a combined total of 7·34 per cent.

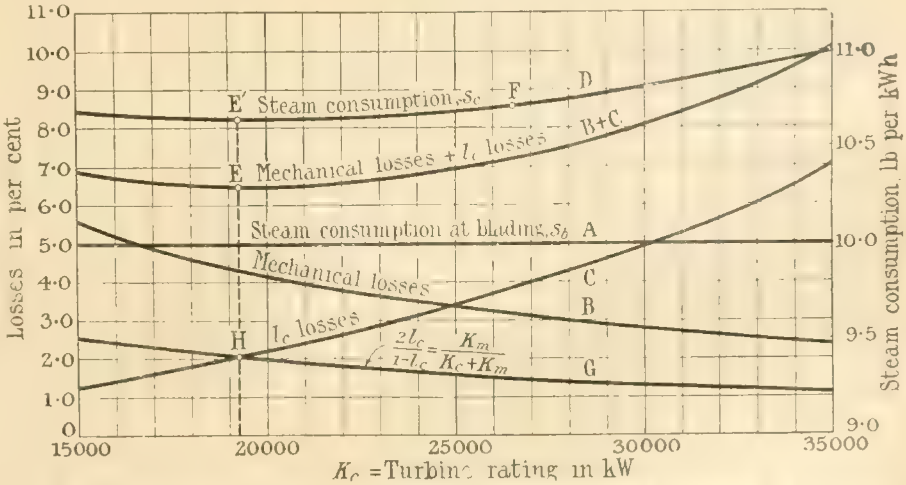


Fig. 4.—Variation of Losses and Steam Consumption with the Rating of a Turbine.
Steam conditions 200 lbs. per sq. in. (gauge), 200° F. superheat and 29 in. vacuum.

Economical Rating of Turbine Frames.

The manner in which the various losses classified in the table mentioned above are distributed is shown diagrammatically in Fig. 4 Curve *A* shows the variation of the steam consumption s_b in lb. per kilowatt-hour at the blading if c^2 losses do not exist. This consumption is independent of the rating, and curve *A* is, therefore, a

Approximate Cost of a Power Station of a Total Installed Capacity K_e (Economical Rating) of 100 000 kW Steam Consumption 10·0 lb. per Kilowatt-hour.

	Total cost in £	Ratio of Total	Cost in £ per kW	
1. Land, buildings and foundation, roads and railway sidings	850 000	0·303	8·50	*a.* For boiler plant £3·5 per kW capacity. *b.* For condensing plant £1·5 per kW capacity. *c.* For electrical plant and turbine £3·5 per kW capacity.
2. Boiler house plant ...	480 000	0·171	4·80	Total cost of boiler and coal plant £6·2 per kW capacity, or £0·62 per lb. per hour of steaming capacity.
3. Coal-conveying plant ...	140 000	0·050	1·40	
4. Turbine ...	250 000	0·089	2·50	
5. Condensing plant, house set and auxiliaries ...	220 000	0·078	2·20	Total cost of condensing plant £3·7 per kW capacity.
6. River work, water culverts...	150 000	0·054	1·50	
7. Alternator ...	220 000	0·078	2·20	Total cost of electrical plant £7·2 per kW capacity. This is independent of the steam economy of the plant.
8. Transformers...	100 000	0·035	1·00	
9. Switchgear and instruments ...	200 000	0·071	2·00	
10. Converting plant, wiring, cranes, miscellaneous...	200 000	0·071	2·00	
Total ...	2 810 000	1·000	28·10	

A. Cost of plant which depends on the kilowatt capacity of the station (1*c*)+ (7)+ (8)+ (9)+ (10) ... =£10·7 per kW
B. Cost of plant which depends on the steaming capacity of the station (1*a*)+ (2)+ (3) ... =£9·7 per kW
C. Cost of condensing plant which depends on the steaming capacity and on the thermodynamic efficiency of the turbine (1*b*) + (5) + (6) ... =£5·2 per kW
D. Cost of turbine ... =£2·5 per kW
Total £28·1 per kW

horizontal line. Curve *B* shows the variation of the mechanical losses expressed as a percentage of the output measured at the coupling. In the case which is considered, the mechanical losses amount to $K_m = 835$ kW. Curve *C* shows the variation of the c^2 losses expressed in percentage of the total heat drop available for a back pressure of 1 in. abs. These losses vary approximately as the square of the rating. Curve *B* plus *C* shows the variation of the total losses expressed as a percentage of the output at the turbine coupling. Curve *D* is the economical consumption characteristic, and shows the variation of the economical steam consumption for the various designed ratings referred to the outputs at the turbine coupling.

The minimum steam consumption rating is affected by a variety of factors, and formulæ for this are given in the original Paper. A pressure drop of 10 per cent. for governing is allowed. This reduces the efficiency by about 1 per cent. The author next discusses the economic rating. Diagrams are presented showing the diminution of rating with varying vacuum and load factor. The relation between losses coefficient and varying vacuum and load factor is also shown. The economic rating is shown to vary inversely as the fourth root of the cost of coal, directly as the fourth root of the interest factor, directly as the fourth root of the evaporation, and directly as the fourth root of the initial cost of the turbine.

Finally, the overall economic rating is considered. In this factor account is taken of other considerations such as the fact that a more efficient turbine enables the boiler house to be smaller. For every 1 per cent. improvement in steam consumption the amount of heat to be dealt with per kilowatt capacity is decreased by 1·4 per cent., which is the amount by which the capital cost of condensing plant will be decreased. The author summarises the items contributing to the cost of a power station of given installed capacity in the Table given above.

MAXIMUM OUTPUT OF TURBINES AT A GIVEN SPEED.

In the fourth section of the Paper the following factors are successively considered: (1) Leaving losses, (2) the specific speed of turbo machines, (3) exhaust losses, (4) combined leaving and exhaust losses, (5) review of different types of exhaust designs, (6) overall dimensions and weights of some large turbo sets, (7) the law of similarity applied to steam turbines, 1 500 revs. per min. versus 3 000 revs. per min. turbines. Dimensions, weights, costs, efficiency.

The design of the last wheel of the turbine is discussed in detail, and other matters affecting blade design, such as the increase in blade leaving area as a function of increased sectional area, are considered. Particulars of the last row of moving blades in a number of typical turbines are assembled in tabular form. Thus in some of the largest turbines of the General Electric Company the mean diameter of the last wheel is 88 in. and the blade height 22 in. The blade area in some of the latest types (42·3 sq. ft.) has been diminished from a former value of 52·3 sq. ft. Economical capacity is diminished about 20 per cent., but the machine is regarded as safer, as stresses are reduced in proportion. Formulæ affecting specific speed of turbines and data enabling exhaust losses to be calculated are presented. Reviewing different types of exhaust designs, the author comments on various solutions of the problem of reducing leaving losses, such as reduction of speed, increased blade length with speed, double-flow exhaust end, &c. A proper solution must comply with a suitable factor of safety, reasonable cost, and avoidance of special precautions in manufacture, avoidance of excessive overall dimensions. A table summarising dimensions and weights of typical turbines is included in the original Paper. During the period under review floor-space per 1 000 kW economical capacity has been roughly reduced from 40 sq. ft. to 20 sq. ft., and the weight per 1 000 kW from 14 tons to 7 tons.

It is remarked that a turbine of a capacity of 20 000 kW running at 1 500 revs. per min. can be made with a certain weight (say, 100 tons) and at a given cost (say, £50 000) and with a given efficiency (say, 80 per cent.). By reducing all the dimensions to one-half, a turbine of 3 000 revs. per min. would be obtained, the rating being reduced to 5 000 kW, the areas being reduced to one-quarter, and the volumes to one-eighth. The weight of the 3 000 revs. per min. turbine would accordingly be only one-eighth of the weight of the larger turbine, and the weight per kilowatt only one-half. Actually, however, it is not practical to obtain such conditions, for the clearances between moving and stationary parts would be reduced one-half, which is too small for practical workmanship; similar considerations of present foundry practice limit the diminution in thickness of castings. Generally speaking, in multiplying capacity by speed where the same product is obtained, the efficiency should be about the same. An increase in the capacity speed factor of 100 per cent. would advance the efficiency by about 2 per cent., provided the leaving losses remain the same.

GOVERNING OF STEAM TURBINES.

Part V. of the Paper is on the governing of steam turbines, and is concerned mainly with: (1) Nozzle versus throttling governing (by-passing at high temperatures), (2) design of nozzle boxes, (3) steam chests, (4) design of high-pressure end (C.S.).

In Part VI. some recent steam consumption guarantees and test results on large turbines are summarised. The higher the steam pressure the more difficult it becomes to design a turbine for a given efficiency. From a diagram relating to thermodynamic efficiency correction and variations in pressure and superheat from those for which a turbine is designed, it is deduced that: 100 per cent. increase in pressure decreases efficiency by approximately 2 per cent.; 100 per cent. increase in superheat increases efficiency by approximately 2 per cent.

A similar chart giving efficiency correction for vacuum is also presented. This correction depends much on the degree to which the particular turbine is rated, the correction being substantially greater for a higher rating.

Since the efficiency of a turbine can be improved at the expense of increased cost per kilowatt, an allowance in efficiency for such additional cost should be made in making a comparison between two designs or types of turbines on an "economic" basis. Efficiency can be increased at the expense of extra cost, (*a*) by underrating the turbine, (*b*) by increasing the number of stages. With single-cylinder units of large size there is not much scope in this direction. (*c*) By increasing the number of stages and adopting the two-cylinder design. Besides entailing extra cost, this last method involves increased floor space and complication of arrangement.

OPERATING EXPENSES.

Finally, some account is given of operation experiences with large turbines. Difficulties have been associated partly with the high stresses arising from higher peripheral speeds, but mainly with increased tendency of parts to vibrate. In view of the large units now becoming usual the discussion of the causes of breakdown is of vital importance, and the author remarks that turbine construction has now arrived at a critical stage. A valuable tabular *résumé* of turbine troubles from 1917-20 is given, the reference to the source of information being quoted in each case, and the cause of the accident discussed and analysed. Among the troubles experienced are distortion of turbine, rotor and stator, deflection of diaphragm, cracking and breaking of turbine discs, breaking of moving blades, corrosion and erosion of blades, faulty lubrication and bearings, defective governing and steam leakage, each of which is discussed in turn. Particular directions are given regarding the starting up of large turbines, the aim being to produce temperature conditions similar to those which should exist when the machine is running under load.

Electricity and Matter.

Sir Ernest Rutherford, F.R.S., Sir J. J. Thomson's successor as Cavendish Professor of Experimental Physics at Cambridge, has also succeeded him as Professor of Natural Philosophy to the Royal Institution, and in that capacity he delivered his first series of three lectures on Saturdays, March 5, 12, 19. In the selection of his subject again, one might say, he followed his predecessor—naturally, because "Electricity and Matter" cover the major portion of modern physics. During the last twenty years our ideas on this subject had been revolutionised, Sir Ernest remarked in his introduction, though the idea of the atomic nature of electricity had come in almost unnoticed; at present the title of his lecture might, in fact, be: "Electricity, No Matter."

The Advance from the Frictional Era.

The first great advance from the ages of frictional electricity had been Volta's discovery that chemical reactions produce electricity. In 1853 Faraday disclosed the laws which control the passage of electricity, and that discovery of Faraday, from both the philosophical and industrial standpoints, had been second in importance only to his discovery of electromagnetic induction. To exemplify the delicacy of electrolysis, Prof. Rutherford showed C. T. R. Wilson's experiment of decomposing diluted mercurous nitrate with the aid of a kathode consisting of a Wollaston wire of platinum just emerging from its glass sheath; the current induced by withdrawing a magnet from a coil of wire was sufficient to give rise to the growth, at the wire, of a mercury globule which could be watched microscopically. In such experiments Faraday found that the mass of metal or gas deposited at the electrodes was either proportional to the atomic weight itself, or to half or quarter of it (stannous and stannic salts), one-third, &c., the electro-chemical equivalent being thus equal to the quotient atomic weight/n, where n was a small integer. That could be accounted for by assuming that the potassium ion carried 1 charge, the stannous ion 2 charges, stannic ion 4 charges, nitrogen 3, &c., never a fractional charge, and the fact implied that there was a definite unit of electricity. Great men like Maxwell and Helmholtz (Faraday lecture 1881) fully recognised this; Maxwell indeed spoke of molecules of electricity, Helmholtz, in more modern language, of atoms of electricity; but both were loath to accept the startling consequences—for two reasons. The conception of charge was not then clear; and the flow of electricity through a metal appeared not atomic, and totally different from that through an electrolyte. The discovery by Crookes of kathode rays, invisible, yet capable of producing phosphorescence and of being deflected by a magnet, led to other discoveries, and to J. J. Thomson's recognition of the rays as negatively charged particles travelling at speeds up to 100 000 miles per second.

The Early Work of Thomson.

That any particle of matter had its mass increased by carrying an electric charge was recognised by J. J. Thomson as early as 1881. Such a travelling-charged particle constituted a current (Rowland), and would create a magnetic field around it; the energy stored in the ether was therefore greater than when the particle was uncharged, and with very small particles moving at very high speeds that increase in mass would become comparable to the mass of the atom. By deflecting radium rays attaining almost the velocity of light, both by magnetic and electric fields, W. Kaufmann proved that the swifter particles were moving at two and three times the speeds of the slower particles of the same mass, and that their mass was, therefore, almost all electrical and not associated with matter, though possessing the properties of ordinary matter. The relationship was the following. If M were the mass of the hydrogen atom carrying in electrolysis the charge E, and N the number of atoms per gram, then $NM=1$ gram, and $NE=9\,650$ electromagnetic units required to liberate 1 gram of hydrogen; hence $E/M=9\,650$. If similarly m_0 and e applied to the electron at low speed, experiments showed that $e/m_0=1{\cdot}77\times10^7$ units. Assuming now $E=e$ numerically, then $m_0/M=9\,650/1{\cdot}77\times10^7=1/1\,830$. The mass of the electron changed with its speed, as Heaviside had worked out. By Einstein's relativity relation we understood more easily, however, that, if m denoted the mass of the electron at any speed, $m/m_0=1/\sqrt{1-\beta^2}$, where $\beta=$ velocity of light/velocity of electron. From this it followed that for particles of 0·98 the speed of light (the swiftest α-particles) the mass would become 5 times their mass at slow speeds. Einstein's relation, it should be noted, would generally hold, also for uncharged particles. There was little doubt, however, that the electron was an atom of electricity merely electric in mass.

Measuring the Electronic Charge.

He had presumed in this argument that the charge of the electron was equal to the charge on the hydrogen atom, though the atom might be many times larger. Ionisation experiment with X-rays had justified that assumption. When the beam of rays passed through a layer of air between plate electrodes joined to a battery, the negative ions would move, say upwards to the positive upper plate, and the positive ions downwards—the latter movement being slightly slower, especially in the presence of moisture; the battery could hence maintain a current through the ionised air. Now ultra-violet light falling on a polished plate of zinc discharged electrons which, attaching themselves to air molecules (Lenard), ionised the air and rendered it conductive. If we could measure the charge on the ion, we could find the charge e of the electron. This was accomplished by J. S. Townsend (1897 and later). When sulphuric acid was electrolysed, the oxygen liberated might carry either a positive or a negative charge. In moist air each particle became a nucleus of condensation for the water vapour, and a cloud of mist was produced which cleared very slowly. The rate of speed at which the particles settled (Stokes' law) depended upon the radius of the sphericle; the particle would fall in air 12 mm. per second if radius $=0{\cdot}01$ mm., and only 0·12 mm. per second, if r were 0·001 mm., the formula being $v=2gr^2\sigma/9\eta$, where σ and η were the density and viscosity of the medium. By observing the rate of fall Townsend was able to deduce r, the σ and η being known; the total mass of water in all the droplets was determined by passing them through sulphuric acid and by weighing the acid, and from the mass and radius the number of droplets was deduced. As most of the droplets, fortunately, carried only one charge, the charge itself was determinable. He thus found that the charge of the ionised gas particles was, within 10 per cent., numerically equal to the charge carried by the hydrogen ion. In his demonstration of Stokes' law Sir Ernest made use of small glass balls and glycerine; each ball fell uniformly, but the bigger ball soon overtook the smaller.

These determinations of the unit charge had been carried further, Sir Ernest said in the second lecture, by C. T. R. Wilson, who produced the condensation desired by suddenly expanding the air in a chamber the bottom of which could be dropped. When this operation was repeated several times, no further condensation was observed; but when the X-rays were passed through the air there was again condensation on the ionic nuclei formed. This method had been adopted by J. J. Thomson and others with relatively good results. Yet the method could not be very accurate, because we had to presume that the droplets carried only one charge, and, further, because the condensed globules began to evaporate again as soon as they formed, so that their mass estimates were uncertain. Those objections were overcome in 1909 by the method of Millikan, who took many observations on a single drop which he introduced into an electric field.

Millikan's Experiments.

If a negative particle charge, E, were placed in the electric field X between two plates at distance d, charged to a potential V_1, then $X=V/d$, and the particle would be impelled upward to the upper positive plate with a force XE, while gravity pulled it down. By varying the field a single particle could be held stationary or be made to move up or down. The air particles could be charged by passing X-rays through them; in their motion through other particles they might pick up further charges of either sign, the fact being indicated by an acceleration or retardation. There was a pin hole in the upper plate, through which particles entered the field, and single particles might be caught and watched by the aid of a microscope between cross wires. In the actual experiments, oil (which gave non-volatile drops) or mercury was atomised by forcing air through it. A single particle electrified by friction was delivered from a mouth-piece into the hole. Both the charge and the potential V were varied. The particle was then moved up and down many times, the velocity being observed by a chronograph. If, now, v_1 were the velocity due to gravity alone, and v_2 the velocity due to the field, then $v_1/v_2=mg/(XE-mg)$, and $E=mg\,(v_1+v_2)/Xv_1$, m being the mass of the particle. If we returned the charge E to E_1, the loss of charge would be $E-E_1$, and the new velocity, v_3, was given by $E-E_1=mg(v_2-v_3)/X$. The observed velocities did not appear to show any regularity; but when the differences of the v were plotted, one at once recognised that they were either 0·00891 cm. per sec. or simple multiples of that figure. Starting with drops of, say, 100 charges, Millikan always came down to the same simple multiples by varying the charges. There was thus a definite unit charge or atom of electricity, and every electric charge, small or large, frictional or induced, was built up of such atoms. The experiments also proved that the ionisation of a gas molecule by X-rays consisted in the detachment from a neutral molecule of one elementary charge.

Millikan's final value for e, the atom of electricity, was 4·774 $\times 10^{-10}$ electrostatic units, and was probably correct within 1 per cent., possibly wtihin 0·1 per cent. But this, the atomic character, was, of course, understood long before Millikan; yet the accurate measurement was of the utmost importance, since the e affected the other constants, the mass of the hydrogen atoms, the number of molecules per cm.^{3}, the radiation constants, Planck's h, &c.

Properties of Charged Matter.

Passing to the properties of charged matter, and to the extraordinary delicacy of our measurements of charges at high speeds, Prof. Rutherford showed Geiger's apparatus, in which a fine needle was mounted axially in a cylinder charged by a battery, the point facing a hole in the end of the cylinder, which was exposed to α-ray bombardment. When a particle happened to find its way through the hole, it discharged the tilted electroscope joined to the needle. In this way the kinks of Fig. 1 (α and β particles) were produced; they were not spaced at regular distances, and that was what one would expect, since the discharge of the particles was only subject to the law of probability. The discharge of particles could also be made visible by the aid of the scintillation produced when a particle struck a fluorescent screen. A speck of radium placed on a photograph film gave a splash from which rays extended in all directions, the rays being made up of grains of reduced silver. The expansion method of C. T. R. Wilson also gave very remarkable results. The path of an α-particle through moist air was marked by a row of very small water drops, mostly straight lines, sometimes, however, showing distinct deflections. The effects of β-particles (electrons) were much feebler, and the paths were peculiar crooked lines. Bumstead had also made such experiments in hydrogen (Fig. 2). In the Wilson apparatus of T. Shimizu (made by the Cambridge & Paul Instrument Company, and exhibited) the discharge of α-particles could be watched at leisure. By means of a small electric motor, the piston of the chamber, about 2 in. diameter, was worked up and down; the piston was smeared with glycerine, and the top of the chamber closed by a glass plate. A speck of polonium was attached to the cylindrical wall underneath the glass. Rays were seen to shoot across the plate, two or three per second, radiating out in all directions, and these rays remained visible for several seconds.

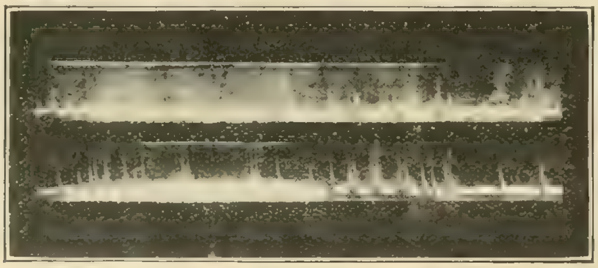


Fig. 1.—Photographs of α and β-Particles Given Off by Radium.

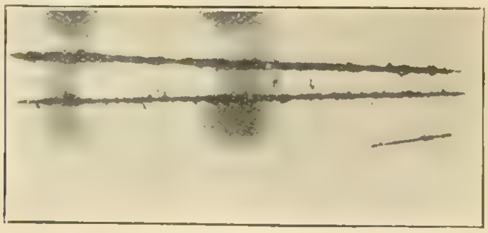


Fig. 2.—Trails of α-Particles Through Moist Hydrogen.

The Inter-Relations of Mass Atoms and Electrons.

How were the mass atoms and its electrons inter-related and cemented together? The electron was a constituent of all matter. A moving electron constituted an electric current. The current though a wire was carried by a stream of electrons, the positive charge remaining fixed; in electrolysis both the charges were migrating. How many electrons were in the atoms, and what else was there? Somewhere, he fancied, must be the exact counterpart to the negative electron, the positive electron. But nature did not work that way. We had never been able to detect a charge associated with a smaller mass than the atom of hydrogen, 1 800 times as large as that of the electron. Was there then an essential distinction between positive and negative electricity? It seemed to be so, and upon that might depend the possibility of our universe as it was. Prof. Rutherford proceeded to show his atom model, a positive nucleus surrounded by electrons. A heavy α-particle shot at the nucleus would little be disturbed by the electrons; but it was deflected sometimes, as mentioned, to such an extent as to suggest gigantic collisions. Yet there need not be actual collisions, as an experiment showed. The bob of a pendulum suspended from the ceiling was formed by a rod-shaped solenoid (the α-particle); underneath the bob was another fixed vertical electro-magnet (the atom), the two coils belonging to the same circuit with their north poles facing one another. When the bob was pulled away, the swinging pendulum was deflected by magnetic repulsion, the deflection being maximum when the speed was highest and when the swing was in the direction of the fixed pole. In gases the Wilson photographs showed the deflection might amount to 45 deg.; when α-particles were bombarding gold foil (atoms with very heavy nuclei) the deflection might amount to 170 deg., so that the particle was actually turned back. That proved the enormous forces at work. Yet most of the particles were only deflected by about 5 deg.; if we represented the particles scattered through that range by a line 16 6 km. in length, the lengths corresponding to deflections of 30 deg. and 90 deg. would be represented by lines of 13·4 m. and of 25 cm. respectively. These deflections, from which the charge on the nucleus was roughly deduced within 10 or 20 per cent., were in accord with a repulsion following the law of inverse square; they proved that the mass concentrated in the nucleus was of extraordinarily small dimensions, occupying perhaps 1/10 000th of the space occupied by the electrons. The experiments upon which these conclusions were based had been made by letting α-particles (from a speck of radium) fall on gold foil (or other metal), and then, after penetrating, upon a screen of zinc sulphide which was placed at different distances so as to catch the particles scattered at different angles; the scintillations produced were counted by the aid of a miscroscope.

The Grouping of Atoms.

Further researches had proved that the nuclear positive charge of an atom was equal to half its atomic weight, and that the nuclear charges increased by units from one element to another. It seemed clear that the hydrogen atom consisted of a nucleus of unit charge with one electron at some great distance, and that the helium atom had two nuclear charges and four electrons. We were less certain about the other atoms, but the great generalisation of Moseley helped us. When Laue (1912) and Bragg had studied the grouping of the atoms in crystals and had measured the wave lengths of X-rays by these means, Moseley found (1913) that the characteristic K radiations of all the elements consisted of two principal lines which shifted in equal steps, more and more, into the region of higher frequency with increasing atomic weight, and that the properties of the elements were better defined when we arranged the elements as to their atomic numbers—ordinal numbers, Sir Ernest would say by preference—than when arranged by their atomic weights. When we arranged them in the order of Moseley, as completed by Siegbahn and others, two pairs of elements, cobalt and nickel (atomic numbers 27 and 28, atomic weights 58·97 and 58·65) and similarly tellurium (number 52) and iodine (53) appeared to be in the wrong order in Mendeleieff's table, and a few gaps remained in the atomic number series, from hydrogen 1 up to uranium 92. But the recent experiments of Chadwick showed that the nuclear charge was really equal to the atomic number. Thus the properties of the atom were really defined by the nuclear charge, and the atomic weight became in a sense a secondary quantity.

How then was the nucleus built up? The investigation of radioactive disintegration had led to another generalisation by Russell, Soddy, and Fajans. The explosive disintegration of an atom did not take place in the external parts, it must occur in the nucleus as we were unable to modify it by heat or in other ways. Now when uranium U or UI (atom. weight or mass 238, number 92) decayed, it threw off an α-particle and changed into UX_1, mass 234, number 90; the α-particle was the nucleus of a charged helium atom of mass 4. UX_1 in its turn threw off a β-particle, practically of no mass, and changed into UX_2 of mass 234 again, but of number 91, since the loss of a β-particle meant the acquisition of a positive charge. Again UX_2 lost a β-particle and turned into UII, still of mass 234, but of number 92, since another positive charge had been acquired. Further, UII threw off an α-particle and changed into ionium of mass 230 and number 90. Thus we had three substances of mass 234, but of the three different atomic numbers 90, 91, 92, and two substances of the same atomic number 92, but of different atomic weights 238 (U) and 234 ($U\pi$). Similar relations held for the radium and thorium families. That there should be atoms of the same properties and of the same atomic number, but of different atomic weights (isotopes), had appeared strange. But it was confirmed by the atomic weight determinations of the end products of the disintegration. Both uranium-radium and thorium finally decayed into lead; the two series should yield a radium-lead of mass 206 and a thorium-lead of mass 208. Ordinary lead had the mass 207·2; if it were a mixture of the two lead isotopes mentioned, the final decomposition products of minerals in which both radium and thorium had occurred in various proportions, we should expect to find lead specimens of masses lying between the limits $Pb=206$ and $Pb=208$, and that was fully comfirmed by Soddy, Hoenigschmid and Richards; Hoenigschmid's highest value was 207·91.

Nuclear Charge the Determining Factor.

So far the chemists had been unable to discover any differences between radium-lead and thorium-lead, and the slight difference in mass would only affect the rate of vibration by 1 : 1 000 000. In radioactive elements the atomic number, *i.e.*, the nuclear charge, was thus the determining factor, not the atomic weight. But was isotopy confined to radioactive elements? The positive-ray analysis of F. W. Aston showed that chlorine, neon, argon, krypton, mercury and some other elements had isotopes, whilst carbon, nitrogen, oxygen and fluorine had not, and, further, that when we referred the mass to oxygen=16, all the atomic weights (with the exception of hydrogen) came out as integers. How was that to be understood? Helium (mass 4) was certainly a constituent of radioactive atoms; why not of others? The other likely constituents were electrons and the hydrogen nucleus, and helium itself might be built up from hydrogen. Thus carbon, atomic weight 12, might be 3×4, oxygen $16=4\times4$, nitrogen $14=3\times4+2\times1$. What was that unit? The hydrogen atom, chemists and Aston agreed, had the mass 1·008, not 1; if, then, helium were to have the mass of four hydrogen atoms, its mass should be $4\times1{\cdot}008=4{\cdot}032$, and not 4. But suppose we had a hydrogen atom and brought an electron up to it; as it came nearer the electron, energy was given out, and when the two parts were close together, their total mass was less than the sum of the two masses, the deficit being equivalent to the energy lost during approach.

Was there experimental evidence supporting this suggestion? Radioactive explosions generated helium, but not hydrogen. In bombardments from light gases like fluorine (mass 19 possibly= $4He+3H$) by α-particles, hydrogen might be driven out, and that hydrogen, he had calculated, should go on with 1·6 the velocity of the α-particle, just as in a collision between a heavy ball and a light ball (suspended in pendulum fashion), the light ball moved on at increased speed. Sir Ernest had not tried fluorine. Disc charging, together with Mr. Chadwick, α-particles into hydrogen, however, he found that up to 40 times as many hydrogen nuclei were hurled against the fluorescent screen as he had expected; Fig. 3 illustrated such a collision between an α-particle, which went on in its path, and a hydrogen molecule, which flew off at an angle. The photograph was taken by the Wilson method. In similar experiments with nitrogen and air hydrogen was also liberated, too many atoms of it again; nitrogen seemed to have been dissociated by colliding with the α-particle, and hydrogen to have been given off. Even aluminium gave off particles with this bombardment. That the hydrogen found in the cases of nitrogen and aluminium was not due to contamination of the apparatus with hydrogen was proved by the ranges of the particles. If the range of α-particles were 7 cm., that of the hydrogen particles was found to be 28 cm. (possibly 29); the particles from nitrogen had a range of 40 cm., those from aluminium a range exceeding 80 cm. It seemed reasonable to suppose that atoms were built up of the helium nucleus and the hydrogen atom, and the helium nucleus itself of a hydrogen nucleus and electrons. If, then, the atoms of all elements could possibly be expressed in terms of electrons and of hydrogen atoms, the hydrogen nucleus with unit positive charge would be the looked-for counterpart of the electron with unit negative charge. Though that unit of positive electricity had 1 800 times the mass of the electron, it was equivalent to it in electric charge. In this sense Sir Ernest had previously spoken of the "asymmetric" character of the atom and of electricity. The positive electron had its energy much more concentrated than the negative electron. But all matter could be resolved into these two units, and he came back to what he had started from, that matter was disappearing and we had only electricity left.

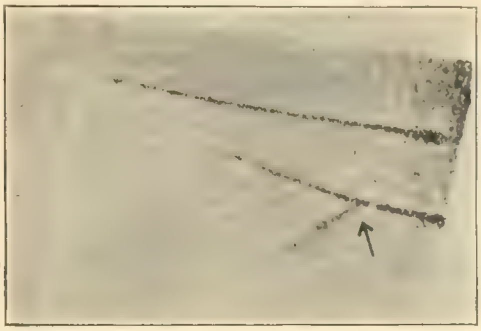


Fig. 3.—Collision Between an α-Particle and a Hydrogen Molecule.

The Institution of Electrical Engineers.

A Useful Paper on Steam Turbines.

The audience which assembled at the meeting of the Institution of Electrical Engineers on April 7th to listen to a Paper on "Some Recent Developments in Large Steam Turbine Practice," by Mr. K. Baumann, an abstract of which will be found on another page of this issue, was quite as large as usual, although the subject was a purely mechanical one both in essence and in treatment. Steam turbine development is, indeed, so closely related with the future of electricity supply that its details and difficulties are well worth close study by electrical engineers. This applies with special force to turbo-alternator designers, who may be recommended to read the Paper carefully so as to obtain a better idea of the problems which turbine manufacturers have to solve, and to discover what assistance can be given towards the common object of improving the operation of the combined equipment. The author is to be congratulated on his success in boiling down the contents of what is almost a volume into an interesting continuous narrative, lasting some 20 minutes, but, as the President said, his exposition hardly gave an accurate idea of what the Paper included, while the time members had had to study the advance copies of the Paper seems to have been equally inadequate to allow a considered discussion of its details. This was particularly the case with regard to costs, an important question upon which no speaker touched.

Mr. Atkinson went on to say that it was an opportune moment for having a review of turbine progress. Large power stations were being envisaged and electrical engineers were rather uneasy about the breakdowns that had occurred with some large turbines. He agreed with the author that a full and frank discussion of these failures was one of the most important points to which the discussion could be directed.

Some American Experiences.

Mr. W. H. Patchell, who in recent years seems to have become more of a mechanical than an electrical engineer, was then called upon to open the discussion and gave a kaleidoscopic *résumé* of his recent visit to the stations of the Detroit Edison Company, where he had been afforded an opportunity of seeing how the troubles that had been experienced with large steam turbine operation were overcome on the other side. By "big" the author apparently meant 15 000 kW or 20 000 kW; in the States 20 000 kW was normal, while in the Conners Creek station of the Detroit Edison Company they had one 45 000 kW machine and another 30 000 kW machine actually in operation. There had been numerous troubles with these machines, troubles which Mr. Patchell ascribed to war conditions and lack of opportunity to test out the designs. Continuing in lively fashion, the speaker described the somewhat devastating series of experiences that the Detroit Company had been through with the various 20 000 kW and 30 000 kW machines they had erected. He showed a number of slides to illustrate his remarks. One particular feature on the steam end of a 40 000 kW machine owned by the company was due to the fact that it was made of that foul stuff called semi-steel. It split through bodily. The centre of the shaft of this machine was 7 ft. from the floor. The steam pipe was 22 in. in diameter and looking down into the condensers before the top was put on was like looking into a tunnel. Faults on these sets were not confined to the turbines. On one 45 000 kW alternator the corona winding had given out, but another had been in almost continuous operation since it was put into service last year, and had worked most satisfactorily. The first, after re-blading, was also performing quite well, though alternator troubles had prevented it going back again on to the line as early as they had expected. This machine ran at 1 200 revs. per min. and weighed 115 tons. Mr. Patchell also gave particulars of a 70 000 kW machine (though he mentioned that this rating was a little prophetic), which had been built by the Westinghouse Company for use in the 74th Street Station of the Interborough Rapid Transit Company of New York. It had three shafts, one driven by high pressure and two by low pressure, with arrangements which enabled either of the low pressure cylinders to be cut out in event of trouble or to be supplied with high pressure steam through reducing valves. Trouble had been experienced with this machine, owing to the labryinth packing seizing, but it was fortunately unattended by such serious consequences as those that had occurred at the station of the Boston Elevated Railway, where a 30 000 kW machine had gone through the roof owing to a failure from the same cause. Owing doubtless to lack of time Mr. Patchell drew no moral from this chapter of accidents. But we suggest that he should develop the subject in either a Paper or a lecture.

An Economy in Test Results.

Mr. A. R. Carnegie complained that whatever else the Paper contained, it was singularly free from test results, owing, according to the author, to the fact that there had only been one test published in the period under review. Mr. Carnegie, in trying to fill this hiatus, repeated a number of figures relating to the 20 000 kW Parsons turbine at Chicago, and three of the 10 000 kW turbines at Carville, which he gave in the discussion on Mr. I. V. Robinson's Paper at the I.M.E.A. Convention last June. These will be found in The Electrician, Vol. LXXXV., p. 34, July 2nd, 1920. He pointed out that original tests made in 1914 and a series of repeat tests made in March 1918 were extraordinarily close, while a similar machine which had been tested that day gave a steam consumption of 10·3 lb. per kilowatt without any corrections, the guarantee being 10·9 lb. per kilowatt. Corrected results for the four machines he had mentioned were 10·35 lb., 10·53,lb., 10·51 lb. and 10·44 lb. per kilowatt, so that not only a low but a constant steam consumption could be expected. This was after an operating period of 2½ years in the case of two of the Carville machines and 4½ years in the case of the third machine. The total number of running hours amounted to 68·5 per cent. of the total possible running time. Similar tests at Dunston, where the conditions were not so good, pointed to the same constancy. The lessons of these tests was that to obtain a high efficiency in a reaction turbine was not a matter of chance. He thought Mr. Baumann should have said something about end tightened blading, for tubines had suffered in the past from the use of too fine radial clearances.

Some Criticisms from a User.

Mr. R. A. Chattock, who is a rare visitor to London, had been scared by the statement that to increase the average maximum output and the highest possible speed were the objects of turbine designers. He was a little re-assured, however, when he found that "the highest possible speed" only meant 1 500 revs. per min. This, however, was high enough, as high speeds tended to reduce reliability, the one factor that was all important in the user's eyes. Even thermodynamic efficiency should not be developed at its expense and it was worth while going to any reasonable cost to obtain it. He did not like geared turbines. The author had emphasised the necessity for not going through the critical speed, but alternator builders often wanted to do this, thus causing undesirable vibration. Erosion, he thought, was chiefly due to the presence of moisture in the steam. There was more condensation with present-day pressures and the greater heat range to which they were working. Oil temperature was not always a sure guide of the condition of the bearings and he advocated the use of temperature indicators and the fitting of an additional thrust bearing as a standby. He preferred the proper filtration of oil to the partial methods suggested by the author.

The Advantages of High Pressures.

Mr. H. L. Guy said that the question of how the gain in heat consumption obtainable by using higher pressures was affected by the inherent limitations of modern turbines must be considered in relation to the effect of the losses that occurred in cylinder and diaphragm and from friction and windage. There were advantages in using higher pressures in the larger size machines, but the pressure actually chosen depended on a compromise between the capitalised value of the net gain and the increased cost of the high pressure plant. In a 25 000 kW set for instance, the net gain was 8 per cent. of what was theoretically possible at 300 lbs. per sq. inch, or 17 per cent at 500 lbs. per sq. inch. Almost the same increase could be obtained by adopting the two-cylinder design, though the higher cost of the machine itself would approximately cancel the capitalised value gained. Its adoption might, however, be necessary for mechanical reasons. Mr. Guy was rather hard to hear apparently because he was reading a short Paper. His behaviour on hearing the president's warning bell suggests that Prof. Waller might make a study of the physiological effects of this disturbing influence. There are those who start and look red, there are those who apologise and sit down abruptly, and there are those who, like Mr. Guy, take no immediate notice.

Support for the Geared Turbine.

Mr. S. E. Fedden came out as a supporter of the geared turbine. He had been running two with a capacity of 2 500 kWA for three years These machines took the place of two 1 500 kW turbines and had been put down on the original condensers and were driving the original alternators. Their guaranteed consumption was 15 lbs. and they were running steadily at ½ lb. less than that. He wanted to know how long the impulse turbine could be run without being rebladed and was critical of the author's remark that a disc which ran without vibration at a steady load might vibrate on a change of load. In spite of the author he still thought that the reaction type of blading usually gave the best steam consumption results. His argument that a 10 000 kW turbine running at 3 000 revs. per min. was equivalent to a 20 000 kW. set running at 1 500 revs. per min. was really an argument against very large turbines until these had been thoroughly tested. Mr. Carnegie's figures were an excellent advertisement for 10 000 kW. sets. Mr. Fedden also objected to the author's scheme for passing high pressure steam into low pressure cylinders and pointed out that cast steel "grew" just as much as cast iron. In considering steam temperatures and pressures it must not be forgotten that the turbine was not the only place where losses occurred. Altogether a thoroughly critical contribution from an experienced user of turbines.

Two Directions in Turbine Development.

Mr. B. Pochobradsky was made the subject of an interesting experiment by the President in that he was called down to the front of the room to deliver his remarks. It worked very well. Modern turbine design in his opinion was developing in two directions, one towards the use of a large number of stages of comparatively small diameter and the other towards a small number of stages with rather larger diameters. The United States were in the first class, and the Continent in the second class, while in this country both were represented. It was only fair to add that the Continental ideas gave the best results on the test bed and in the laboratories. Developments were also being made in the use of increased pressures and temperatures, and every effort should be directed to secure all the advantages obtainable by improving our heat consumption by intermediary and feed water heating. It was not only a question of using high pressure but of seeing that the increased pressure was utilised in the right way. He did not agree with Mr. Baumann that steam turbine manufacture was in a critical stage, as the accidents to which so much attention had been called had also occurred in the past and could probably be attributed to local causes and not to defects in particular designs. There was, however, the other side of the picture and he instanced a series of designs in which no provision was made for expansion, where clearances were insufficient and where the oil service could be too easily interrupted. Most accidents were due to causes which were well known though those due to the diaphragms were probably mainly caused by the higher temperatures and pressures now being used and to the longer blades. This could be overcome by preventing sudden changes of temperature, by the elimination of by-passes, by leaving room for expansion and providing proper fixing, while accidents to discs might be avoided by a better inspection of the materials used.

The Leaving Losses Fallacy.

Mr. W. A. **Jude** twitted the author on his attitude to leaving losses. After all what were they? Their sum, as stated in the Paper, was between 7 and 8 per cent., the average efficiency of the turbine being 80 to 82 per cent. Where were the missing 10 or 12 per cent.? Were they radiated as heat or did they go into the oil? He was sure that they had gone down the exhaust pipe. In other words the whole of the losses were leaving losses. To deal with these poor little 2·8 per cent. losses Mr. Baumann advocated the use of long peripheral blades, but it was doubtful whether the cure was really worth it. On a 20 000 kW turbine where the leaving losses were about 1·57 per cent. of the total available energy, it would be necessary to use blades 24 in. long. With blades 14·75 in. long the leaving losses would only be 3·25 per cent., or 1½ per cent. only would be paid for reducing the blades by that large amount. It might therefore be worth it. Using long blades was asking for trouble, as the cost of a breakdown and a fortnight's stoppage might well be £24 000. He did not like the idea of a multi exhaust machine. Its design was bad as the valves were out of proportion to the size of the steam pipes and the split nozzle arrangement was unsuitable for the kind of turbine illustrated.

Simple Straightforward Methods.

Mr. R. J. **Kaula** did not agree with Mr. Jude about the defects of Mr. Baumann's multiple exhaust design. Nevertheless, all these methods of overcoming difficulties were at best temporary, and sooner or later we should have to get back to simple straightforward designs. Obstacles to the use of the large single flow turbine were the difficulty of obtaining a disc of reliable material throughout and uncertainty with regard to the vibration. He gave an account of a case of vibration on one of 20 similar machines, the only difference between them being that the one that gave trouble was coupled to a 25-cycle alternator. Vibration took the shape of a wave, stationary in space, and having a peripheral length 120 degs. The result was that the blades touched the adjacent diaphragm as did the rim of the disc and considerable damage was done. The fault was probably due to the material of which the disc was made. For when a new one of carefully selected steel had been made and the blades placed at a greater distance from it the vibrations were still present, so that the trouble was not due to the steel. It had been found by calculation and experiment that the lateral frequency of the disc was 3 000 per minute, which coupled with the fact that it was a 25-cycle alternator, represented 33 000 pole changes per minute. As every pole change meant an impact it followed that the disc itself must be the cause of the vibration, and the trouble was eventually remedied by stiffening it considerably.

A Plea for the 3 000 r.p.m. Machine.

Mr. A. B. **Field** complained that undue prominence had been given to the 1 500 r.p.m. machine. In his opinion the most promising feature of the period the author had dealt with was the development of the 3 000 r.p.m. turbo-generator. It was true this development had taken place almost entirely in Europe, but that was due to the differences in the standard frequencies here and in the United States. Before the war there seemed some prospect of a demand for 50 000 kW sets in this country, but that prospect had disappeared for the present, in spite of the fact that makers were willing to design machines of 20 000 kVA capacity running at 3 000 revs. per min. The author had mentioned that a 30 000 kW machine of the type he had described was under construction at Schenectady. Mr. Field believed that statement would have been equally true four or five years ago.

Work of the British Electrical and Allied Manufacturers' Association.

The annual general meeting of the British Electrical and Allied Manufacturers' Association was held on March 17th, Mr. W. O. **Smith**, Chairman of the Association, being in the chair.

In proposing the adoption of the annual report, of which we give some account below, the **Chairman** said that nobody could deny that the electrical industry was to-day faced with a more difficult position than ever previously, and at present there did not appear to be much sign of improvement. Export business was particularly affected owing to German competition, as the exchange position allowed them to sell their wares in other countries at something like half the price the British manufacturer could offer.

The Stock Exchange was one of the best indications of the state of the country's trade, and the heavy fall in the value of all industrials connected with engineering was therefore significant. It was to be feared that until there was some stability in exchange and some protection against the stream of cheap foreign imports British manufacturers would be at a great disadvantage and our late enemies would win back in commerce what they had lost in war. The present position was attributed variously to E.P.D., instability of exchanges, restriction of output by workpeople, large increases in wages, and extravagance and unfair treatment on the part of the Government. No one of these causes alone could be the reason of the trouble.

The Reason for the Trouble.

It was rather due to the accumulative effect of them all, especially to the unsettled condition of the coal-mining industry and to the exhaustion and inaction which had resulted from the strain of the war. Before the country generally, and the electrical industry in particular, could be brought once again to a state of efficiency harmonious working between employer and employed was absolutely essential. The employer must pay a fair and reasonable wage. The employed must be prepared to give a full day's work for a full day's pay and must also realise that the excessive wages which they had extracted from the Government in time of emergency could not be continued now that the industries had reverted to private enterprise. It was an encouraging sign that workpeople in some industries were beginning to see the effect of excessive wages and were themselves approaching the employers with offers of reduction.

The Transport Question.

Continuing, Mr. Smith said he did not propose to refer particularly to the report. He would only deal with the question of transport which, as would be seen, had largely occupied the attention of the Traffic Committee of the Association during the year. The abolition of the Ministry of Transport did not mean that any of the problems dealt with would disappear, and it mattered little whether the party with whom they had to deal on this matter in future was Sir Eric Geddes or the Railway Department of the Board of Trade. It was necessary that their efforts on this question should not be relaxed.

In concluding, he called attention to the very large number of sectional committee meetings which had been held during the year, the result of whose deliberations had been of the greatest assistance to the Council. He also referred to the thorough and efficient manner in which the staff of the Association, under the able guidance of Mr. Dunlop, had performed their duties.

The Annual Report.

In the annual report of the Council, which was presented and adopted at the meeting, it was pointed out that during the year the B.E.A.M.A. had maintained its position in the foremost rank of the industrial associations of a country. The business year of 1920 had afforded little occasion for favourable comment, for it was not very old before the numerous enquiries for engineering machinery from overseas markets changed to complaints. Conditions at home had made it no easy matter to fix a definite date for delivery, or to give definite prices. The Association has been one of the worst involuntary sufferers from the Price Adjustment Clause. Attempts were still being made by the Government in the form of credit schemes to help the European countries to do business and to develop their currencies, and in the form of Parliamentary Bills for the regulation of imports to prevent danger to our own industries. In the meantime the world generally and labour in particular were being schooled in the commonplace lesson that something could not be got out of nothing, and that more strenuous work and higher effective production for lower wages were the inevitable results of war.

Exchange of Ideas and Education.

The visits of various trade commissioners during the year had enabled valuable accounts of the position in their respective territories to be obtained. A new constitution had been arranged for the Overseas Committees and it was believed that their usefulness had thus been materially strengthened. The preparation of the proposed B.E.A.M.A. code for the industries represented by the

Association had made good progress during the year and now only awaited the settlement of certain questions of copyright and patent right.

The procedure for receiving into British works properly qualified student apprentices, nominated by overseas Governments and educational institutions, had also been settled. During the latter part of the year 12 students nominated by the Egyptian Government were so placed, while in addition many officers of H.M. Forces were engaged in particular works for short periods of intensive training.

Research.

The incorporation of the British Electrical and Allied Industrial Research Association gave members of the B.E.A.M.A. the right to become candidates for election to this body free of all individual liability for subscription. The privilege of belonging to such an Association established with Government funds and charged with the duty of managing all public researches proposed by the electrical and allied industries should, in the Council's opinion, be taken advantage of. The organisation of the Association and the manner in which its work was carried out pointed conclusively to its rapid expansion. The important insulating researches with which it began its career now aimed at covering the requirements of makers in all branches, and the majority of materials at present used. The corrosion of condenser tubes, the special B.E.A.M.A. research into the most suitable materials for turbine blades and research into the proper proportions of turbine nozzles were all being dealt with. The B.E.A.M.A. Research Committee after reconstitution would continue its function of acting as a feeder to the Electrical Research Association and putting into shape such research proposals as members might wish to discuss privately amongst themselves.

Importance of Standardisation.

During the war the great importance of standardisation in the economic production of machinery and apparatus on a large scale was deeply impressed upon members. For dealing more effectively with this work several sections have set up permanent technical committees usually in conjunction with the Standardisation Committee, and are carrying out work to form foundations on which the British Engineering Standards Association can build a final text.

In addition to public business of this kind the sections have done much useful work on the domestic side. The Switchgear Section have prepared a revised edition of their purchasing specification, slate panels and slabs, and in collabration with the Insulation Section have standardised a complete line of moulded insulating bushes for use in switchgear and allied work. The Industrial Instrument Section have also in collaboration with the Switchgear and Meter Sections provided standard drilling centres for the ends of instruments and meter shunts. These standardisations will be embodied in future editions of the Association rules. The Stationary and Portable Accumulator Sections have standardised the relative capacities of batteries of all rates of discharge, together with final voltages. Standard curves have been plotted, and these have been accepted by Government departments and large buyers. A curve for portable accumulators has been adopted as a standard British practice by the Association of Motor Manufacturers and Traders.

The Standardisation Committee have made recommendations to the Turbo Design Section on methods of declaring the efficiency and standard overloads of turbo alternators, to the Rotary Converter Section on the permissible ripples in the direct-current voltage of rotary converters, and to the Gas and Oil Engine Section on cyclic speed irregularities in its relation to parallel running of synchronous machines.

The Association is represented on the International Electrotechnical Commission, on the committees of the Institution of Electrical Engineers dealing with Wiring Rules, &c., and on the Electric Vehicle Committee.

Traffic Rates Problems.

The Traffic Committee of the Association had a very busy year in the preparation of evidence for the Rates Advisory Committee, and the Council note with satisfaction from the report of the first portion of their terms of reference that this Committee has adopted certain principles which formed a part of the Council's recommendations. It will, however, be necessary to oppose the amendments to the classification of merchandise traffic, which the Committee are now making, and rebutting evidence in favour of a lower classification in certain items has been prepared. The Council of the Association has advised members of the Association during the year on matters relating to this important question.

Other Work.

The rule barring members of the Association from incurring expense by exhibiting at exhibitions not sanctioned by the Council, has been modified to permit of members exhibiting at exhibitions which are wholly or mainly electrical, after the end of the present year.

The report also calls attention to the work of the British Electrical Development Association, to the formation of an instrument transformer section, to the close working relations of the Association with other similar bodies, and to the decision to dispense this year with an annual dinner.

It is pointed out that the Association subscription list is in a very satisfactory state, and that the way in which members have met the call for increased subscriptions is an excellent testimony to the work that is being accomplished. A fund has been created to meet applications for financial support from other organisations in the electrical and allied industries, and especially to assist the British Electrical Development Association, the Electrical Research Association, and the British Engineering Standards Association. The number of members on the register of the Association at the end of the year was 224, 14 members being admitted to membership during that period, while 15 resigned due in many cases to amalgamation, reconstruction or dissolutions.

Correspondence.

"TRAFFIC CONTROL BY TELEPHONE."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The abstract of Mr. Lee's Paper in your issue of April 1 contains two suggestions which, as they appear, are likely to be exceedingly misleading to a non-railway reader:

The first suggestion is that the passenger service runs to a definite pre-arranged time table, and the freight service runs as required; that the quantity and class of goods varies enormously from day to day, and so on. Speaking for my own railway, and I believe for other similar lines, the freight service is run to a time table, and is run punctually. This is particularly true of the largest portion of the traffic—minerals. It may interest Mr. Lee some day to go to a district control office, and see the actual timing and running of the coal trains on the Midland Railway to London.

The second item which is misleading is the suggestion that it is a good thing on a control telephone system to arrange only for speaking from headquarters to the "way-stations" as he calls them, and to make it impossible to speak between the various "way-stations." The Midland Company have found the reverse to be the truth, and for this reason have not found it desirable to adopt any of the so-called "selective" systems.

The image that Mr. Lee calls up is of a District Controller, with a head telephone set, constantly calling up "way-stations" and giving them instructions; but a first-class railway, on which the traffic is being properly conducted, does not require this constant supervision, and the expensive trunk telephone circuits are better employed by being used by the "way-stations" as well as by the Head Controller.—I am, &c.,

Derby, April 9th. J. Sayers.

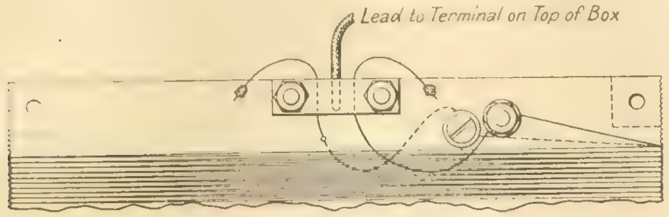
RESISTANCE WITHOUT SELF INDUCTANCE OR CAPACITY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It might be of interest to those of your readers who are occupied with laboratory work to know how one can in a very simple way, make a resistance, which has neither self inductance nor capacity. The principle is this: The resistance has two windings wound in opposite directions over a sheet of, say, micanite. These windings are connected in parallel. The number of turns and the resistance of each winding being the same the current in each winding will be the same, and consequently there will be no magnetic field and no self inductance. As the capacity of two consecutive turns is very small, and these small condensers are connected in series the capacity of the resistance will be negligible.

To put these windings on regularly the edges of the sheet should be perforated as shown in the sketch, the diameter of the holes being, say, 0·7 mm. and the centres 1 mm. apart; a brass plate with a corresponding row of holes should be used as a jig while drilling the holes in the micanite, and when more sheets are wanted the perforation can be used for separating them from each other.

The thickness of the sheet may be less than 1 mm; the length and width depends, of course, upon how great a resistance is required and the material used for the wire. A sheet for a 1 000 O resistance wound with a 0·1 mm. manganin wire (about 46 O per metre) will be about 13×20 cm (about 5×8 in.). For 2 000 O about 167 turns in each winding will be required, and there will then be space enough at the ends of the sheet for terminals and for fixing the sheet in a box if necessary. As there is no P.D. between the two wires where they cross each other, they only need have a thin coating of insulating material.



On a sheet 13×20 cm. there will be room enough both for a 600 O and a 100 O resistance; also 500 O and 200 O can go on one sheet, and 300 O and 400 O on another; the sheets can be fixed up in a box quite close to each other, as near as the terminals permit. For resistances smaller than 100 O heavier wire should be used and for resistances greater than 1 000 O a thinner wire should be employed. If the wires are fixed to terminals as shown on the sketch (between two brass plates silverised on the inside) the resistance can be regulated very accurately, and should it vary with time, it can easily be adjusted.—I am, &c.,

Copenhagen, March 31, 1921. S. P. Madsen.

"HEATING OF BURIED CABLES" REPORT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I understand that in the discussion at Liverpool upon the Heating of Buried Cables Report, Mr. J. A. Morton referred to some results which I gave at Birmingham as to the relative heating with continuous currents and three-phase 25-period currents in the same length of cable, and suggested that the results given, namely a 50 per cent. sheath loss in a 3-phase cable, as compared with the copper losses of the same cable when traversed by continuous current, in the experiments quoted by me were incorrect, and were due to the fact that a current of 400 A (direct current) was passed through one core instead of a current of 230 A direct current through each core.

I beg to say that Mr. Morton is wrong in his assumption, and that, as a matter of fact, experiments were tried in which 230 A direct-current was actually passed through each core, and, so far from the temperature rise with direct-currents coming out higher in this case as Mr. Morton expected, the actual temperature rise was 12½ per cent. less.

The 3-phase (25-periods) tests were, however, repeated later, and it was found that, instead of 50 per cent. loss in the sheathing and armouring, there was only 33 per cent. if compared with 400 A direct-current in a single core; but that there was 50 per cent. if compared with 230 A direct-current in three cores. The results given therefore substantially stand for 25 periods.

On the other hand, more recent experiments carried out at 50 periods showed that the losses were considerably less with 50 periods than with 25 periods, except in the case of single-phase currents.

Has Mr. Morton seen "La Revue Générale de l' Electricité" for August 7, 1920, in which (I am told) Monsieur Capelville demonstrates, and quotes experiments to prove, that the loss in the lead sheathing is equivalent to a drop in the copper conductor of 30 V per mile? Now the drop in the copper conductor due to a continuous current at 1 000 A per sq. in. would only be 50 V per mile, therefore, according to M. Capelville, the loss in the copper due to a continuous current would be increased *by 60 per cent.* when traversed by an equal alternating current, due to the losses in the lead sheathing. This seems to fully bear out my contention, assuming that his experiments were made at 25 periods.

I believe I have the correct explanation of the losses (contrary to my expectation) being less with 50 periods than with 25 periods, but will not trespass upon your space at the present time to give my reasons. I may say, however, that I have tests to show that the losses with single-phase 50-cycle currents in armoured cables are greatly in excess of those with 25 periods.

As it is probable that in the near future we shall work with single-phase conductors, and specially high voltages (see Clark and Shanklin's Paper—Am.I.E.E.), the reduced lead sheath losses with 3-phase cables at 50 periods will not help us very much.—I am, &c.,

Birmingham, March 23. A. M. Taylor.

SYNCHRONOUS INDUCTION MOTORS AND POWER FACTOR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Referring to Major A. M. Taylor's letter in The Electrician for April 1st, on "Synchronous Induction Motors and Power Factor," the industry should be grateful for having this method of improving power factor brought to their notice.

Although it is hardly possible to employ existing induction motors for this purpose, the ratio of rotor to stator ampere-turns being insufficient for stability, we are prepared to construct self-starting and self-synchronising motors of all sizes with self-contained exciters. These machines are capable of starting against 2½ times full load torque and synchronising against full-load torque.

The only control gear required is a three-pole switch for the stator and liquid starter for the rotor, the whole operation of starting being practically the same as the ordinary slip-ring induction motor. If desired, the user can employ a shunt regulator for the exciter, by means of which the power factor can be adjusted as desired.

We have supplied, or have under construction, a large number of these motors with outputs of from 50 b.h.p. to 800 b.h.p. and with leading power factors of 0·6 to unity.—We are, &c., Crompton & Company, Ltd.

Chelmsford, April 4th.

I.E.E. Western Centre—Meeting at Swansea.

An ordinary meeting of the I.E.E. Western Centre was held at Swansea on April 4th, Mr. A. J. Newman (Bristol) being in the chair. Dr. S. Parker Smith, of the Imperial College, London, delivered a lecture entitled "The Commercial Application of Variable-speed Motors."

In the past the practice of the Western Section has been to hold its meetings at Bristol and Cardiff alternately, but last year the experiment was made of holding a meeting at Swansea. This proved so successful that it was decided that in future one of the six meetings of each session should be held at Swansea. The crowded and enthusiastic audience which Dr. Smith addressed confirmed the wisdom of this decision. In fact, Principal T. F. Sibly, D.Sc. (University College, Swansea), pleaded at the conclusion of the lecture that the interest and support forthcoming from West Wales was sufficient to justify Swansea in claiming that from next session onwards not only one, but two, meetings of the Western Centre should be held in the town.

The Chairman admitted the apparent validity of the claim, and promised that it should receive the sympathetic consideration of his Committee. Further than that he could not commit himself, because it was doubtful whether adequate funds would be forthcoming unless the membership was proportionately increased. Swansea claimed to be the industrial heart of South Wales, but it was reasonable to assume that there were still many electrical engineers in the district who had not yet done their duty to their profession by joining the Institution. Moreover, now that Swansea had its own University College, they might anticipate a considerable increase in the number of students and graduates who ought to join the Institution.

Principal Sibly replied that it was the policy of his college to work in the closest co-operation with the surrounding industries, and he recognised how desirable it was that their students of electrical engineering should become students of the Institution. He was in a position to state that the engineering department of the college, under the direction of Prof. F. Bacon, intended to do everything it could to foster the interests of the Institution, and, as an earnest of that intention, he hoped to arrange that the course of lectures Mr. Burr (borough electrical engineer, Swansea) had offered to give at the University College next session on Power Station Economics would be thrown open to junior members of the Institution on payment of a merely nominal fee.

An animated discussion followed the lecture, in which Messrs. J. W. Burr, A. Ellis, F. Bacon, R. G. Isaacs, D. Jenkins and F. D. Smith took part. Dr. S. Parker Smith replied with his accustomed ability and pungent humour, finishing with a reasoned appeal for more complete recognition of the necessity that the rising generation of engineers must be fully as well equipped in the matter of scientific and technological training as were their Continental competitors. Developments in many directions, such as single-phase railway electrification, &c., were taking place abroad at an astounding rate, using systems of which the bulk of electrical engineers in this country knew little, and had absolutely no practical experience. Unless quick and appropriate action was taken by British firms, it was inevitable that before long huge orders for electrical equipment would be driven abroad, or, worse still, we should expend enormous sums on unsuitable equipment.

In a subsequent issue we hope to give an account of Dr. S. Parker Smith's lecture.

Modern Developments in Wireless Telegraphy and Telephony.

The large hall of the Municipal College of Technology at Manchester was well filled when Prof. E. W. Marchant, of Liverpool, delivered a popular lecture, now a regular annual feature of the programme of the North-Western Centre, on wireless telegraphy and telephony. Ald. W. Walker presided.

Influence of the Thermionic Valve.

The lecturer emphasised the fact that progress had primarily been due to the thermionic valve, which did not originate in pure scientific research, being based on an observation by Edison in 1884, and communicated by Sir William Preece to the Royal Society. If a metal plate were sealed in an incandescent lamp Edison showed that the passage of a current through the lamp filament, so as to render it luminous, resulted in the passage of a current from the positive leg of the filament to the plate, due to the emission of electrons from the heated filament, the bombardment of the plate being severe enough to cause it to become red hot. Subsequently, Prof. Fleming discovered that the arrangement could be used as a rectifying valve, and applied it to detect wireless signals. De Forest made the next advance by introducing a third electrode or grid. There was a limit to the current passing between filament and plate, and an increase in temperature of the filament, with a corresponding increase in electron emission, did not result in a corresponding increase in current, as the negative electrons surrounding the filament tended to repel back to the filament the electrons emitted by it. An equilibrium was established, just as, after a certain limit is reached, the number of molecules leaving the surface of water in still air was the same as the number returning to it. The grid could be compared to a wind which removed the moist air and left evaporation free to continue. It cleared the atmosphere immediately surrounding the filament by removing some of the negative electrons. The grid enabled the valve to be used for amplifying currents, as the small variations in voltage on the grid might produce considerable variations in plate current. An amplification of 4 : 1 was quite common. The amount of amplification possible by using valves in cascade was theoretically unlimited, but there were practical limitations owing to valve noises. Mr. Campbell Swinton had recently shown that signals received on an aerial could be made to operate a Creed printer, this giving printed messages direct from wireless signals.

Wireless Telephony.

The lecturer next described the use of the valve as a generator of high frequency oscillations, which, transmitted to a sending aerial, gave rise to a steady train of oscillations more regular than those of the Poulsen arc, and readily controlled by a microphone for wireless telephony. Capt. Turner had recently described and used an oscillatory valve relay, now being adopted as a calling-up device for ringing up any desired station, the valve being set so that it was on the point of becoming self-oscillatory. A remarkable advance had been made by Mr. Eckersley, the transmission valve being set so that speech not only controlled the strength of the waves, but actually acted as a switch to start the emission. When speech ceased the generation of waves ceased, an ideal condition for duplex working. The arrangement, however, was not wholly satisfactory and usually a "change-over" switch was employed. In aircraft work two aerials working on different wave-lengths had been employed and by sharp tuning the receiving aerial could be made deaf to waves from the transmitting aerial, this permitting the simultaneous transmission and receipt of messages.

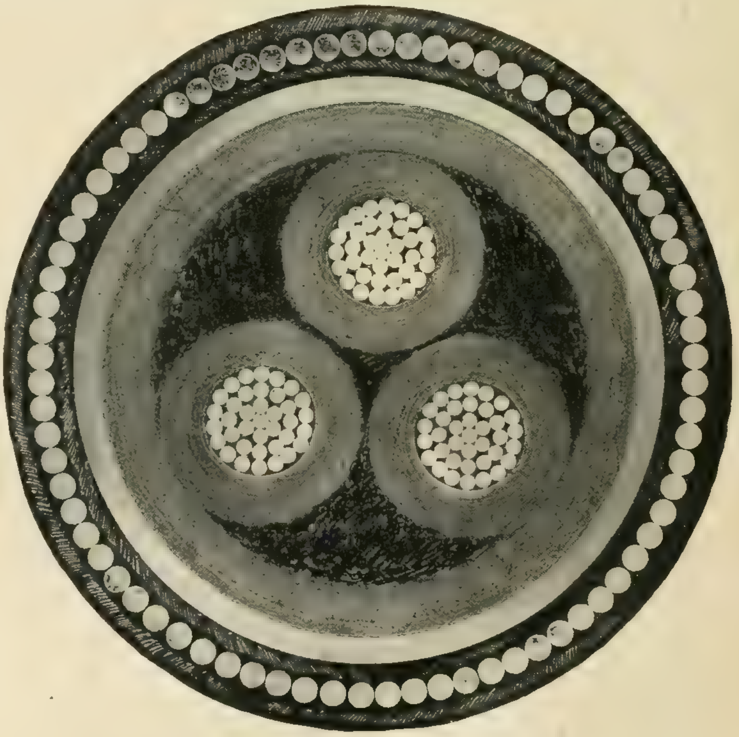
Directional Wireless.

The distortion of sounds in wireless telegraphy was small and independent of distance. Wireless telephony had been carried out across the Atlantic, and between Washington and Paris. A most important development was that of direction finding, and the frame aerial, with refined methods of measuring, would measure direction to a quarter of a degree. The Bellini-Tosi system, which employed two aerials at right angles, had very convenient arrangements for the rotation of the frame. Sir Henry Jackson had recently described how directional wireless at Chelmsford detected the emergence of a German ship from Heligoland, and Jutland was the result. During the engagement, when the British fleet lost touch with the German fleet, directional wireless again supplied the necessary information. There were factors, however, causing variations, such as reflection of waves from cloud surfaces, ore-seams, &c.

The lecture was fully illustrated by means of lantern slides and experimental demonstrations, and during the meeting wireless signals were received from Paris and wireless telephone conversations conducted.

Super Cables at Birmingham.

There are at present being laid in the City of Birmingham three-core cables for the transmission of electricity at a pressure of 33 000 V. This cable is protected by the Beard-Hunter system of automatic protection, and its total length is about 10 miles. Two cables run through the city from the new Nechells generating station to the existing station at Summer-lane, and one cable is laid from the latter station to a substation at Bourneville, where the pressure will be stepped down to supply the surrounding area at 5 500 V.



Section of New 33 000 V Cable for Birmingham.

We give an illustration of the cable, which consists of three conductors, each of 0·2 sq. in. sectional area. It is paper-insulated, lead-sheathed and steel wire armoured, waterproofed and laid direct in the ground. Three-core compensated pilot cables, for use with the Beard-Hunter automatic protective system, are laid in the same trenches, four pairs of telephone cores being provided for communication between the different stations.

Messrs. W. T. Henley's Telegraph Works Company, Ltd., have manufactured all these cables, and the same firm is also carrying out the laying and jointing. The joints are not of the usual lead sleeve type, but are made with gun-metal sleeves plumbed direct on to the lead sheathing of the cable. The cables are laid under the footway where possible, but where the footway is too congested, they are laid under the roadway. The high-pressure three-core cables are laid in the trenches 18 in. apart, to counteract any possible heating effect, and the pilots and a thirty-pair telephone cable are laid between them.

After laying, the high-pressure cables will be tested at 90 000 V direct current, and the portable apparatus for this test will be supplied by Messrs. Henley's. The apparatus which will be used is the "Delon," which is light in weight and of small capacity for such very high pressure. At the time of writing, the greater part of the cable between Nechells and Summer-lane has been laid.

Birmingham is to be congratulated upon being one of the first cities to build a power station necessitating the use of 33 000 V-cables, and Messrs. Henley's are to be congratulated upon another pioneer achievement in both the manufacture and laying of this super-pressure cable.

The Telephone Inquiry.

The Parliamentary Committee recently appointed to inquire into the working of the Telephone Department of the General Post Office has commence to take evidence, the first witness being Sir Evelyn Murray, K.C.B., Secretary to the Post Office.

Sir Evelyn Murray said that after the transfer of the telephone undertaking from the National Telephone Company in 1912 up to the outbreak of war the efforts of the Post Office engineers were mainly devoted to renewing and replacing the company's plant, which was by no means of a modern character, to amalgamating exchanges, and providing extensions. Progress had been made up to the outbreak of war.

The Chairman (Mr. Evelyn Cecil) drew attention to the fact that when the National Company was taken over they were making a profit which quickly disappeared.

Sir E. Murray said that this was partly due to the deficiencies they were trying to overtake and to the outbreak of war. In 1914 the Post Office contemplated a large programme of development extending over several years, and that was eventually carried out, though very considerably delayed, but subsequent construction was restricted to installations for military and other national requirements. There was a further difficulty owing to about 13 000 of the 20 000 men in the engineering department joining the Army early in the war. At the beginning of 1919 the efficiency of the plant was below the proper standard, and there were arrears of renewals estimated at about £1 200 000 at pre-war, or about £3 000 000 at post-war prices.

Wireless Telephones.

In the past two years difficulties were experienced in getting supplies from contractors. Wireless telephones had been brought within the bounds of practical politics for use on ships, but the question of interference was not within reach of being solved and there was no prospect of their use on land at present. In the two years before the war there was a small surplus on the telephone service. The expenditure had risen from about £6 000 000 in 1914 to £14 200 000 in 1920-21, while the revenue had only increased from £6 200 000 to £9 700 000. There would be an estimated deficiency in the current year of about £4 500 000. The principal item in the growth of expenditure was salaries and wages, which had increased by about £6 200 000. Another large item was £850 000 increase in the amount of depreciation and an increase of £350 000 for pensions liability.

Complaints of Users.

Replying to the Chairman regarding complaints of users that they were charged for calls they never had, Sir Evelyn Murray said it was an old complaint. With such a vast number of calls there were bound to be mistakes. The instructions were that calls were not to be charged until conversations were finished. In 1908 the London Chamber of Commerce sent a deputation to the principal exchange to see the actual work in operation, and they expressed their satisfaction at the system and at the small percentage of errors. Experiments were being made with a view to providing satisfactory meters, but he thought they would increase the grounds for complaint, and he doubted whether the heavy cost would be justified. Six per cent was paid by the company in their last year, when the gross profit was £1,500 000. Two years later, on the same basis, the Post Office surplus was £2 000 000.

The Message Rate.

The witness proceeded to justify the decision to abolish the unlimited service and the measured service rates and the establishment of the message rate. The large user had an undue preference over the small user in the unlimited service; it encouraged the increased use of the service, but failed to provide the additional revenue for expansion. The message rate was the only fair system, and met the case of every one. It was being substituted for other systems in New York and other large cities. The present charges were based on the probable expenditure within the five years 1920-1924. The user was entitled to the benefit of any material change in the probable cost, and reductions would be made if possble. The annual charge per instrument represented interest and sinking fund on the cost of instruments and installations, and the charge per call represented the cost of administration. Call boxes did not pay, but there was a difficulty in increasing the amount charged for their use. They contemplated equipping automatic exchanges, but they were very costly and took time.

On Monday Sir Evelyn Murray was asked if there were conferences between the heads of different departments and their subordinates at which the advice and co-operation of the subordinates was invited for the improvement of the services. In reply he stated that subordinates were consulted from time to time, but that there were no conferences. It was to some extent true that the first profit on the trunks was due to Government use during the war. There was a heavy loss in 1919, which was mainly due to the increase in the war bonus. The rates to small users would have had to go up more but for the abolition of the preference previously given to the unlimited service users. The system of keeping records could not be improved. The actual record was made by a series of meters—the system in use in New York for 12 years. There were complaints from all parts of the country, but they were not numerous. One supervisor for every eight operators was not a large proportion; it was the same as under the National Company and in other telephone systems. The service would suffer if the supervisors were withdrawn or reduced in number. When the plant that had been ordered had been put into operation there would be increased efficiency.

Sir Henry Bunbury, Comptroller and Accountant-General of the Post Office, gave evidence as to the accounts and expenditure of the service. He put in a comparative table of wages showing the alterations for the different classes of labour, some of them showing an increase of 297 per cent. over July, 1914.

Tribute to Sir John Benn.

A luncheon in honour of Sir John Benn, chairman of Messrs Benn Brothers, Ltd, was given at the Connaught Rooms on Thursday, April 7th, the Marquis of Lincolnshire, K.G., being in the chair.

Sir John Benn, who a short time ago celebrated his seventieth birthday, is "father" of the London County Council, having completed 32 years consecutive service on that body, and is now its only original member.

The attendance included a large number of past and present members of the Council, and, among others, the Marquis of Crewe, Mr. E. B. Barnard, Sir Melville Beechcroft, Mr. C. W. Bowerman, Viscount Burnham, the Rev. John Clifford, Sir William Collins, Sir Edwin Cornwall, Sir Willoughby Dickinson, the Earl of Haddo, Mr. Percy Harris, Sir Harry Haward, the Rev. John Scott-Lidgett, Mr. H. W. Massingham, Mr. T. P. O'Connor, Sir George Paish, Lord Pentland, Sir Robert Perks, Lord Riddell, Sir Walter Runciman, Sir John Simon and Sir Evan Spicer were present.

In proposing the toast of "Our Guest," Lord Lincolnshire spoke of Sir John Benn's "genius for geniality," and declared that he was admired alike for his public work and his private virtues. He was one of the best chairmen the London County Council had ever had, never in the limelight, never pushing himself forward, but always working for the good of the County of London, often under very difficult circumstances. Lord Lincolnshire read a letter from Lord Stamfordham, saying that His Majesty was interested and pleased to hear of this recognition of Sir John Benn by his friends and admirers for his long service in the government of London, and it was decided to send a telegram of affectionate greeting to Mr. Will Crookes and another to Lord Rosebery, the first chairman of the London County Council.

Sir John Benn, who was received with the greatest enthusiasm, said that whatever the London County Council had achieved, or failed to achieve, it had certainly become the finest municipal academy in the world. "That old workshop of ours," he said, "has turned out 107 M.P.s, 12 Privy Councillors, 6 Cabinet Ministers, a Deputy Chairman of Committees, a Governor of Madras, a Viceroy, a Prime Minister and 2 Knights of the Garter." The moral of this was that parents and guardians might well see that their youngsters underwent a course at Spring Gardens to finish their education. Sir John referred briefly to the work accomplished by the County Council for the improvement of London. This included the construction of Kingsway, the reduction of the death rate, the addition of 2 300 acres to the parks, the tramways, the housing of the working classes, improvements in amusements, which had been purified nd made more popular, and education. "I ask yo u," Sir John Benn concluded, "to preserve as a very precious heritage those ideals which governed the early Council."

Electrical Trades' Benevolent Institution.

A smoking concert, which was organised by the Local Advisory Committee for Manchester & District of the Electrical Trades' Benevolent Institution, was held at the Albion Hotel, Manchester, on Friday, April 1. Over 200 were present, and an excellent programme had been arranged by Mr. W. J. Smith, the energetic secretary, who also accompanied the songs. Mr. J. A. Robertson, the engineer of the Salford Corporation, who is chairman of the Committee, presided.

In the course of the evening Mr. Robertson pointed out that the main object of the Smoking Concert was to induce some of the very large number of those in Manchester who were qualified to become Members to join the Institution. He expressed the hope, in view of the fact that there were more people on the staffs of the electrical firms in Manchester than in any other town, that the number of Members joining the Institution from that district would be greater than all those at present included in the list of Members.

He afterwards called upon Mr. F. B. O. Hawes, honorary secretary of the Institution, who gave a short address on the objects and operations of the Institution, and drew attention to the fact that it was a duty as well as a privilege of every qualified person to become a Member. Those present were enthusiastic in their desire to support the Institution, and a considerable number of new Members joined.

Telephone Developments in London.

The current issue of "The Post Office Electrical Engineers' Journal" gives an account of the new Langham Telephone Exchange which is situated in an emergency building over the Western District Post Office. The whole of the plant is located on one floor, and this has permitted the adoption of an economical cable scheme, and the conditions under which the working of the exchange will be carried on leave little to be desired. The suite of switchboards, comprising 24A and 10B positions, with the usual test and plugging-up positions, monitor's and supervisor's desks, was manufactured by Messrs. Ericssons at their Nottingham factory, and has been arranged along three sides of the room. Provision for 20 electrophone connections is made by means of a canopy fitted over the last A position.

The present day No. 10 equipment is identical with that of a No. 1 exchange, except that larger plugs and jacks are used and the sections are each of one position. The equipment is of the 40-V type, and the condenser and impedance coil system of transmission is employed. The increased size of the jack gives improved facilities for marking, with a consequent advantage in operating. The multiple field allows for 2 000 subscribers, and a full multiple has been installed. The four-panel multiple is of the branching jack type. An outgoing junction four-panel multiple of 400 is fitted. The position meters are mounted in the cable-turning section at one end of the line of switchboards. The result is entirely satisfactory and a considerable saving in floorspace has thereby been effected.

A combined main and I.D. frame is fitted, accommodating a total cable equipment of 4 600 pairs. The street cables are connected to the lower portion; the upper portion comprises the I.D.F. Above the line side of the main frame are fitted horizontal blocks for the answering equipments. The multiple is accommodated on vertical blocks placed immediately above the protectors on the exchange side of the main frame, and the cabling of the multiple and outgoing junctions is reduced to a minimum. This type of frame has marked advantages from the point of view of cable economy.

In connection with the battery installation a counter E.M.F. battery of six cells is fitted to allow current to be fed to P.B.X. switchboards at 24 V. These cells consist of plain lead plates immersed in sulphuric acid and are inserted in series with the negative pole of the battery and the 24-V bus bar on the fuseboard.

An exchange, similar to "Langham," to be known as "Berkeley," which will afford further relief to Mayfair, is in course of construction, as is also a relief exchange to Holborn, to be named "Chancery," and a relief exchange to Avenue, to be called "Minories."

Legal Intelligence.

Electric Filament Renewal Machines.

On the 6th inst. Mr. Justice Salter commenced the hearing of an action in which Jas. Pitkin & Company, Ltd., sued the Aladdin Renewal Electric Lamp Corporation, Ltd., for damages in respect of an alleged breach of contract to pay for 20 special winding machines used for renewing filaments of electric lamps and failure to accept delivery of 46 others, the remaining portion of the contract to make 100 machines.

The defence was a denial of the alleged breach and an affirmation that the contract was that the machines were to be delivered at the rate of 20 per month or as defendants might require them. Defendants said that on February 23rd they wrote to plaintiffs to defer delivery until they sent definite instructions as to destination. Defendants also put in a plea that the machines were defective and they counterclaimed for damages and asked for an injunction restraining plaintiffs from selling the machines to any lamp manufacturers other than defendants.

Mr. Disturnal, K.C., said that in 1919 plaintiffs were approached by a company known as Seymour, Gordon & Company, to manufacture a number of machines for winding the filaments of electric lamps. Seymour, Gordon & Company were also connected with a company called the Renew Electric Lamp Company, and they were now represented by the present defendants. The action was brought to recover the price of 20 machines at £52 10s. each and damages for refusal to take the balance of the machines arranged for under the contract. Thirty-four machines had been delivered and paid for, and with the 20 additional there had been a total delivery of 54. As to the remaining 46 plaintiffs had done everything necessary for the completion of the machines, but defendants had refused to take them. A question arose as to certain patent rights. Plaintiffs, in the course of the development of the machines, had made certain inventions which they thought it prudent to protect and accordingly they had got provisional protection, but there was a dispute between the parties as to who had a claim to the patent rights. That dispute was settled by agreement and one of the defences set up was that the agreement had been broken by plaintiffs. The plaintiffs said there was absolutely no foundation for that. Eventually a letter was written by Sir Harry Foster, chairman of defendant company, asking that the delivery of the machines should be deferred until definite instructions as to their destination were sent. Since then defendants had refused to take delivery of the remaining 46. As to the 20 in dispute, defendants never rejected them or sent them back to plaintiffs. Counsel suggested that the contract did not mean that defendants could say "We are not going to have any machines from you until such time as we like," and submitted that it meant that defendants should take delivery at 20 per month or as the defendants might reasonably require them. They were not entitled to put off delivery for ever if they liked. As to the defence that the machines were defective, there was no suggestion of defects made before the writ was issued. They had, in fact, received and paid for 34 machines without any question. Defendants had now given particulars of defects in 59 machines, but as not more than 54 had been delivered some of the particulars delivered must be imaginary. Plaintiffs' experts went to see the machines after the particulars had been delivered when they were shown 40 machines, but could get no information in regard to the remainder. The machines they saw were in a dirty and neglected condition and 14 had been tampered with by the removal of the number plates.

Mr. Richard L. Lee, managing director of plaintiff company, gave evidence bearing out Counsel's opening statement stating that the machines had been made and could have been delivered.

In cross examination by Mr. Watt (for the defence) he said he had obtained provisional protection for everything included in the machine on December 10, 1919. The nine months' grace for completing the patent had lapsed and the specification had not been completed. He said his firm was to have the right of selling the machine for purposes apart from refilling electric lamps. He thought the machine had possibilities for other purposes. His firm had made a modified machine; they had introduced new devices and they were entitled to patent those devices. He came to the conclusion in June or July that it was not worth their while to spend money on the patent. The defendant company objected to the firm patenting the modified machine on three grounds. First, they wanted other people to make it; secondly, some of the shareholders in the Aladdin Company were able to make it themselves and would object to plaintiffs making it, and thirdly, the people in France would insist upon having it made in France. He could not agree to that. He was keen on keeping the whole thing, but as a concession he gave defendants the power of renewing. It was discussed at an interview that they (plaintiffs) should have the machine for all purposes other than the making or renewal of electric lamps. They did not agree upon that.

The case was continued on Friday, when evidence was given on behalf of defendants relating principally to the terms of the contract.

Mr. Compston, K.C. (for the defence), argued that in order to maintain an action for non-acceptance there must be proof of an agreement to deliver after the contract date, and in that case there was no such proof. Plaintiffs were not ready to deliver, and no damage could be claimed.

His lordship reserved judgment pending the report of experts for which a period of 14 days was allowed.

Sheppard v. Glossop Corporation.

Last week the Court of Appeal (Lords Justices Bankes, Scrutton and Atkin) concluded the hearing of the appeal of the defendants from the judgment of Mr. Justice Greer, awarding the plaintiff £279 10s. damages for personal injuries sustained by him owing to the alleged negligence or breach of duty of the defendants as the lighting authority for the district. It appeared that on the night of Christmas Day, 1918, plaintiff was returning home, intending to go there by Dun-lane and Quarry-road. The former was a highway repairable by defendants as surveyor of highways, and Quarry-road was a public footway belonging to Lord Howard of Glossop, but had not been taken over by them as highway authority. For a considerable time there had been a lamp in Quarry-road placed above a retaining wall on Lord Howard's land. This place was dangerous to foot passengers on a dark night if the lamp was not lighted. The plaintiff, walking along Quarry-road, owing to the darkness, missed his way and got in front of the lamp and fell from the top of the retaining wall, fracturing his skull and receiving other injuries. The light in the lamp had been extinguished at 9.30 in pursuance of defendants' instructions, who, by a resolution previously passed by the Lighting Committee, had determined for reasons of economy that the lights in the borough should be extinguished at 9 p.m. Plaintiff accordingly brought the present action with the result stated.

Lord Justice Bankes, in giving judgment allowing the appeal, said the case raised a question of importance to local authorities outside the metropolitan district. His lordship said there was no doubt that the spot was dangerous, but so far as the evidence went not a dangerous place made dangerous by the Corporation. It was dangerous since it came into existence when it was carved out of the adjoining ground. The first thing to consider was what was the statutory duty of the Corporation with regard to the lamp. The defendants' statutory authority for lighting the district was to be found in Sec. 161 of the Public Health Act, 1875. The effect of that Section was that it gave defendants authority to light their district; but it created no obligation to light it and gave the authority a discretion whether they would light only some portions of the district, and as to when the lamps were to be kept lighted in any portion of the district which they elected to light; there was a great distinction to be found between the powers given to local authorities under that Section and the powers given under Sec. 130 of the Metropolis Management Act, 1855. There was no authority to support the proposition that Sec. 161 of the Public Health Act created any obligation upon the lighting authority to light any portion of the district. It was not possible to establish that defendants were under any duty to plaintiff to keep the lamp alight, and the appeal must be allowed with costs.

The other members of the Court delivered concurring judgments.

Electricity Supply.

WINCHESTER City Council has applied for authority to borrow £21 200 for a 150 kW turbo-generator, a new feeder cable and mains and services for three years.

BARNSLEY Electricity Committee advise the Corporation to apply for sanction to borrow £22 000 for the extension of mains in the Huddersfield road district.

HINCKLEY Rural Council has refused to assent to the application of the Midland Electric Light & Power Company to the grant of a special order to authorise the supply of electricity in several parishes in the district.

YORK City Council has rejected a recommendation of a sub-committee of the Tramways and Electricity Committee that the scale of salaries of the engineers put forward by the National Joint Board be adopted. The Salaries Committee had declined to accede to the suggested scale, and objected to it being made retrospective to May, 1920.

WORCESTER City Council were recommended on Tuesday to authorise the expenditure of over £62 000 on extensions of the electric supply undertaking. The Electricity Committee proposed to ask for authority to a loan to carry out the work, and, in the event of not securing sanction, the Electricity Commissioners are to be asked to make an order forming a sub-district of South Worcestershire, to be administered by a committee on which Worcester would be represented.

On the suggestion of the borough electrical engineer (Mr. J. W. Burr), the SWANSEA Electricity Committee is to consider the advisability of using liquid fuel at the electricity station. It is thought that, in view of the limited space available for the storage of coal, an alternative method of firing the boilers by liquid fuel should be considered. It is not suggested that liquid fuel should replace coal, but that burners be fitted so that it could be used in case of emergency.

A large firm of manufacturers in the MUSSELBURGH area recently applied to Edinburgh Town Council for a supply of electricity and declined to take a supply from the Musselburgh Electric Light and Traction Company. Edinburgh Corporation have intimated that they would be willing to grant a supply, subject to the consent of the Musselburgh Local Authority, when the new power station at Portobello is complete. The legal position is being investigated by the Musselburgh Provost's and Law Committee.

HOYLAND NETHER Urban Council has applied to the Electricity Commissioners for a Special Order to extend the period within which the Council is required to lay mains, and to alter the third schedule of the principal Order so as to include therein only High-street, Market-street and King-street, in which mains are to be laid within a specified period; also to authorise the Council to transfer their electricity undertaking and powers to Electrical Distribution of Yorkshire, Ltd. Any objections must be sent to the Commissioners before May 6.

MANCHESTER Electricity Committee has adopted a scheme for the reorganisation of the staff drawn up by Mr. S. L. Pearce, the chief engineer and manager. Mr. H. A. Ratcliff, at present chief electrotechnical assistant, will be superintendent electrical engineer, at a salary of £940 per annum. Mr. W. Kidd, recently engaged on the supervision of constructional work at Stuart-street, will be constructional engineer at Barton, at £596 per annum; Mr. A. Pollitt becomes assistant constructional engineer at Barton, at £376; and Mr. J. Stamp, assistant mains engineer, at about £500 per annum.

DUBLIN Corporation has agreed on the recommendation of the Electricity Committee to obtain a reliable survey and report on the possibility of utilising the WATER-POWER of the LIFFEY in generating electricity. Ald. Shields, who moved the adoption of the report, said the development of the power to be derived from the rivers of Ireland was a matter the importance of which could not be exaggerated. He detailed the electrical possibilities which were opened up by the power available on the Liffey, and he urged that an expert should be engaged at a cost not exceeding £1 000. With coal at 50s. a ton it would pay to develop water-power. The city electrical engineer, Mr. L. J. Kettle, was of opinion that the Liffey, if properly utilised, was probably capable of supplying all the present power requirements of Dublin and district.

Business Items, &c.

The telephone number of TWISS ELECTRIC TRANSMISSION, LTD., has been altered to Victoria 7625.

Geo. Edwd. Purdy and Wm. Hy. French, trading as PRIMROSE POWER COMPANY, electrical and mechanical engineers, 364, Humberstone-road, Leicester, have dissolved partnership. Debts by Mr. French.

Messrs. HOGAN & WARDROP have appointed Mr. Alex. Morrison, 12, Waterloo-street, Glasgow, as Agents for Scotland, and the Castle Engineering Company, Ltd., Church-street, Eccles, to represent them in Lancashire for the sale of E.M.I. fans and small motors.

Mr. J. B. RUDKIN, 212a, Shaftesbury-avenue, London, W.C.2, has been appointed representative in Great Britain for the SPRECHER & SCHUH COMPANY, electrical apparatus manufacturers, of Aarau, Switzerland. The Swiss firm specialise in the manufacture of high and low-tension switchgear for any service. Telegraphic address: Gabionage, Westcent, London; telephone: Regent 280.

Messrs. McCLURE & WHITFIELD, Mersey Dynamo Works, Stockport, have appointed the City Electrical Company, 1, Emerald-street, Holborn, London, W.C.1, their sole agents for export and also for the following districts: London and South-East Coast, 1, Emerald-street, Theobalds-road, London, W.C.; Lincolnshire, High-street, Scunthorpe; East Riding of Yorkshire, Jameson-street, Hull; North-East Coast, 67, Grey-street, Newcastle-on-Tyne; South Wales, 16, Charles-street, Cardiff.

Electric Traction.

The SOUTH STAFFORDSHIRE TRAMWAYS COMPANY has decided to relay the track along the Darlaston-road, Wednesbury.

EDINBURGH Corporation has approved Mr. R. S. Pilcher's report recommending the electrification of the tramway route from Pilrig to Nether Liberton, and estimates are to be prepared for converting the route from Pilrig to Goldenacre.

The dispute which has existed for some time between ABERDEEN CORPORATION and the Aberdeen Suburban Tramways Company in regard to the charge for electric current and running costs has been settled, and a new agreement will be entered into by the parties.

Up to Jan. 31 the ABERDEEN Corporation tramways department spent £11 358 on track renewals, or £358 over the sum allowed for the whole year, and a further sum of £2 000 will be required up to May 31. The borough engineer, Mr. J. Gordon, points out that tramway tracks generally now require a great deal of attention and repair, and the burden of maintenance is bound to be an increasing one until such time as some of the tracks come to be renewed.

The total receipts of the BRADFORD Corporation tramways department for the year ended March 31 were £702 108, compared with £598 566 in the previous year, an increase of £103 543, but the increased sum paid in wages and bonuses alone was £138 400. Running costs, exclusive of renewals, amounted to practically the same amount as that of income. Renewals (about 3d. per car-mile) are responsible for a deficit of £80 000. Ald. E. Priestley, chairman of the Tramway Committee, states that this is the first time in his long experience that the department has not been able to show a substantial profit. The number of passengers carried were 88 865 080, an increase of 3 386 543.

Institution Notes.

The FARADAY HOUSE OLD STUDENTS' ASSOCIATION DINNER, which was fixed for to-day (Friday) has been postponed owing to the strike.

A smoking concert will be held by the FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION on Friday, April 22, at Anderton's Hotel, Fleet Street, London, E.C.

The Friday evening discourse at the ROYAL INSTITUTION on April 22 will be delivered by Sir James Walker on "Electro-Synthesis in Organic Chemistry."

The meeting to inaugurate the INSTITUTE OF PHYSICS will take place on Wednesday, April 27, 1921, at 6 p.m., at the INSTITUTION OF CIVIL ENGINEERS, Sir Richard Glazebrook, K.C.B., president, will preside, and Sir J. J. Thomson, O.M., will deliver an address. Mr. A. J. Balfour is also expected to be present and extend a welcome to the Institute. Non-members of the Institute or of the societies associated with it may obtain tickets of admission on application to the secretary, 10, Essex-street, Strand, W.C. 2.

The following Papers are to be read at the INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION CONVENTION, which is to be held in Dundee in the week beginning Monday, June 13: "Financial and Business Aspects of Electricity Supply," by Mr. E. Cross (Rotherham) and Mr. C. W. Charlesworth (Wolverhampton); "Modern Boiler-house Practice," by Mr. D. Wilson, (Babcock & Willcox) and Mr. W. M. Miles (Sheffield); and "State of the Electricity Supply Industry after the War," by Mr. I. V. Robertson (B.E.A.M.A.).

At the meeting of the BIRMINGHAM AND DISTRICT ELECTRIC CLUB on April 9 a Paper on "The Supply of Electrical Energy in Birmingham and District" was read by Mr. Frank Forrest, chief assistant engineer to the Birmingham electricity supply department. Mr. Forrest dealt with his subject in three main divisions, historical, descriptive and futuristic, the last part having reference to the electricity supply in the West Midland industrial area. The vast possibilities of electrical development in this area were wisely considered and some account of the steps which are actually being taken for dealing with the matter were given.

The annual dinner of OFFICERS of the OVERSEAS ANTI-AIRCRAFT SEARCHLIGHT SECTIONS, R.E., was held on April 1st at Frascati's, Restaurant, Lieut.-Col. W. C. H. Prichard, D.S.O., R.E., being in the chair. About 20 officers attended and a very pleasant evening was spent. It was decided to hold the next dinner in April, 1922, and the undermentioned joint honorary secretaries were appointed to make the necessary arrangements: Capt. D. R. ffrench-Mullen, R.E., Anti-Aircraft Searchlight and Sound Locator School, Gosport, Hants.; K. L. Wood, Esq., 95, Salisbury House, Finsbury Circus, E.C.2. All officers who did not receive a communication concerning the recent dinner are requested to forward their addresses to one of the secretaries.

At the meeting of the INSTITUTION OF ELECTRICAL ENGINEERS on April 7th the President announced that a communication had been received from the Electrical Research Association stating that considerable sums had been guaranteed for its development, and that these, together with an equal contribution from the State, would be sufficient for the working expenses. The Institution could, therefore, be released from the guarantee of £750 a year for three years which it had made two years ago when the Association was in process of formation. In making this announcement Mr. Atkinson said the Institution were to be congratulated on having been able to support the Association at a critical period and, at quite a small expense, to assist in launching a body of great importance to the industry. The Council had now decided to make a subscription of £200 towards the funds of the new Association. because all the Institution's members would benefit by the information which would be published broadcast.

Imperial and Foreign Notes.

The Egyptian Government estimates for the financial year 1921-22 provide the sum of £E108 500 for telephone extensions and improvements.

The Scottsdale (Tasmania) Lighting Bill, authorising the Municipal Council to establish a small hydro-electric plant, has now passed the State Parliament.

An Order in Council has authorised the raising of a loan of £81 600 by Invercargill (N. Z.) Borough Council for a tramway and street improvements electricity supply, &c.

The Glen Innes (N.S.W.) Council is raising a loan of £14 000 for an electric supply undertaking. The plant will include three 50-kW electric generators and three 85-h.p. suction gas engines.

Negotiations have been recently concluded between the Hydro-Electric Power Commission of Ontario and several privately-owned electric companies, whereby the latter will join the hydro-electric system, to which 84 companies now belong.

Inangahua (N. Z.) County Council has received permission to erect electric lines at Waiuta, whilst similar authority has been given for Thames, Hokitika, Westland County, and Gore, and for a transmission line in Mataura and Southland County.

The Commonwealth Government is being urged to take over the Thermol Company's properties in Cairns (Queenlsand) in order to safeguard the supply of wolfram. At a recent meeting of the Townsville Chamber of Commerce a resolution was passed in favour of Federal assistance, and other commercial bodies have done likewise.

The offer of the Melbourne Electric Supply Company has been accepted for electric lighting in the streets of Richmond (Melbourne) in substitution for the present gas lighting. The charge will be £3 12s. per lamp per annum, compared with the gas company's rate of £2 16s., but the electric light will be available for the three nights per month at full moon upon which the gas was not used.

Sydney (N.S.W.) Council is taking 9 000 kW from the Railway Commissioners, because of the Council's inability to supply the whole of its consumers' demands from the municipal generating plant. The city electrical engineer (Mr. H. R. Forbes Mackay) has repeatedly urged the City Council to take adequate steps to hasten the completion of the buildings required to house the Council's additional generating plant, some of which has now arrived.

The Australian Postmaster-General has decided to erect several wireless telegraph plants in remote pastoral areas in Queensland and the Northern Territory. The first experiment is being made at Camoomeal on the western border of Queensland and Powell's Creek, in the Northern Territory. It is expected that when the Government stations are working many owners of property in the Territory and in Western Australia will apply for permission to erect plants to communicate with the system. It is thought that the provision of a telephone system to cover the district would not be a financial success, as iron poles would have to be used because of the prevalence of white ants.

According to the chairman of the Victorian Electricity Commissioners, Melbourne City Council and the Melbourne Electric Supply Company are unable to meet the whole of the requirements of electrical energy in the Melbourne metropolitan area, and it has been decided to extend the plant at the railway power station at Newport so as to be in a position to supply energy equal to 10 000 kW to Melbourne Council, and a similar quantity to the Company. The contemplated additions to the plant at the Newport station include two 14 000 kW generating sets, and the Commissioners propose ultimately to link up the Newport station with the Morwell generating scheme. Messrs. Merz & McLellan are consulting engineers for the extension of the Newport plant.

The Italian Government propose to issue a decree abolishing, among other things, the monopoly in electric lamps, and suppressing the Bureau of Trade Monopoly.

According to "The Engineer," the number of electric lamps manufactured in the United States during 1920 was over 230 000 000, excluding miniature types, which approached 125 000 000 per annum. The carbon filament lamps form only about 7 per cent. of the total.

Objection has been made in the French Senate to the Convention of Oct. 29, 1920, which, it is alleged, hands over the French wireless communications with Great Britain, Spain and the United States to a private company. It is declared that the Convention is null and void by law, as the posts and telegraphs are a State monopoly. The Convention will be submitted to Parliament for approval.

Bankruptcies and Liquidations.

A meeting will be held at 225, Royal Liverpool-buildings, Liverpool, on May 9, to receive an account of the winding up of the Electric Supply Company of Western Australia, Ltd.

A first and final dividend of 11s. will be payable on April 20 at 4, Castle-place, Park-street, Nottingham, to creditors of Jas. Cruickshank Thomson, lately electrical engineer and contractor, of Station-street, Mansfield.

The Anglo-Foreign Tramway Syndicate, Ltd., and the Orizaba Tramways Syndicate, Ltd., are being wound up voluntarily, and Mr. A. F. Dickin, Sardinia House, Sardinia-street, Kingsway, W.C.2, has been appointed liquidator.

Miscellaneous.

Four electrical and mechanical companies of the Volunteer Defence Force are being formed at the headquarters of the London Electrical Engineers, 46, Regency-street. Those with electrical and mechanical experience, and especially ex-officers and men of the London Electrical Engineers who are able to undertake duties in the present emergency, are requested to apply for enlistment at the above address. The term of enlistment is 90 days, and full army pay and allowances will be drawn.

Another enjoyable evening was spent at the Eustace Miles Restaurant, Chandos-street, W.C., on Friday, under the auspices of Benn Brothers Social Circle, the company numbering between seventy and eighty members of the staff, including several of the directors. The first part of the programme consisted of a series of impromptu debates on subjects drawn from a hat by each victim. Musical and elocutionary numbers, with conjuring entertainment followed, all provided from inside the house, with Mr. A. C. Slaughter as accompanist.

We have received from the "Financier & Bullionist" publishing offices, Dean-street, Fetter-lane, E.C.4, a copy of the 17th (1921) edition of "The Financier Rubber Share Handbook." Full financial and statistical details are given of rubber-growing companies in various parts of the world, and there is also an alphabetical list of directors. The book, which is now in its 17th edition, will be of great assistance to all who are interested in the important rubber industry, either as growers, users or investors. It contains over 900 pages and is published at 10s.

At the regular meeting of the Kelvin Lodge, which was held at the Connaught Rooms on the 31st ult., the reigning master (Mr. H. Porter-Cox) presided over an assembly of 87 members and visitors, including many men well known in the electrical profession. During the course of the various speeches which were made at the banquet following the Masonic Ceremonies, he referred to the fact that in the course of the next few weeks he was due to be installed in the Chair of the Kelvin Chapter and would then be occupying simultaneously the Chairs in both the Lodge and Chapter, an occurrence which it was quite likely would never occur again. He felt the honour and responsibility of his position, but at the same time expressed his keen appreciation of the way in which he had been supported by members in connection with the great masonic charities, and he also referred to the rapid growth of the Lodge.

On Friday an inquest was held at Ilkeston upon two miners who were killed at the Cossall Colliery on March 7 as the result of an explosion. A coal-cutter named Holbrough said he was working with the deceased (Wm. Sutterfield and Fred Elliott) and they were going to start the machine after cleaning up. As soon as witness switched on the current an explosion occurred, coming straight from the coal face across to them. They had two safety and four electric lamps. The flash came from the hole where the coal was being cut, and came straight across the machine. He had never seen gas on that face.

The manager (John Whyte) said the machine was brought out of the pit and tested on the surface. It was also tested before being brought out, when it was found to be free from electrical faults. At the test on the surface on March 9 nothing wrong was discovered. He had a theory that the explosion was caused by the crown wheel getting out of gear with the cutting wheel, which would cause friction and sparks. The crown wheel had been rubbing on the teeth, making dents, which led him to that conclusion. On the Wednesday following the explosion a small quantity of gas was found at the roof, and more gas on the floor, showing that the appearance of gas was spasmodic. A deputy would remain with the coal-cutter in that district for the future until danger of outbursts of gas had passed away.

Ultimately, the jury returned a verdict that the ignition of gas was due to sparks emitted from the coal-cutter, owing to the crown and cutting wheels getting out of gear; the accumulation of gas was due to a sudden outburst and no one was to blame for the accident.

Personal and Appointments.

Commander R. L. Nicholson has been appointed Director of Wireless Telegraphy in India in succession to Col. A. Simpson.

We regret to learn that Mr. J. J. Smith, who has been for many years borough electrical engineer at Stockton-on-Tees, has resigned owing to ill health.

The Parliamentary Committee which is inquiring into the telephone service has appointed Mr. William W. Cook, consulting engineer, to be its scientific assessor. Mr. Cook, as our readers will remember, was connected with the National Telephone Company.

Obituary.

We regret to announce the death on April 9 of Mr. Bertram Blount, F.I.C., the well-known electro-chemist. For some years he was in partnership with Mr. R. H. Stanger, under the style of Stanger & Blount, but lately he practised on his own account. He was the author of several good works on applied chemistry and electro-chemistry, including "Chemistry for Engineers and Manufacturers" (with Mr. A. G. Bloxam), "Electro-Metallurgy," and "Practical Electro-Chemistry."

The "Elektrotechnische Zeitschrift" announces the death of Dr. Karl Ilgner, whose name is well known in electrotechnical circles in connection with the system he invented for driving rolling mills and other heavy machinery. Dr. Ilgner received his early education at Charlottenburg, and was afterwards for some years with the Lahmeyer Company. In 1905 he was appointed to the Vienna office of the Siemens-Schuckertwerke, but owing to ill-health he only held this position for a short time, and returning to Breslau entered into practice as a consulting engineer.

Catalogues, Price Lists, &c.

Messrs. Higgs Bros., Sand Pits, Birmingham, have issued their April list of d.c. and a.c. dynamos and motors.

A leaflet giving particulars of the "Falco" Electric Irons, has been issued by The Falkirk Iron Company, Ltd. Since the issue of the original list the price has been reduced from 35s. to 27s.

The B. E. Company (of London and Birmingham), Ltd., 57, Upper Thames-street, E.C.4, have issued their new list of Hendon Lamps which gives the reduced prices of both the ordinary standard one watt drawn wire and gasfilled types.

A four-page illustrated pamphlet recently issued by Messrs. Herbert Morris, Ltd., Loughborough, gives prices and general particulars of the Morris Electric Hoist Blocks. Those occupied with economy in transport problems should be interested in the pamphlet.

A catalogue and price list of "Rex" electricity meters for single-feed a.c. circuits is being issued by Messrs. Thompson & Company, 48, Watling-street, London, E.C.4. These meters are manufactured by the Societe Genevoise d'Instruments de Physique, for whom Messrs. Thompson are sole British agents.

Messrs. Hyatt, Ltd., Thurloe-place, London, S.W.7, have recently issued a new sectional catalogue dealing with the applications of Hyatt Roller Bearings to industrial trucks and trollies. Owing to high costs of manufacture, considerable attention is being paid to economies in power and the reduction of friction losses, and those interested will find some useful information on the subject in the catalogue, which is copiously illustrated.

A leaflet on the Ediswan Acme accumulator has been issued by the Edison Swan Electric Company, of Ponder's End. Illustrations of the construction of the positive and negative grids are shown, and it is claimed that the maximum capacity of discharge is obtainable under the most exacting conditions, due to the complete continuity of the paste throughout the grids. The bars of the positive grid are pierced and those of the negative staggered.

A leaflet illustrating the design and construction of the "Nilfisk" Suction Cleaner is being circulated by Messrs. Gillespie & Beales, 12, Norfolk-street, Strand, W.C.2. This cleaner is suitable for industrial purposes such as hotels, theatres, stores, factories, power stations, &c. It is supplied in four sizes, and the new price of each complete with accessories is set out. Copies of the leaflets, overprinted with the names and addresses of dealers, will be supplied by the firm.

The new Simplex Lighting Fixtures list (No. 860) of the Simplex Conduits, Ltd., is a comprehensive publication and contains a number of neat and artistic designs of brackets, ceiling and semi-indirect fittings, hall lanterns, pendants, table lamps, standards, reflectors, bowls, &c. Everything required for interior domestic, office or outside lighting or for the illumination of shop windows can be found within the 50 odd pages of the list, which is supplied with a good index giving the price and finish of each fitting.

Leaflets on the "Ecal" belt-driven and hand tachometers have been issued by the Engineering & Colliery Appliances, Ltd., of Sheffield. The former has been designed for steam engines and turbines, gas engines, dynamos and electric motors, &c., but it can be used for many other purposes. It is made with four standard sizes of dials, but other types can be supplied, and, if necessary, for chain or flexible shaft driving. There are three standard ranges of hand tachometers. Prices and other particulars are included.

The Moving Iron Instruments manufactured by the Electrical Apparatus Company, Ltd., South Lambeth-road, S.W.8, are described and illustrated in leaflet M.6. Dimensions, weights and prices of the various types of instrument are given. The chief characteristic of these instruments is their robust construction rendering them capable of satisfying modern industrial requirements. The wall and pedestal types mark a new departure, and the terminal arrangements are claimed to be in advance of anything on the market for front of board connection or pedestal mounting.

The general catalogue of Messrs. Campbell & Isherwood, Ltd., electrical and mechanical engineers, Bootle, runs to over 100 pages and contains particulars of the small steam generating sets, d.c. motors, switchboards, electric winches, hoists, drills and fans, pinions and gearing, as well as a variety of electric light fittings for mills, factories and other industrial purposes which are manufactured by the firm. The list also contains a number of electro-technical tables and other information which should prove useful to users of electrical plant. The firm undertakes contracts for lighting and power installations for industrial purposes or on ships.

A leaflet is being distributed by the Electric Street Lighting Apparatus Company, of Canterbury, containing an illustrated description of the system of street lighting invented by Mr. Haydn T. Harrison. Both the General Electric Company and the Company are sole licencees to manufacture the lanterns and fittings for this system. By means of Mr. Harrison's longitudinal lighting lanterns the illumination of streets is greatly improved and dark patches are avoided. Various types of lanterns embodying the invention are being manufactured, and are intended to replace existing high-power lamps, flame arcs or extra-high-pressure gas lamps. They are designed to take up to 500-W gasfilled electric lamps, but as, with 300-W lamps, these lanterns give from 3 000 to 7 000 c.p. on the outside rays, it is rarely that more than 300-W lamps are required. The system is in use in the High-street, Canterbury, where excellent results have been obtained.

Tenders Invited and Accepted.

Tenders are invited by Ipswich Corporation electric supply department for the supply of a 500-kW rotary converter or motor converter. Particulars from the chief engineer and manager, Mr. F. Ayton.

St. Anne's-on-the-Sea Urban Council invite tenders for the supply and erection of a natural-draught cooling tower. Particulars from the electrical engineer, Mr. J. H. Clothier.

Rathmines and Rathgar Urban Council require tenders by April 25 for the supply of cable and a feeder pillar. Specifications, &c., can be obtained at the Electricity Works.

The municipality of Pretoria invite tenders for the supply and erection of switchgear. Tenders to Deputy Town Clerk, Municipal Offices, Pretoria, by 4.30 p.m., May 10.

London County Council requires tenders by April 18 for about 5 500 tons of standard steel girder tram rails, lipless track rails and guard rails, &c. Form of tender from the Chief Engineer, County Hall, Spring Gardens, S.W.1.

The Borough Council of King William's Town (S. Africa) invites tenders for steam-driven electrical generating machinery, boilers, switchgear and cable. Specifications from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C.2, to whom tenders by June 25.

The time for tendering for the telephone switchboards required by the Postmaster General's Department, Melbourne (Schedule No. 1 670) has been extended from 19th April to 31st May. Specifications can be seen at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

Belfast Corporation invite tenders for the manufacture and erection at the new Harbour power station of extra-high pressure and low pressure switchgear. Specifications from the consulting engineers, Messrs. Preece, Cardew & Rider, 8, Queen Anne's Gate, Westminster, S.W.1., or the city electrical engineer, Mr. T. W. Bloxam. Tenders to the Town Clerk's Office, City Hall, Belfast, by April 25.

Tenders are invited by April 30 for the following requirements for the Calahorra-Arnedillo (Spain) electric railway:—2 750 metric tons of rails (weight 30 kilos per metre and 12 metres in length), 7 400 pairs fishplates, 45 800 seat plates, 29 500 nuts, 267 500 bolts and 48 points. Tenders to the Sociedad de Ferrocarriles Electricos, Plaza de Canovas 4, Madrid.

The National Board of Sanitary Works, Buenos Aires, invite tenders (by June 3) for the supply and erection of plant for a new generating station, including three 375 h.p. four-cycle Diesel engines (to run on crude petroleum) and three three-phase alternators, each of 250 kW 2 200 V between phases, 50 cycles and power factor of 0·8. Conditions, &c. (in Spanish) at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

In regard to the tenders required by the Victorian Government Railways for 12 miles of two-core lead-sheathed, wire armoured 2 200-V cable, H.M. Senior Trade Commissioner in Australia states that the Department is prepared to give consideration to alternative offers for cable with the section of each core 0·0145 sq. in. in lieu of 0·015 as originally specified. Tenders to the Victorian Railway Commissioners, Spencer-street, Melbourne, by May 4. Specifications are available at the Department of Overseas Trade, 35, Old Queen-street, S.W. 1.

The Electricity Commissioners of Victoria invite tenders for the supply and delivery at the Morwell Power House of street poles and copper cable. Copies of tender forms from the Agent-General for Victoria, Victoria House, Melbourne-place, Strand, London, W.C.2, and specifications may be inspected at the offices of the consulting engineers, Messrs. John Coates & Company, Ltd., also at Victoria House. Tenders to the Secretary of the Commissioners, 673, Bourke-street West, Melbourne, Australia, by May 31.

Tenders are invited in connection with the electrification of the Cape Town–Simonstown and Durban–Pietermaritzburg Railways, for the supply of turbo-alternators, boilers, condensing plant, passenger and freight locomotives, motor coaches and underframes, motor bogies, electrical equipment of coaches, sub-station equipment and transformers. Specifications and forms of tender from the High Commissioner for the Union of South Africa, or the General Manager, Johannesburg. Further technical information can be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1. Tenders to the High Commissioner by May 3.

Tenders are also invited for the overhead equipment of permanent way and overhead transmission lines, switchgear and accessories and track bonds. Specifications and forms of tender from the High Commissioner, Trafalgar-square, London, W.C., or from the General Manager, Johannesburg, and further technical information may be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, S.W.1. Tenders to the High Commissioner by June 22.

Last week the Swansea Electricity Committee considered two tenders for the supply of about 600 meters. One firm (a British firm) had made a purchase of German meters and was able to tender at a cheaper rate than the other who specified meters of British manufacture. Some members of the committee favoured the purchase of the German meters, on the ground that under the Reparation Act 50 per cent. of the money would go to the British Government as indemnity. A motion that the offer of the German-made goods be not entertained was lost, it being urged that the opportunity of making an immense saving was thus being thrown away, and the matter was adjourned for further inquiries to be made.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

158 385 Jensen & Tilney. Electric circuit-breakers particularly for the electric-ignition systems of internal-combustion engines. (6/11/19.)
158 386 Miller, Miller & Sanders. Cable connectors for use with electric motor lamps and other purposes. (7/11/19.)
158 392 Nalder Bros. & Thompson, Ltd. & Lipman. Frequency meters. (10/11/19.)
158 396 B.T.-H. Co. (G.E. Co.) Electric motor control. (11/11/19.)
158 415 Koretzky. Portable electric lamps for torches. (19/11/19.)
158 419 B.T.-H. Co., Young & Warren. Magneto-electric machines. (21/11/19.)
158 436 Zweigbergk. Electric motors. (28/11/19.)
158 452 Diver. Electrical heater for wells. (23/12/19.)
158 455 Rees. Wireless telegraphy and telephony receiving instruments. (5/1/20.) (Cognate application 2005/20.)
158 457 Simpson. Electrical circuit-breaker. (9/1/20.)
158 458 B.T.-H. Co. (G.E. Co.) Electric discharge devices. (19/1/20.)

Relates to an electric discharge device suitable as a rectifier or as a generator of high frequency oscillations comprising a sealed envelope containing an anode and a co-operating tungsten cathode maintained at incandescence by the passage of current there through during the operation of the device and a filling substantially of helium gas, preferably at a pressure in the neighbourhood of two-thirds of an atmosphere.

158 462 Davies. Electric fusible cut-outs having replacement devices. (23/2/20.)
158 486 Fellows. Magnetos. (19/5/20.)
158 488 B.T.-H. Co. (G.E. Co.) Electric lamps with luminous discharge. (6/6/14.) (Divided application on 13 759/14.)

Relates to an electric lamp provided with a sealed envelope containing a rarefied atmosphere of a gas such as neon and electrodes between which a luminous electric discharge takes place, in which the electrodes comprise co-operating metal cups mounted upon a common stem.

APPLICATIONS FOR PATENTS.

August 23, 1920.

24 425 Fawssett. Measurement of temperature of cables.
24 438 B.T.-H. Co. (G.E. Co.) Amplifying systems for electric currents.
24 451 Young. High-frequency alternating-current machines.
24 456 Seward. Electrolytic apparatus.

August 24, 1920.

24 506 Ellmore. Fault indicator.
24 515 Dadd. Flexible conductors.
24 525 Haake & Hagedorn. Electric igniters.
24 528 Macfarlane & Spink. Electric heating device.
24 546 B.T.-H. Co. (G.E. Co.) Incandescent arc devices.
24 547 B.T.-H. Co. (G.E. Co.) Electric discharge.
24 565 Vandervell. Electrically-driven air compressors.
24 566 Bailey. Switches.

August 25, 1920.

24 589 Davies. Generator and motor.
24 592 Young. Motors and generators.
24 593 Bishop & Chadwick. Electrically driven wheels for automobiles.
24 597 Hailwood. Miners lamps.
24 607 Turner. Electric generator lamps.
24 632 Sturge. Electric fires.
24 659 Marino. Electrolyte for electro-deposition of metals, &c.
24 660 General Electric Co. & Ryde. Incandescent lamps.
24 683 Magerle. Electric gongs, &c. (24/2/19, Austria.)
24 688 B.T.-H. Co. (G.E. Co.) Vacuum tube circuits.
24 690 Levy. Selecting and receiving system for telegraphy and telephony. (25/8/19, France.)
24 691 Clark. Electrical measuring instruments.
24 692 Armstrong, Whitworth & Co. & Smalley. Electric cables.
24 697 Soc de l'Accumulateur Tudor. Containers of accumulator cells. (27/9/19, Belgium.)
24 701 Godfree. Magneto-electric generators.

August 26, 1920.

24 741 Nobbs. Electric vehicles.
24 751 Bradley. Electric window-cleaning device.
24 753, 24 754 & 24 755 Metropolitan-Vickers Electrical Co. Electrical systems of automatic sub-stations.
24 764 Siemens & Halske A. G. Planet gear for power elements running in opposite directions. (26/8/19, Germany.)
24 773 & 24 774 Igranic Electric Co. (Cutler-Hammer Mfg., Co.) Regulating alternating currents.
24 775 Thompson. Feeding and rotating of electrodes. (26/3/18 U.S.)
24 789 Withers. (Renault.) Electric furnaces.
24 793 Warne. Electric heating appliance.

August 27, 1920.

24 820 Joseph. Electric cooking utensils.
24 822 James. Electric theft-prevention device for motor cars.
24 833 Siemens, Collyer & Petithory. Telephone call indicators
24 835 Naamlooze Venootschap Philips, Glacilamperfabrieken, Filippo & Lely. Electric discharge lamps. (27/8/19, Holland.)
24 836 Wilson Welder & Metals Co. Arc welding systems. (18/2/20, U.S.)
24 837 Wilson Welder & Metals Co. Rheostats. (7/5/20, U.S.)
24 838 Wilson Welder & Metals Co. Connections of electrical conductors. (19/6/20 U.S.)
24 839 Wilson Welder & Metals Co. Arc welding systems. (26/6/20, U.S.)
24 841 Siemens & Ferreira. Electric signalling for railways.
24 847 Norske Aktieselskab for Elektrokemisk Industri Norsk Industri Hypotekbank. Production of alumina from aluminium nitrate solutions. (19/9/19, Norway).
24 854 Haglund. Electrolytic tanks with diaphragm cells.

August 28, 1920.

24 880 Radio Communication Co. Wireless receiving systems.
24 910 Mottram. Miners' safety lamps.
24 942 Edison Accumulators, Ltd., & Monnot. Operating constant voltage circuits from variable speed dynamos.

August 30, 1920.

24 956 Taylor. Earthing neutral point of three-phase systems.
24 975 Simplex Conduits, Ltd. & McLaughlin. Switches and switch boxes.
24 988 Pattison (Dictograph Products Corporation). Telephone instruments.
25 011 Langdon & Weber. Electro-magnetic action for pipe organs.
25 017 Dingle & Urquhart. Automatic switches for electric irons
25 022 Soc. Da et Dutilk. Apparatus for measuring ratio of strength of two currents, (30/9/19, France).
25 029 Frost. Electric water heater.
25 033 Marks (Horn). Telegraphic receiving and transmitting apparatus.
25 035 Davis. Batteries.
25 046 Ges fur Drahtlose Telegraphic. Receiving apparatus for electrical oscillations (6/9/19, Germany).
25 055 Smith. Motors.

Companies' Reports, &c.

THE MACKAY COMPANIES.

The annual report of the trustees of the Mackay Companies states that the position of the companies continues to be one of great strength. The gross receipts and net profits of the cable and land line systems, while not as great as in the preceding year, are nevertheless very satisfactory. During the year the cable system transmitted a volume of traffic greatly in excess of any pre-war year, and the prospects for a continuance of a heavy volume of cable business seem assured. By means of new devices London has been brought into communication with New York without relays and without the sacrifice of any of the advantages of the old method of operation and very distinct advantages of the new. The circuit over which this direct and constant transmission is maintained is composed of 3 461 miles of submarine cable, and 168 miles of underground lines, the total distance being 3 629 miles. The land line system also experienced a satisfactory year, but owing to increasing expenses an increase of the rates for full paid telegrams by 20 per cent. was introduced on December 1, 1920. Large sums were expended in the extension and reconstruction of the land line system.

Particular attention has been paid to the continued development of the long-distance telephone service operating principally in the South, South-West and on the Pacific Coast. 154 cities and towns are now reached by that service and approximately 40 000 miles of wire are utilised and provided for its use. The giving of a long-distance telephone service by the land line system does not require the stringing of new wires, but is conducted over wires which simultaneously carry telegraph and telephone traffic, thus creating a by-product from the present facilities. The increase in revenue from that service in 1920 was 35 per cent. over that of the previous year. The value of the long-distance telephone service was very great, and a special department has been created for its development. The new line from East Palatka to Miami, Florida, will put the system in touch with the principal resort cities on the East Coast of Florida, and connect with the new cable of the Commercial Cable Company of Cuba from Miami to Havana, Cuba, which was opened for business last month.

New Cable Repair Ships.

A contract has been signed with Messrs. Swan Hunter and Wigham Richardson for the construction of a new cable-repairing steamer to replace the "Mackay-Bennett." The new steamer, which will be completed early in 1922, will be an oil burner of 360 ft. in length, and will be fitted with the latest machinery for cable repair work. It will be named the "John W. Mackay," in memory of the founder of the system. In the past the Commercial Company has depended on chartered cable repair steamers to make repairs of its cables off the Irish, English and French Coasts, but an additional vessel has been purchased, and converted into a cable-repairing steamer for effecting repairs in the localities mentioned. This steamer has been named the "George Ward," in honour of the Vice-President and general manager of the company. It is pointed out that there is nothing more important in the conduct of the cable business than the prompt and efficient repair of cables, and the new cable-repairing ships will assist in the maintenance of uninterrupted service.

The report also refers to the International Communications Conference of Washington, the readjustment of Franco-American cable rates, &c.

Messrs. A. Reyrolle & Company, Ltd., have declared a dividend of 12½ per cent. on the ordinary shares.

The Marconi Wireless Telegraph Company has restored its Deferred Service to Canada, Newfoundland and the West Indies.

The Castner-Kellner Alkali Company, Ltd., has declared a half-yearly dividend at the rate of 16 per cent. per annum, less tax.

The directors of the Lancashire Dynamo & Motor Company, Ltd., have declared a dividend of 6¼ per cent. actual on the ordinary shares, making 10 per cent. for year, as for the previous year.

The directors of the English Electric Company, Ltd., recommend a dividend of 8 per cent. (less tax) on the ordinary shares for the year 1920, payable on April 28.

The Monte Video Telephone Company, Ltd., has declared a dividend of 6 per cent. per annum (tax free) on the ordinary shares, for the half-year, payable May 2.

Applications are being invited for an issue of £300 000 8 per cent. second cumulative preference and £94 050 ordinary shares of £1 each of the City of London Electric Lighting Co., Ltd. The lists close on the 21st inst.

The directors of the Direct United States Cable Company, Ltd., have declared a final dividend of 4s. per share (less tax), making with the interim dividend a total of 4 per cent. for the year ended March 31.

During the week applications were invited for an issue of £500 000 8 per cent. secured and guaranteed notes of the Central Electric Supply Company, Ltd. The principal and interest are guaranteed by the St. James' & Pall Mall Electric Light Company and the Westminster Electric Supply Corpn.

The profit of the Torquay Tramways Company, Ltd., for 1920 was £24 969, and with the profit on motor omnibuses, &c. (£4 878) the total is £29 847. After deducting debenture interest and amount transferred to sinking fund, &c., the balance is £23 247 plus £5 786 brought forward. The sum of £8 000 has been placed to reserve and renewals account, £1 000 to reserve for equalisation of dividends, and a dividend of 8 per cent. for the year, tax free, has been declared, the sum of £10 302 being carried forward.

The annual report of the American Telephone & Telegraph Company, shows gross earnings of $103 946 988 (£20 789 398), against $70 502 682 (£14 100 536) last year, and net earnings of $70 686 904 (£14 137 381) against $60 243 387 (£12 048 677). At the end of the year the system had 12 601 935 stations, or 806 188 more than in 1919, and a wire mileage of 25 377 404. The directors have increased the dividend to 9 per cent. per annum in order to make subscriptions to new stock issues attractive under existing conditions.

During 1920 the connections to the Wycombe (Borough) Electric Light & Power Company's mains rose from 3 181 to 3 519 kW. an increase of 338 kW. The new engine, dynamo and boiler installed in 1919 have resulted in further economy in the generation of current, but the cost of labour and fuel increased greatly. Including balance from contracting business, the gross profit was £16 993, compared with £2 845 in 1919, and, after paying interest on debentures, loan and outstanding accounts, also making provision for income tax, and adding amount brought forward, the balance was £11 662. A dividend at rate of 7½ per cent. has been paid for the year; a sum of £5 000 has been placed to reserve for renewals, and £2 500 to general reserve, the balance of £412 having been carried forward. The Electricity Commissioners have authorised an increase in the maximum price to 1s. per unit.

Mr. Alfred R. Holland, who presided over the annual meeting of the Llanelly & District Electric Lighting & Traction Company, Ltd., last week, pointed out that the year 1920 had been one of great difficulty, and congratulated the shareholders on the fact that the results achieved had enabled the directors to recommend the maintenance of dividends at the same rate as in 1919. The power side of the business had continued to develop very satisfactorily, and many new and important consumers had been connected, some of whom were already taking a supply, and others would follow shortly. The public lighting contract had been renewed for a further period of ten years from Jan. 1, 1921, at increased rates, and powers had been obtained to increase the lighting charges. The contracts already made were sufficient to employ fully and profitably the new plant which had been installed, and, given a eturn to something like normal conditions, the prospects were exceedngly good for the supply of electricity in the area. With the new plant t was possible to effect economies in working expenses, and that would be helped by the decontrol of coal. The tramway results were adversely affected by the great increase in wages and cost of material, and permission had been obtained to increase the fares. With regard to capital expenditure, which up to the present had been dealt with mainly by means of temporary loans, the directors had under consideration the terms of an issue of capital.

Presiding over the annual meeting of the British Aluminium Company, Ltd., last week, Mr. A. W. Tait said that the trading profit for 1920 was £373 779, against £292 327 in 1919. He explained that the past year had been exceptional, particularly in the motor trade, which was a large user of the metal, not only in this country, but throughout the world. The year had started with a very strong demand, which in the first half could not be met, but owing to financial stringency, caused largely by over speculation, there was a sudden falling off in business in August and September, and the motor trade was placed in a serious position in consequence of the large stocks which it was carrying and had on order. Although all their works had been operated to their full capacity during the year and a record output obtained, while the sales effected were the largest in the history of the company, it had been necessary to make radical alterations to meet the changed conditions. There were signs that the worst period of depression might shortly be over, but it was essential to be in a position to meet foreign competition, particularly from Germany. The fall in prices should enable British industry to compete successfully in the markets of the world. When the present period of depression was over trade should resume its normal progress, and the field for development in their industry was large. It was, therefore, necessary to look ahead, and, as the industry very largely depended upon the generation of electricity at the lowest possible figure, the board had decided to renew the demand for the powers demanded in 1918. The profits justified a final dividend on the ordinary shares, making 10 per cent. for the year.

The Folkestone Electricity Supply Company, Ltd., reports that at Dec. 31 last the equivalent of 198 808 8-c.p. lamps was being supplied, an increase of 16 981 8-c.p. over 1919, being the largest increase in any year since the incorporation of the company. Including the receipts from hired installations, the profit was £14 914, an increase of £611. With £939 brought forward and interests on investments, &c., and after deducting interest on debenture stock and bank overdraft and dividend on preference shares, the balance is £10 226. The directors have carried £7 019 to depreciation fund, and they recommend payment of a dividend at the rate of 4¾ per cent. (less tax) on the ordinary shares for the year, which will require £2 375, leaving £832 to carry forward. Negotiations have been entered into with the Air Ministry for the supply of current to the Hawkinge Aerodrome, a contract has been prepared in connection with the public lighting of Cheriton, and other contracts are being negotiated, in addition to substantial increases made from thime to time in connection with ordinary private supplies. To cope with these demands it is necesasry to lay down further plant, which will entail a considerable expenditure. The shareholders will therefore be asked to pass a resolution authorising the directors to raise an additional sum of £50 000 over and above the present issue sanctioned of £100 000.

For the year 1920 the profit of the Metropolitan-Vickers Electrical Company, Ltd. (including £51 089 from 1919), was £359 580, and this has been appropriated as follows: To special depreciation of plant, &c., £35 000, general reserve £100 000, dividend on preference and ordinary shares at 8 per cent. and 12½ per cent. respectively, less tax, £165 756, balance carried forward £58 824. Notwithstanding the difficulties attendant on production during the period, the directors are pleased to be able to present an improved position as compared with the previous year. During the year 32 866 preference shares were converted into 65 732 ordinary shares, and an application for a quotation of the latter is before the Stock Exchange. The total conversions to Dec. 31, 1920, amount to 42 952 preference shares into 85 904 ordinary shares. The directors regret to announce the resignation of Sir E. V. Hiley, whose co-operation has been of great value to the company, and they have elected Sir Francis H. Barker to the vacant position of vice-chairman. Sir Vincent Caillard, D.L., has been appointed to fill the vacant seat on the board.

At the annual meeting of the British Engine, Boiler & Electrical Insurance Company, Ltd., last week, the chairman (Mr. R. C. Longridge) said that the volume of business undertaken last year exceeded all previous figures. The premiums and fees amounted to £290 799, against £208 970 in 1919, and the growth was well spread as between insurances on electrical plant, boilers engines, lifts, cranes and special inspection work. Expenditure had progressed more rapidly than receipts, with the disappointing result that for the sixth year in succession there had been a shrinkage in the ratio of trading profit, which had fallen from 15·5 in 1914 to 4·8 per cent. in 1920. The charges had necessarily been increased with a view to recovering the enhanced working costs. Examining the reasons leading to the expenses exceeding anticipations, the Chairman stated that in the early part of last year wages were raised substantially in various engineering trades, thus further advancing the cost of repairs, whilst the cost of additional remuneration to the Company's staff had been substantial. Other causes had also contributed. During the war the rationing of metal and other difficulties experienced in obtaining new boilers resulted in many discarded boilers being repaired and brought into use again, &c. In other classes of plant, particularly engines, the Company had also been affected by the pressure of economic conditions upon plant owners. Maintenance work had been postponed, breakdowns had occurred which could have been prevented, and the Company had been obliged to pay for losses which would not have happened under normal conditions.

During the year there had been some particularly heavy losses caused through the breakdown of large generating machines in public electricity supply stations, sometimes at the steam end and sometimes at the electrical end, and an accident in the London area involving a break-up of the generator, a piece of which was flung across the Thames, unfortunately killing a man, proved that generators were not immune from mechanical damage, whilst, of course, the risk of damage from electrical causes was material. There was a readier disposition on the part of public authorities to insure against such losses. That, no doubt, reflected the stringent financial situation and recognition of the fact that repairs to such machines, which to a large extent must necessarily be paid for at overtime rates, cost three or four times as much as in pre-war days. An echo of the war was found in the fact that a number of German submarine engines were now being used on land, and some of them had been submitted to the Company. Whilst those engines were no doubt well suited for the purposes for which they were intended, they had not commended themselves to the Company for work on land, and it was felt undesirable to accept them. The continued expansion in the use of electrical machines had led them to arrange for the Company's Scotch electrical business to be controlled from Glasgow. Similar arrangements were made in London a few years ago for handling the electrical business in the South of England. In both Glasgow and London as well as in Manchester and Birmingham, their subsidiary Company, British Electrical Repairs, Ltd., had large workshops for carrying out repairs to electrical machines.

New Companies.

The following list is compiled from information supplied by Messrs. Jordan & Sons, Ltd., company registration agents, Chancery-lane, London, W.C.2:

H. C. BAGSHAW & COMPANY, LTD. (173 954)—Reg. March 30, capital £1,000 in 985 £1 ordinary and 300 1s. founders' shares, to carry on business of mechanical, motor, electrical and general engineers. Directors: Florence M. Bagshaw, L. Norbury and C. E. Warren-Roberts. Reg. office: 4, Chorlton-street, Manchester. (Private company.)

CLEMENT-VICKERS, LTD. (173 851)—Reg. March 23, capital £1 000 in £1 shares, to carry on business of mechanical and electrical engineers. Directors: C. J. Wyke and G. B. Vickers. Reg. office: 10, Corporation-street, Manchester.

EMERGO ECONOMIC LAMP COMPANY, LTD. (173 880)—Reg. March 24, capital £1 000 in £1 shares, to carry on business of dealers and manufacturers of electric lamps and electric fittings. Directors: H. R. Prosser, E. T. Pheils, W. S. Metling, E. T. Cruise and H. L. Denston. Reg. office: 45, Newhall-street, Birmingham. (Private company.)

GUY V. LAYCOCK, LTD. (173 770).—Reg. March 18, capital £10 000 in £1 shares, to acquire and carry on business of electricians and electrical engineers and merchants. Directors: Beatrice S. Laycock, H. I Ripley and W. H. Laycock. Reg. office: 12, Cloth Hall-street, Huddersfield.

M. E. C. ELECTRICAL COMPANY, LTD. (173 800)—Reg. March 19, capital £1 000 in £1 shares, to carry on business of electrical and mechanical engineers. Directors: H. F. Collier, I. F. Milne and F. Westwood. Reg. office: 9, Stoney-lane, Birmingham.

OSCILLOSCOPE SYNDICATE, LTD. (173 846)—Reg. March 22, capital £3 000 in £1 shares, to carry on business of engineers and scientific instrument makers. Directors: A. J. H. Elversch and H. H. M. Thomas. Reg. office: 9, Quality-court, Chancery-lane, W.C.2.

F. PATRICK, LTD (173 905)—Reg. March 24, capital £15 000 in £1 shares, to carry on business of electrical, mechanical and general engineers. Directors: F. Patrick (26, Delph-lane, Leeds) and T. H. Breed. (Private company.)

REGAN, BENNETT & COMPANY, LTD. (173 779).—Reg. March 18, capital £5 000 in 2 000 10 per cent. £1 cum. pref. and 60 000 1s. ord. shares, to carry on business of electrical and mechanical engineers. Directors: J. W. Regan, W. H. Bennett and A. J. Marten. Reg. office: 32, Charing Cross. Whitehall, S.W.1.

RELY-A-BELL BURGLAR & FIRE ALARM COMPANY, LTD. (173 780).—capital £1 000 in £1 shares, to manufacture and fit burglar and fire alarms. Directors: H. J. Tibbles, F. V. Gunn and M. Gunn. Reg. office: 80A, Coleman-street, E.C.2.

WESTMINSTER COACH WORKS, LTD. (173 874)—Reg. March 23, capital £3 000 in £1 ordinary shares, to acquire and carry on business of mechanical and electrical engineers. First directors: A. T. Holsteinson (1, Craven-mansions, Craven-terrace, Hyde Park, W.2.).

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"The Cabinet Maker."—"Complimentary Luncheon to Sir John Benn"; "Annual Dinner of the Nottingham Centre of the National Federation of the Furniture Trades"; and "The Building Exhibition."

"Chemical Age."—"The Working of the German Reparation Act"; "World's Petroleum Supplies"; and "New Technological Applications of Old Reactions."

"Farm and Home" (Special Dairy Number).—"British Dairy Cattle," by Prof. James Long; "National Institute for Research in Dairying"; and "Utensils in Practical Dairying," by Dora Saker.

"The Fruit-Grower."—"Railways and Road Transport"; "State Assisted Horticulture"; and "Supply of Potatoes."

"The Gas World."—"Examination of the New Method of Charging for Gas," by George Braidwood; "The Gas Mantle as a Key Industry"; and "The Coal Miners and the Gas Industry."

"The Hardware Trade Journal."—"Ironmongers and Small Repairs"; "Hardware at the Building Trades Exhibition"; and "Internal Stresses in Brass Tubes."

"Aeronautics."—"The Design of Long Struts Exposed to the Air," by John Case, M.A., A.F.R.Ae.S.; and "The Artificial Control of Weather," by Sir Napier Shaw, F.R.S.

Prices of Metals, Chemicals, &c.

TUESDAY, April 12.

		Price.	Inc.	Dec.
Copper—				
Best selected…………	per ton	£70 10 0	£1 0 0	—
Electro Wirebars …	,,	£74 0 0	£0 10 0	—
H.C. wire, basis ……	per lb.	0s. 11½d.	0s. $\frac{1}{16}$d.	—
Sheet …………………	,,	1s. 0½d.	—	—
Phosphor Bronze Wire (*Telephone*)—				
Phosphor-bronze wire, basis ……….	,,	1s. 3½d.	0s. $\frac{1}{16}$d.	—
Brass 60/40—				
Rod, basis …………	,,	0s. 8½d.	—	—
Sheet, basis …………	,,	1s. 1d.	—	0s. ½d.
Wire, basis …………	,,	1s. 1d.	—	0s. ½d.
Pig Iron—				
Cleveland Warrants .	per ton	£6 5 0	—	£1 10 0
Galvanised steel wire, basis 8 SWG	,,	£26 0 0	—	£3 0 0
Lead Pig—				
English ……………….	,,	£22 5 0	£1 10 0	
Foreign or Colonial …	,,	£20 15 0	£1 7 6	—
Tin—				
Ingot ………………	,,	£163 5 0	£9 0 0	—
Wire, basis …………	per lb.	2s. 3¼d.	0s. 1¼d.	—

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £13 10s.

,, (Roll-Brimstone).—Per ton £12 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £32 10s.

Boric Acid (Crystals).—Per ton £74.

Sodium Bichromate.—Per lb. 7½d.

Sodium Chlorate.—Per lb. 5d.

Rubber.—Para fine, 11d.; plantation 1st latex, 11½d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

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Forty Years Ago.

(THE ELECTRICIAN, APRIL 16, 1881.)

PERSONAL.—Prof. W. E. Ayrton and Dr. Alder Wright are to be elected Fellows of the Royal Society in June next.

THE FIRST ATLANTIC CABLE COMPANY.—The 10th of March last was the twenty-seventh anniversary of the organisation of the first Atlantic company.—*Operator.*

ELECTRIC LIGHT AT THE BUILDING EXHIBITION.—Messrs. Wells & Company are exhibiting the Jablochkoff system of electric lighting at their stalls at the above exhibition in the Agricultural Hall.

ELECTRIC LIGHTING FOR THEATRES.—Roused by the recent lamentable accident at Nice, the question of introducing the electric light into theatres instead of gas is the subject of a good deal of discussion amongst our neighbours on the other side of the Channel just now.

EXPERIMENTS ON MAGNETIC COERCIVE FORCE.—Dr. Kulp magnetises iron and steel rods in spirals, which he opens before taking out the rods. On percussion, the permanent magnetism of the rods is partly increased, partly diminished and partly inverted. A series of induced currents arise in the rods on opening the spiral, which is explained by their having been exposed to magnetising forces in alternating directions. —*Weidemann's Bieblatter.*

Arrangements for the Week.

FRIDAY, April 15th (to-day).

INSTITUTION OF CIVIL ENGINEERS—STUDENTS' MEETING.

6.30 p.m. At Great George-street, London, S.W. Paper on "The Increased Efficiency of the Locomotive," by Mr. E. A. Phillipson.

INSTITUTE OF METALS—SHEFFIELD LOCAL SECTION.

7.30 p.m. At the University, St. George's-square, Sheffield. Paper on "A Non-Ferrous Electric Furnace," by Mr. H. A. Greaves.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

7.30 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "The Causes of Detonation in Internal Combustion Engines," by Mr. H. T. Tizard.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At Caxton Hall, London, S.W. Paper on "The Metering of Steam," by Mr. C. R. Sams.

MONDAY, April 18th.

ROYAL SOCIETY OF ARTS.

8 p.m. At John-street, Adelphi, London, W.C. Cantor Lecture on "Recent Applications of the Spectroscope and the Spectrophotometer to Science and Industry," by Dr. S. J. Lewis. Lecture II.)

TUESDAY, April 19th

INSTITUTION OF ELECTRICAL ENGINEERS.—NORTH-WESTERN CENTRE.

7.30 p.m. At the Albion Hotel, Piccadilly, Manchester. Smoking Concert.

INSTITUTION OF ELECTRICAL ENGINEERS.—SOUTH MIDLAND CENTRE.—STUDENTS' SECTION.

7.30 p.m. At the University, Edmund-street, Birmingham. Address by Mr. F. Forrest, followed by Annual General Meeting.

WEDNESDAY, April 20th.

INSTITUTE OF COSTS AND WORKS ACCOUNTANTS.

7 p.m. At the Institute of Chartered Patent Agents, Staple Inn Buildings, Holborn, London, W.C. Lecture on "The Work in Progress Account; an Essential Feature in Modern Costing," by Mr. R. Stelling.

THURSDAY, April 21st.

RONTGEN SOCIETY.

8 15 p.m.—At University College, Gower-street, London, W.C. Paper on "A New Form of Stereo-fluoroscope," by Prof. A. M. Tyndall and Mr. E. G. Hill.

FRIDAY, April 22nd.

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers on "The Effect of Viscosity on the Flow Through an Orifice," by Mr. W. N. Bond; "The Viscosity of Water at Low Rates of Shear," by Dr. A. Griffiths and Constance H. Griffiths; "A Method of Measuring Frequencies," by Mr. G. F. Partridge and B. S. Smith.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At Storey's-gate, London, S.W. Paper on "Limit Gauging," by Sir Richard T. Glazebrook, K.C.B., F.R.S.

TECHNICAL INSPECTION ASSOCIATION.

7.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Lecture on "Physical Properties of Clay," by Mr. A. S. E. Ackermann.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At Caxton Hall, London, S.W. Lecturette on "Construction and Working of Marine Water-tight Doors," by Mr. H. P. H. Anderson.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.

8 p.m. At Anderton's Hotel, Fleet-street, London, E.C. Annual Smoking Concert.

ROYAL INSTITUTION.

9 p.m. At Albemarle-street, London, W. Discourse on "Electro-Synthesis in Organic Chemistry," by Sir James Walker, F.R.S.

THE ELECTRICIAN

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Notes.

The First Joint Electricity Authority.

THE first Joint Electricity Authority has been formed. For, as we go to press, we are gratified to learn that the Electricity Commissioners have come to the conclusion that there should be one Joint Electricity Authority for the whole of the Mersey and West Lancashire area, though for a few years a separate committee will be established for working the Wirral peninsula. Some small additions have been made to the area of the district as provisionally determined and arrangements are outlined for making full use of the generating plant of the Mersey Power Company and for linking up the areas of the Wirral Committee and of the Company. A capital station is to be built in the neighbourhood of Liverpool and the erection of a transmission system connecting it with Liverpool, Bootle, Prescot, and St. Helens is to be the immediate duty of the new authority. We give elsewhere details of the decision of the Commissioners and of the provisions of the proposed Draft Order which is to be prepared. We shall refer to the matter more fully in our next issue.

The Fundamentals of the Coal Dispute.

THE general relief at the decision of the railway and transport workers unions not to support the miners by striking has somewhat naturally obscured the fact that the coal industry remained, and still remains at the time of going to press, at a standstill. It is true we have escaped national disaster, but we are still faced with a condition of things which cannot fail to do irremediable harm to our trade and industry. Among much loose talk about key industries we are liable to forget that the master key industry of all our key industries is coal. We not only export it, or used to export it, as raw material, but because our supplies were cheap and ample we were also able to export finished and semi-finished articles, especially iron and steel and textile goods, which depend on its employment for their production. There are some who find comfort in the present crisis in the supposition that if we cannot obtain cheap coal from our own fields we can import it from abroad, but this supposition loses sight of the fact that ultimately we only pay for goods with goods and that in the limit we should simply become factors, a position which, if it were permanently possible, would be a great declension from our once proud place in the ranks of trading nations. The one bright spot in the present state of affairs is that what has happened may teach us to use our fuel more economically than we have done in the past, to explore every method for improving steam-raising and generating plant and to block every channel whereby waste occurs. In all these directions the electrical industry should be able to help the nation and the nation the industry.

The Need for Saner Councils.

As regards the dispute itself, the rapidly moving events of last week tended to illuminate many of the dark and tortuous ways which were being followed by all the parties concerned. They showed that the Government might have been more conciliatory, that the mine owners case could not stand the full stress of close examination and that while the miners talked publicly about wages, on which question they have had a good deal of public sympathy, in private they continued to press for nationalisation in one or other of its numerous guises. As we write the leaders have temporarily abdicated leadership, and are consulting with their supporters as to whether the joint offer of the Government and mine owners of a temporary wages settlement should be accepted or whether the full demands for a national wages board and a national pool should continue to be pressed. Events go to show that the more vocal elements still insist that the latter course should be pursued. Nevertheless, we sincerely hope that by the time this Note is published saner councils will have prevailed. The miners are now fighting what can only be a losing fight against the full strength of the nation. But while they can only lose, as in most battles, those who win will suffer almost as much as those who are beaten. A settlement, which while being fair to all parties shall also be durable, is urgently required in these ever-recurring disputes in every industry, and especially in the mining industry. For they prevent any real recovery of trade and are gradually sapping the resources of the nation in a way which will be most severely felt by those who would benefit most from improved conditions.

A Chester Fallacy.

When laymen start to interfere with the technicalities of electricity supply there is often cause for cynical laughter. About a year ago a man fra' Sheffield wanted, for obscure reasons of his own, to charge large power consumers at the lighting rate. Now we have a Mr. Alan Williams, of Chester, objecting to the installation of additional plant because a difference between maximum load and plant capacity occurs only during two months of the year. This in spite of the fact that there is a waiting list amounting to some 400 kW, and that new industries now being started in Chester and its neighbourhood warrant a progressive policy being adopted. To deal with the increased demand it is estimated that about 1 000 kW of extra generating plant is required and the best method of obtaining it seems to be to link up with the War Office factory at Queens Ferry, where a 5 500 kW plant is installed. An argument in favour of this course is that the necessary interlinking mains will eventually be suitable for employment in connection with the North Wales and Chester electricity district.

The Independent Expert.

Mr. Alan Williams' suggestion for meeting the situation, so far as it comprises anything more than the appointment of the usual "independent expert of repute," seems to be to install extra plant kilowatt by kilowatt as the immediate demand requires. In these days of economy this method has a certain fascination, but we feel sure that the first thing that Mr. Williams' independent expert would tell him is that it is not economical. The Electricity Committee are in fact to be congratulated on adopting a scheme which will enable the interregnum period to be passed with the minimum of expenditure. The one drawback to it is that the War Office may not be able to continue supply for more than three years. But by that time we hope that the Joint Electricity Authority will be in working order.

Water Power and Heat Accumulation.

Fuel problems in Switzerland have to be regarded from a different point of view from that usual in this country. Here coal is (or was) abundant and cheap, there it is scanty and expensive. On the other hand, in Switzerland there is plenty of water power, and it is not, therefore, surprising that the possibilities of using electric heating for operations which we still consider outside its range are there being seriously considered. Some of these depend on the accumulation of heat by steam or hot water, but in a Paper read recently before the Swiss Society of Engineers M. Paul Beuttner described an electrical method of effecting the same purpose. He uses a stove which is electrically heated for 15 hours a day, that is continuously except during the lighting period. This allows meals to be cooked at any time in spite of the fact that the rate of current consumption is small. For instance, in a particular test on cooking the meals of a large family it was found that the breakfast consumed 0·87 kWh, the midday meal 3 kWh, the evening meal 1·95 kWh, while 6·50 kWh went in what is described as "losses."

The Development of High-Load Factor Appliances.

These "losses" apparently go in heating the washing-up water so that a satisfactory electrical service is obtained with a demand of 0·8 kW, lasting 15 hours, or at a cost in Zurich of 0·79 fr. a day as against 1·25 fr. for the same amount of energy used for cooking in the ordinary way. Where a special night rate of 0·03 fr. per unit is available the cost is further reduced to 0·45 fr. These stoves, which are heated by rods of silicium carbonate, function equally well with coal or wood, and are being largely used in the baking industry. This is evidence that a great deal more might be done than is being done in this country in the use of high-load factor appliances, proper care being taken to ensure their removal from the circuit during peak load. It would be interesting to know what switching arrangements are being used in Switzerland for that purpose, but Mr. Beuttner is silent on that point.

Pride Goeth Before a Fall.

Wallasey seems determined to keep in the public eye. A little while ago its local magnates were protesting that its electrical situation would be much better and brighter if it were not included in the West Lancashire district. Unfortunately, facts are stubborn things and certain recent happenings have somewhat cynically gone to prove that if there is one thing that the local electricity undertaking really wants it is a little more supervision. In a report on the undertaking which was recently considered at a meeting of the Town Council guarded references are made to "grave neglect and disregard of duty by the staff," "lack of proper and efficient supervision of the station and staff" and to "corrosion of an abnormal character affecting the efficiency of the plant." This sort of thing is, fortunately, very rare in the electricity supply world, and this example of regrettable neglect is, therefore, thrown into greater relief than would otherwise be the case. The war, of course, is made responsible for some of the trouble. But the war hardly explains why no attempt was made to repair certain defects in the pumps which became apparent in the early part of last year or why no action was taken when these pumps again gave trouble in July. No spare pump equipment was provided, as it should have been, with the result that when the inevitable breakdown occurred reserves were lacking. Matters were not improved by the way the original pumping plant was installed, the natural result being that proper examinations of its working condition was not made.

Proposals for Reorganisation.

To cure the state of things which this report discloses it is now proposed to reorganise the staff at the generating station, to provide office accommodation for the station superintendent, to make the electrical engineer reside in the borough, to call in an expert to investigate the primary cause of the corrosion, periodically to open up the boiler feed pumps for inspection and to install these pumps where they can be easily examined and dismantled. This, of course, is all very right and proper; but it is nevertheless an excellent example of the well-known proverb about closing the stable door. But one thing is not disclosed. It would be most interesting to know how far the neglect of duty at Wallasey—for it is nothing else—was caused by inadequate remuneration of the staff. Without adequate remuneration men of the right sort cannot be obtained to carry out the important work of supervising our electricity supply stations, and while at inadequate remuneration the wrong sort may be obtained, to employ them is in vulgar phrase asking for trouble. We do not suggest that this is the reason for what happened at Wallasey, but we are a little curious.

T.U. Ban on Non-Union Wiring.

The ways of some Trades Unions are past finding out. An example of this is the case, of which several have recently occurred, of a trade unionist official endeavouring to prevent electricity undertakers from giving a supply to premises on the ground that they have been wired by non-union labour. It is scarcely necessary to point out that undertakers cannot refuse a supply because the wiring has been executed by non-unionists, or, if they do, they can be compelled to fulfil their statutory obligations by legal process. If the installation satisfies the ordinary tests applied by the supply authority, and provided the conditions laid down by Sec. 18 and 19 of the Electric Lighting Act of 1882 and by Section 27 of the Schedule to the Electric Lighting (Clauses) Act of 1899 are complied with, there is no option in the matter. A case of this sort has just occurred at Hackney, but as the matter is *sub judice* we refrain from any comment, except to state the facts. A would-be consumer made formal application for a supply of electricity to the Council. Apparently, a master-man was engaged to do the wiring, but during the progress of the work a shop steward from the Council's electricity Department called and asked for his "Union ticket." As the master man did not belong to the Union he was informed that the Council's men would refuse to connect the premises, and that decision is stated to have been confirmed by the borough electrical engineer. A summons has now been granted against the Council and we await the result with interest.

American Cable Companies.

In these days of alarms and excursions about international communication it is interesting to note that both British and American cable companies enjoyed exceptional prosperity during the war. Greatly increased traffic receipts enabled higher dividends to be paid and there is not lacking evidence that this happy state of affairs will continue. Judging by the report of the Mackay companies, which are providing additional cable-repairing ships and are projecting extensions when opportunity serves, there seems to be no fear of the effects of competition by wireless telegraphy. The international cable situation is also referred to in the report, as are the views and claims of the President, Mr. Clarence H. Mackay, on the disposal of the ex-German cables. We dealt with this subject at some length in a recent issue when we urged a careful and impartial investigation of the situation, and pointed out that there was really no precedent to appeal to for guidance in the matter. The thing most like a precedent of which we are aware of is the claim of the Eastern Extension Telegraph Company for compensation for the cutting of their cables during the Hispano-American war. Though the claims of the Company for compensation on account of the expenses incurred in repairing these cables cut by the United States Navy was supported by His Majesty's Government and on three occasions was recommended to Congress by Presidents McKinley and Roosevelt as an act of equity, it remains so far unpaid, and probably will never be met. This is not a good example of just dealing by a nation which professes the highest moral standard, and it is scarcely likely to assist the Commercial Cable Company in its demands, though we hope that these will be dealt with on their strict merits.

Anglo-American Differences.

The differences between this country and the United States appear to have been aggravated by some vague and unsubstantiated charges by various American firms and individuals of cable delays and commercial espionage on the part of British interests. These allegations were made at sittings of the International Conference on Communications at Washington in October last, but, from the correspondence on the subject recently published, no proof is forthcoming and the persons who made them refuse to substantiate them. This is distinctly unfortunate, but the basis of the trouble may, no doubt, be attributed to suspicion and jealousy due to trade rivalry. However, it shows the need for free and unrestricted cable communication between countries.

The New Electricity Supply Bill.

Yet another Electricity Supply Bill has been born. But the foundling, as it may be aptly described, bears a strong family likeness to the No. 2 Bill which was brought in towards the end of last session, but was not proceeded with owing to lack of time. The new Bill consists of 22 clauses with a schedule and its avowed object is to confer certain essential powers upon the Joint Electricity Authorities sanctioned by the Act of 1919. The history of its genesis is briefly as follows :

The Genesis of the Measure.

So far the Electricity Commissioners, armed with such powers as the 1919 Act gave them, have provisionally determined 13 electricity districts. The necessary public enquiries into the organisation of these districts have been held in two cases. A third enquiry was opened, but adjourned for the presentation of certain engineering details, and the date of local investigation has been fixed in the majority of the others. But these enquiries, if they have done nothing else, have at least revealed that the policy outlined in the Act cannot be carried out without additional powers. In fact, the proceedings have exhibited a distressing difference of opinion on fundamentals. For while it is recognised by all electrical engineers that the present methods of generation and supply leave much to be desired, great difficulty has been experienced in obtaining agreement as to exactly how this reorganisation is to be effected without treading on the tender toes of local self-esteem. It is only fair to add that this disagreement has been more obvious among the non-technical than the technical parties.

What the New Bill will Do.

In the majority of cases the plan which finds most favour is the formation of a Joint Electricity Authority as permitted by Section 6 of the Act of 1919. Unfortunately, though the duty and powers of these bodies were laid down in fairly definite terms, no provision was made for them to obtain the money which everyone realised would be necessary for carrying on the work, or, rather, the provision that was made was struck out in the House of Lords. It is obvious, moreover, that nothing much can be done without suitable financial powers, and it is to remedy this omission that the present Bill and its immediate forbears were designed. By its provisions the financial difficulties of the transition period will be solved by giving Joint Authorities powers to borrow money and to issue bonds or stock for purchasing such generating stations or main transmission lines as they require, for carrying out any new permanent constructive work and for providing such working capital as may be necessary during the first three years of the Authority's existence. None of the money will have to be repaid while expenditure remains unremunerative or for a maximum period of five years. This is an increase on the usual time allowed for the suspension of the sinking fund, and as extensions of this kind are inconsistent with sound finance, especially where the use of the life of the plant is limited, we hope undue advantage will not be taken of the concession.

Nature of the Financial Aid.

The exact character of the financial aid which the Commissioners will be permitted to give the Joint Authorities is naturally one of vital interest. It appears from the Bill that the stock issued, as well as the interest thereon, will be charged on the undertaking and the revenues of the Authority. The funds themselves may be supplied by existing and prospective consumers in the district on the lines recently suggested in Birmingham, and local authorities or private persons who are interested in electricity supply will be allowed to guarantee the payment of interest and to give financial assistance in other ways. These borrowing powers may, however, not be automatically employed, for, except in the case of the London County Council, permission must first be obtained for the purpose by local authorities from the Ministry of Health. This seems to be unwontedly dragging another Government department into the business, but is probably considered necessary in order that proper control may be maintained over the expenditure of these bodies. We are not quite sure what is the meaning of "council of a . . . county district," but we presume it means an urban, rural or parish council. It might, however, be advisable to make this phrase more explicit and so avoid misunderstandings which are otherwise sure to arise.

Miscellaneous Provisions.

There are a number of miscellaneous provisions which also deal with this question of finance. For instance, a local authority transferring its undertaking to the Authority may either be paid by terminable annuities or by a capital sum. Instead of taking over an existing undertaking *en bloc*, the Joint Authority may enter into an agreement to work either the transmission lines or the generating station, or may delegate some of its powers in these matters to an existing undertaker. As regard charges for supply, a somewhat similar arrangement to that now in force with gas companies is foreshadowed. The rates are to be so fixed that the receipts will cover the expenditure (including interest and sinking fund charges), together with such a margin as the Commissioners may permit. Modifications of the prices now charged may also be made to secure the benefit of any reduction in the cost of electricity which is attributable to the 1919 Act. In this connection we are glad to note that it is proposed to make three years the ordinary period for the revision of maximum prices, and that the appropriate sections of the Electric Lighting (Clauses) Act of 1899, and of the Electric Lighting Act of 1909, are modified and repealed respectively.

Owners of railway generating stations are to be allowed to supply electricity to Joint Authorities or authorised undertakers subject to certain conditions, and the maximum period of loans raised by Scottish local authorities has been increased from 30 to 60 years. Except for buildings and certain other permanent works the latter period is much too long, but as the actual decision in each case will rest with the Electricity Commissioners it may be expected that a wise discretion will be exercised.

Amendments of the 1919 Act.

Opportunity is taken in the new Bill to make certain amendments in the existing Electricity Supply Act. Under section 18 of this Act a sum of £20 000 000 was to have been provided by the Treasury for temporary work which the Commissioners might undertake. Though it might be useful to obtain financial assistance from the Ministry of Transport during the first few years of the existence of some Joint Authorities, we do not think it to be absolutely essential. Electricity supply, we need not remind our readers, is now so well established; its advantages for power and lighting are so generally recognised, that there is difficulty in keeping pace with the demand, and therefore there can be little doubt that any well thought-out scheme, whether planned by a Joint Authority or by a power company, would receive adequate financial support.

The Rates Bogey.

Owing to the alarming increase in the rates and the heavy burden of existing taxation, any scheme which involves public expenditure is viewed with suspicion at present, and is subjected to considerable criticism—some of it unfair and ill-informed. For instance, Sir J. Remnant asked in the House of Commons last week whether the Government intended to saddle the rates with £30 000 000 for the new electricity scheme as well as the £20 000 000 previously estimated. In addition, we have noticed several articles in the daily and weekly Press which seem to assume that any money expended on electricity supply, especially by local authorities, must mean an increase in the rates. This is a gratuitous assumption, for which there is no real foundation. Some of the most successful electricity undertakings are owned by local authorities, and we need only mention those of Manchester, Liverpool, Glasgow, Edinburgh, Sheffield and Birmingham in proof of our statement. There is no more reason why a well-managed municipal undertaking should be less successful than one owned by a company, and the annual returns bear this out. We do not think any supply undertaking should be rate aided, and wherever this is the case the prices charged to consumers should be so adjusted as to obviate it. We should therefore like to see this subterranean propaganda, of whose birthplace we are all well aware, ended and all efforts made to obtain an agreed scheme. The present Bill, which it may be noted is only permissive in character, is quite definite on this question, and it is clearly intended that the undertakings of Joint Electricity Authorities shall be self-supporting. We hope, therefore, that the Bill will be passed without delay, so that the feeling of doubt and uncertainty which is barring progress may be removed, and that the reorganisation of the supply industry, which is so essential for the industrial development of the country, may be begun without more delay. It is obvious that this is necessary when we say that large schemes for extending many undertakings are being held up until the Electricity Commissioners have evolved a definite policy, while several Urban and Rural Councils are waiting for the creation of Joint Authorities in order to take a bulk supply. Nothing can be done until the new Bill has been passed.

Magneto Design.

In our college days, now some time ago, that type of electrical machine which was excited by a permanent magnet was mentioned by the professor in a perfunctory sentence and dismissed with a semi-contemptuous wave of the hand as being a piece of apparatus hardly worthy of serious study. The magneto, as we now call it, remained in this chrysalis state until the demands of the motor car industry led to its late blooming after a period of gestation prolonged beyond limits usual with electrical apparatus. By this time apparently British electrical engineers, whether imbued with the spirit of our late instructor or concerned with more weighty matters, had lost interest in its qualities, and though magnetos were largely used in this country they came mainly from the United States or Germany, and even when British made generally followed American or Continental practice. This neglect of a most interesting apparatus persisted until the beginning of the war. It is now history that the cutting off of supplies which that event occasioned forced us to develop a magneto industry of our own, with the not surprising result that we have learned a great deal. and owing to the enterprise of certain firms and individuals are now in a position to produce equipment second to none in design and reliability.

An Opportune Paper.

The Paper by Mr. E. A. Watson on "Magnetos for Ignition Purposes in Internal Combustion Engines," which was read before the Institution of Electrical Engineers last week, is therefore most opportune. And while he develops his theme voluminously, not to say discursively, he gives us a good deal of solid nutriment which we should do well to digest. No better protagonist for the subject could be found than he, seeing how much he has had to do with the development of the magneto.

The whole trouble is that most of its energy goes in counteracting the leakage at the plugs, in the wiring and in the magneto itself, and in dealing with the capacity of the leads, plugs and terminals. All these factors tend to lower the voltage generated and prevent a spark occurring. Moreover, it must be possible to obtain an adequate spark from the magnet over a very wide range of speed. More precisely in Mr. Watson's view, it must be capable of giving a peak voltage of 10 000 V. at a speed of 100 revs. per min. or less and it must be equally capable of generating an efficient spark when running at some thousand revolutions per minute or at any speed between these limits. And all this it must be capable of doing many times a minute all day and every day with a minimum of attention.

The Electrical Problem.

The problem is not an easy one whether we consider it from the electrical or mechanical points of view. Electrically, the magneto may be considered as a high tension alternator in which a special artifice is employed to obtain a rapid movement of the flux relative to the armature winding at one particular instant, while keeping the armature speed at a low figure. This is effected by using a portion of the revolution so that the currents induced in it tend to prevent any change in the flux leaving it and consequently produce distortion in the magnetic field. An interruption of the primary circuit cuts off this distorting current with the result that the magnetic flux rapidly returns to its original value, causing a high pressure in the secondary, which leads to a spark passing between the points of the plug. These considerations necessitate that the value of BH should be as high as possible, and the curves connecting BH and H are therefore important factors in choosing the type of permanent magnet and the material employed in its manufacture. At present tungsten steel is the best commercial material for the purpose, but as we have already shown in The Electrician certain cobalt-iron alloys, especially those due to Prof. Honda and Sir Robert Hadfield, give even better results, not only electrically but in a saving of active material and a consequent reduction of weight. Unfortunately, cobalt is very expensive at present and these advantages can therefore only be obtained at an increased cost.

The Effect of the Condenser.

Other matters which Mr. Watson discusses at some length include the theoretical questions of the effects of armature reactance and resistance, the transformation of magnetic to electrical energy. But special mention may be made of what he says about the effect of the condenser. As he points out, the condenser in its relation to magneto operation may be considered either purely as a device for suppressing sparking or as forming one element of an oscillatory circuit which is inductively coupled with the secondary. From the first point of view the problem is not so much the suppression of true sparking as of the suppression of arcing. But the whole matter is very obscure, especially as regards the conditions that exist at the moment of break. A carefully conducted research into the question would be worth while, especially as the important corelated question of finding some metal which can be used instead of platinum at the place of sparking must have an important bearing on this matter. Generally, it may be said that the capacity employed should be a compromise between that necessary to give an absolute suppression of sparking and that which gives the best low-speed performance. In our opinion any such research should also be directed to discovering how Prof. Taylor Jones' important theoretical investigations can be made of some practical use. This will tend not only to the elucidation of certain obscure points, but to the production of equipment capable of giving a better performance.

Mechanical Problems.

Mechanically, improvements in the design of the contact breaker would seem to be the principal need. The duty required from this minute piece of equipment is exceedingly severe. It has to make upwards of 100 interruptions per second, and in its working life may quite well have to break circuit 500 000 000 to 1 000 000 000 times. Slight wear may cause great irregularity of operation, so that its design and manufacture, especially the design and manufacture of its internal cam, is a matter which must receive a good deal of attention. Care is also essential in designing the bearings and lubricating arrangements, providing protection from dust and dirt and generally in giving that degree of foolproofness to apparatus which is obviously necessary when it is remembered that it is generally handed over to the layman to use. There are the further important questions of improving the insulating materials and methods of insulation and of considering whether the magnetic circuit cannot be improved. This especially applies to that part of the circuit which is adjacent to the pole-shoe, where there is a tendency for the flux to be reversed in direction every cycle, a most undesirable condition for magnetic steel to have to fulfil.

The Main Question.

But when all is said and done and when we have studied Mr. Watson's paper, have carefully sifted from it the essentials we must comply with to obtain an improved machine, have put some of the non-essentials aside for subsequent considerations, and have put these improvements into practice, we are reminded that the magneto is a commercial machine and that it is on its success in the world's markets the British magneto must stand or fall. Captious critics may indeed remark that it is all very well spending time and labour in improving the technical side of the apparatus only to find that there is no market for it when it has been made owing to industrial conditions here and elsewhere. We cannot, however, agree that this is quite the right spirit in which to consider this problem. But accepting it for the moment one thing is most evident. Unless our product is properly designed and manufactured it will obtain no permanent market however low its price or however attractive its detail in other directions. We have been given a new outlet for British trade It is to be hoped we shall seize it.

The Theory of the Three-Phase Variable Speed Shunt Commutator Motor.

By J. L. D. RIDSDALE, M.Sc.

(*Continued from page* 450.)

THEORY OF THE OPERATION OF THE MOTOR.

Consider first the operation of the motor when the brushes are in the zero position, *i.e.*, in such position that the axes of the rotor and stator coils coincide. The vector diagrams, Figs. 6 and 7, are drawn for the case of speeds below synchronism and hypersynchronous speeds respectively. The vectors, *OA*, *OB*, *OC* and *OD* represent the same quantities respectively as the corresponding vectors in Fig. 4, *i.e.*, they represent respectively the flux, the stator induced E.M.F. e_1, the rotor induced E.M.F. e_2 and the rotation E.M.F. e_u. The E.M.F. between the neutral and the tapping point of the variable ratio transformer is R_tE where R_t is the transformation ratio of the transformer and E is the supply E.M.F. (star value). R_tE is represented by *OJ* in the diagrams, and for speeds below synchronism is drawn in phase opposition to and for hypersynchronous speeds in phase with the supply E.M.F. E. The effect of the "drop" in, and the magnetising current of, the variable ratio transformer, and of the small compensating transformer, is neglected. The compensating E.M.F. is E_c and is represented by *OQ* in the diagrams leading the supply E.M.F. E by 90 deg. The E.M.F. impressed on the rotor terminals is E_2, the resultant of R_tE and E_c, and is represented by OH_2 in the diagrams. *OR′* is the rotor E.M.F. $e_r=e_2S$, and *OR*, the resultant of E_2 and e_r, is the E.M.F. required to overcome the rotor impedance. The rotor current I_2 lags by an angle α behind *OR*, and the stator current I_1 is the vectional sum of $R_m I_2$ and the magnetising current I_0. These currents are respectively represented by the vectors *OG*, *OM*, *OL* and *OK*. *OH*, as before, represents the supply E.M.F. E.

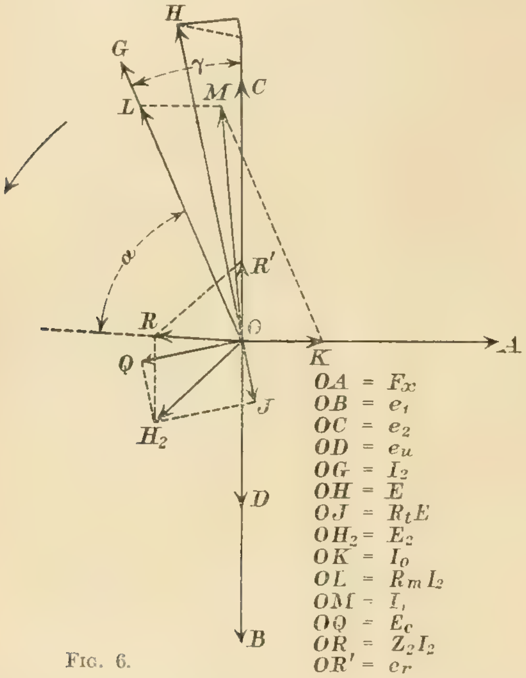


Fig. 6.

The analytical expressions for the torque, power factor and currents can be obtained from the diagrams by making use of the complex quantity.

From the diagrams (Figs. 6 and 7) the following vector equations are obtained :—

$$E_1=Z_0I_0+Z_1I_1 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$E_2=e_r-Z_2I_2 \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$I_1=R_mI_2+I_0. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

E_1 is the E.M.F. (star value) impressed on the stator terminals.

$Z_1=r_1+jx_1$ is the impedance of the stator winding per phase.

$Z_2=r_2+jx_2$ is the impedance of the rotor winding per phase.

$Z_0=jx_0$ is the exciting impedance per phase, *i.e.*, Z_0I_0 is numerically equal to but opposite in phase to the E.M.F. e_1. Substituting for I_1 and remembering that $e_r=e_2S=R_mZ_0I_0S$, equations (1) and (2) become

$$E_1=I_0(Z_0+Z_1)+R_mI_2Z_1.$$

$$E_2=Z_2I_2-R_mZ_0I_0S.$$

These two equations can be solved for I_2 and I_0 and give

$$I_0=\frac{E_1Z_2-E_2R_mZ_1}{Z_2(Z_1+Z_0)+R_m^2Z_1Z_0S} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$I_2=\frac{E_1R_mZ_0S+E_2(Z_1+Z_0)}{Z_2(Z_1+Z_0)+R_m^2Z_1Z_0S} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

whence also

$$I_2=\frac{I_0[E_1R_mZ_0S+E_2(Z_1+Z_0)]}{E_1Z_2-E_2R_mZ_1}$$

$$=\frac{e_2}{R_m}\cdot\frac{E_1R_mZ_0S+E_2(Z_1+Z_0)}{Z_0[E_1Z_2-E_2R_mZ_1]} \quad . \quad . \quad . \quad . \quad (6)$$

$E_1=E$. $E_2=R_tE+E_c$. R_t is positive when the rotor is connected to a tapping above the star point of the auto-transformer and negative for a tapping below the star point. If R_c is the ratio of E_c to E, $E_c=jR_cE$ and $E_2=E(R_t+jR_c)$.

Substituting for E_1, E_2, Z_0, Z_1 and Z_2, equations (4), (5) and (6) become

$$I_0=\frac{E\,.\,[(r_2+jx_2)-(R+jQ)R_m^2(r_1+jx_1)]}{(r_2+jx_2)(r_1+j\,.\,\overline{x_1+x_0})+R_m^2(r_1+jx_1)\,.\,jx_0S}$$

$$I_2=\frac{E\,.\,R_m\,.\,[jx_0S+(R+jQ)(r_1+j\,.\,\overline{x_1+x_0})]}{(r_2+jx_2)(r_1+j\,.\,\overline{x_1+x_0})+R_m^2(r_1+jx_1)jx_0S}$$

also

$$I_2=\frac{e_2[jx_0S+(R+jQ)(r_1+j\,.\,\overline{x_1+x_0})]}{jx_0(r_2+jx_2)-(R+jQ)R_m^2(r_1+jx_1)jx_0}$$

where

$$R=\frac{R_t}{R_m}\text{ and }Q=\frac{R_c}{R_m}.$$

On rationalising and separating the real and imaginary terms, the expressions for I_0 and I_2 become

$$I_0=E\left[\frac{\begin{gathered}r_1(r_2^2+x_2^2)-R_m^2(r_1^2+x_1^2)(Rr_2+Qx_2)-QR_m^2x_0(x_1x_2+r_1r_2)\\+RR_m^2x_0(r_1x_2-r_2x_1)-S[R_m^2x_0(r_1x_2-r_2x_1)-QR_m^4x_0(r_1^2+x_1^2)]\end{gathered}}{(r_1r_2-x_1x_2-x_0x_2-R_m^2x_1x_0S)^2+(r_1x_2+r_2x_1+r_2x_0+R_m^2r_1x_0S)^2}\right]$$

$$-jE\left[\frac{\begin{gathered}(x_1+x_0)(r_2^2-x_2^2)-R_m^2(r_1^2+x_1^2)(Rx_2-Qr_2)-RR_m^2x_0(x_1x_2\\+r_1r_2)\\-QR_m^2x_0(r_1x_2-r_2x_1)+S[R_m^2x_0(x_1x_2+r_1r_2)-RR_m^4x_0(r_1^2+x_1^2)]\end{gathered}}{(r_1r_2-x_1x_2-x_0x_2-R_m^2x_1x_0S)^2+(r_1x_2+r_2x_1+r_2x_0+R_m^2r_1x_0S)^2}\right]$$

$$. \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$I_2=R_mE\left[\frac{\begin{gathered}(Rr_2+Qx_2)(r_1^2+\overline{x_1+x_0}^2)+Sx_0[QR_m^2(r_1^2+x_1x_0+x_1^2)\\+RR_m^2r_1x_0+(r_1x_2+r_2\,.\,\overline{x_1+x_0})]+S^2R_m^2r_1x_0^2\end{gathered}}{(r_1r_2-x_1x_2-x_0x_2-R_m^2x_1x_0S)^2+(r_1x_2+r_2x_1+r_2x_0+R_m^2r_1x_0S)^2}\right]$$

$$-jR_mE\left[\frac{\begin{gathered}(Rr_2-Qr_2)(r_1^2+\overline{x_1+x_0}^2)+Sx_0[R\,.\,R_m^2(r_1^2+x_1x_0+x_1^2)\\-QR_m^2r_1x_0+(x_2\,.\,\overline{x_1+x_0}-r_1r_2)]+S^2R_m^2x_1x_0^2\end{gathered}}{(r_1r_2-x_1x_2-x_0x_2-R_m^2x_1x_0S)^2+(r_1x_2+r_2x_1+r_2x_0+R_m^2r_1x_0S)^2}\right]$$

$$. \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and

$$I_2 = \frac{e_2}{x_0}\left[\frac{R(r_2 . \overline{x_1+x_0} - r_1x_2) + Q(r_1r_2 + x_2 . \overline{x_1+x_0}) - R_m^2(R^2+Q^2)r_1x_0 + S[r_2 - R_m^2(Rr_1 - Qx_1)]r_0}{(r_2 - R . R_m^2r_1 + QR_m^2x_1)^2 + (x_2 - RR_m^2x_1 - QR_m^2r_1)^2}\right]$$

$$-j\frac{e_2}{x_0}\left[\frac{R(r_1r_2 + x_2 . \overline{x_1+x_0}) - Q(r_2 . \overline{x_1+x_0} - r_1x_2) - R_m^2(R^2+Q^2)(r_1^2+x_1x_0+x_1^2) + S[x_2 - R_m^2(Rx_1+Qr_1)]r_0}{(r_2 - RR_m^2r_1 + QR_m^2x_1)^2 + (x_2 - RR_m^2x_1^2 - QR_m^2r_1)^2}\right] \quad . \; . \; . \; . \; . \; . \; . \; (9)$$

These expressions are much simplified if it be assumed that

$$r_2 = R_m^2 . r_1 \text{ and } x_2 = R_m^2 . x_1.$$

In reality the values of r_2 and x_2, which include the resistance and reactance of the transformers, vary as the ratio of transformation R_t is varied, and consequently the above relation between r_2 and r_1, and x_2 and x_1 cannot hold for all values of R_t. For the sake of simplicity, however, the assumption will be made.

On substituting for r_2 and x_2 the expression for I_0 becomes

$$I_0 = E\left[\frac{\overline{1-R} . r_1 - Q(x_1 + x_0 . \overline{1+S}) - j[Qr_1 + \overline{1-R}(x_1 + x_0 . \overline{1+S})]}{r_1^2 + (x_1 + x_0 . \overline{1+S})^2}\right] \quad . \; . \; . \; . \; . \; (10)$$

whence the algebraical value of I_0 is

$$I_0 = \frac{E}{x_0}\sqrt{\frac{(1-R)^2+Q^2}{(r_1/x_0)^2+(x_1/x_0+1+S)^2}}. \quad . \; . \; . \; (11)$$

On making the following further substitutions :—

$$\frac{x_1}{r_1} = \tan\alpha$$

$$x_1^2 + r_1^2 = r_1^2(1+\tan^2\alpha)$$

$$\frac{r_1^2 + x_1r_0 + x_1^2}{r_1r_0} = \frac{r_1}{x_0} + \tan\alpha\left(1+\frac{x_1}{x_0}\right) = K.$$

The expressions for I_2 become

$$R_mI_2 = \frac{E}{r_1(1+\tan^2\alpha)}\left[\frac{(R+Q\tan\alpha)\left[(r_1/x_0)^2+\left(1+\frac{x_1}{x_0}\right)^2\right] + S\left[\overline{1+R}+QK+2\frac{r_1}{x_0}\right]+S^2}{(r_1/x_0)^2+(x_1/x_0+1+S)^2}\right.$$

$$\left.-j\frac{(R\tan\alpha-Q)\left[(r_1/x_0)^2+\left(1+\frac{x_1}{x_0}\right)^2\right]+S\left[\overline{1+R}.K-Q-2\frac{r_1}{x_0}\right]+S^2\tan\alpha}{(r_1/x_0)^2+(x_1/x_0+1+S)^2}\right] \quad . \; . \; . \; . \; . \; . \; . \; (12)$$

and

$$R_mI_2 = \frac{e_2/R_m}{r_1(1+\tan^2\alpha)}\left[\frac{(R.\overline{1-R}-Q^2)+QK+S[\overline{1-R}+Q\tan\alpha]}{(1-R)^2+Q^2} - j\frac{(R.\overline{1-R}-Q^2)K-Q+S[\overline{1-R}\tan\alpha-Q]}{(1-R)^2+Q^2}\right]. \quad (13)$$

Rotor Current, Torque and Speed.

Equation (13) gives the rotor current as the resultant of two component currents respectively in phase with and in quadrature with the flux F_y, rotation in which generates the E.M.F. e_u. The phase angle γ between the rotor current and flux can thus be obtained from this equation.

Converting equation (12) into real form gives

$$I_2 = \frac{R_mE}{\sqrt{r_2^2+x_2^2}}.\sqrt{\frac{(Q^2+R^2)\left[(r_1/x_0)^2+\left(1+\frac{x_1}{x_0}\right)^2\right]+2S[R(1+x_1/x_0)+Qr_1/x_0]+S^2}{(r_1/x_0)^2+(x_1/x_0+1+S)^2}}$$

or

$$\frac{I_2}{I} = 2.\sqrt{\frac{(Q^2+R^2)[(r_1/x_0)^2+(1+x_1/x_0)^2]+2S[R(1+x_1/x_0)+Qr_1/x_0]+S^2}{(r_1/x_0)^2+(x_1/x_0+1+S)^2}} \quad . \; . \; . \; . \; . \; . \; . \; (13\text{A})$$

where $I_s = \frac{R_mE}{2 . \sqrt{r_2^2+x_2^2}}$ is the short circuit current.

The mechanical output per phase in watts is

$$e_uI_2\cos\gamma.$$

Hence the torque in kg. metres per phase is

$$T_q = \frac{e_uI_2\cos\gamma}{61\cdot6u}.$$

If u_1 is the synchronous speed in revs. per second

$$e_u = \frac{u}{u_1}e_2.$$

Substituting for $I_2 \cos\gamma$ from equation (13) and for e_u, the torque per phase in kg metres becomes

$$T_q = \frac{E^2}{61\cdot6u_1r_1(1+\tan^2\alpha)} \cdot \frac{(R.\overline{1-R}-Q^2)+QK+S(\overline{1-R}+Q\tan\alpha)}{(r_1/x_0)^2+(x_1/x_0+1+S)^2} \quad . \; . \; . \; . \; (14)$$

If $1-R+Q\tan\alpha$ is positive, as would always be the case in practice, the torque vanishes when

$$(R.\overline{1-R}-Q^2)+QK+S(\overline{1-R}+Q\tan\alpha)=0,$$

or the torque vanishes when the slip is

$$S_0 = -\frac{(R.\overline{1-R}-Q^2)+QK}{1-R+Q\tan\alpha}. \quad . \; . \; . \; . \; (15)$$

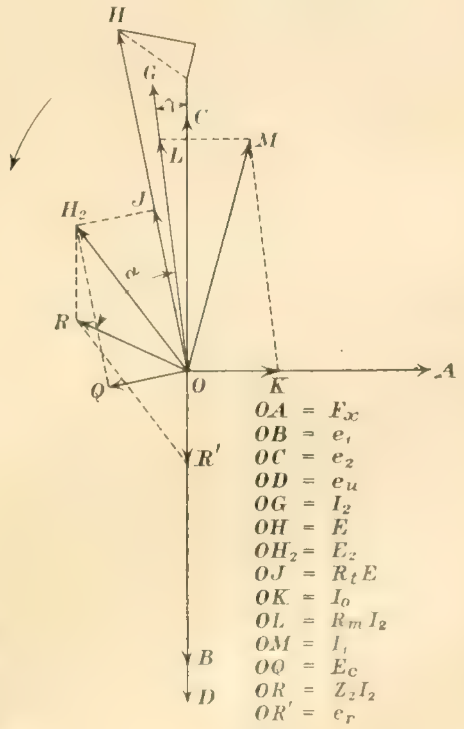
This equation gives the no load speed, and it will be seen that the no load speed can be varied by altering the value of R, *i.e.*, by altering the E.M.F. impressed on the rotor. Since Q is always small, the no load speed is approximately equal to $(1+R)\,u_1$.

In Fig. 8 are drawn for various values of Q and R curves showing the rotor current and speed plotted as a function of the torque, the initial part of the curves only being shown. In Fig. 9 are drawn the complete torque speed curves. The motor is assumed to have the following constants :—$x_1/x_0 = 0\cdot02$ $x_1/r_1 = 3$. $r_1/x_0 = 0\cdot00667$ and $K = 3\cdot0667$.

If $Q=0$ equation (14) becomes

$$T_q = \frac{E^2}{61\cdot6u_1r_1(1+\tan^2\alpha)} \cdot \frac{\overline{1-R}\;\overline{R+S}}{(r_1/x_0)^2+(x_1/x_0+1+S)^2}. \quad . \; (15\text{A})$$

Hence the torque vanishes if $R=1$. This is the "short circuit" position for the motor, the torque vanishing as the flux vanishes. By inserting $Q=0$ and $R=1$ in equation (13A), it is easily seen that the rotor current is $\frac{R_mE}{\sqrt{r_2^2+x_2^2}} = 2I_s$.



$OA = F_x$
$OB = e_1$
$OC = e_2$
$OD = e_u$
$OG = I_2$
$OH = E$
$OH_2 = E_2$
$OJ = R_tE$
$OK = I_0$
$OL = R_mI_2$
$OM = I_1$
$OQ = E_c$
$OR = Z_2I_2$
$OR' = e_r$

Fig. 7.

When R has a positive value greater than unity, the magnetising current is supplied to the rotor. The flux is reversed and with it the torque. The motor therefore runs in the opposite direction to the rotating field. The equations given previously apply, but the case is one of theoretical interest only; the currents approximate in value to the short circuit current, and the torque is only reduced to zero at an infinitely great speed.* From equation (15A) it is seen that when R has a value between 1 and zero the motor runs at hyper-synchronous speed, and when R has a value between zero and -1 the motor runs at speeds below synchronism.

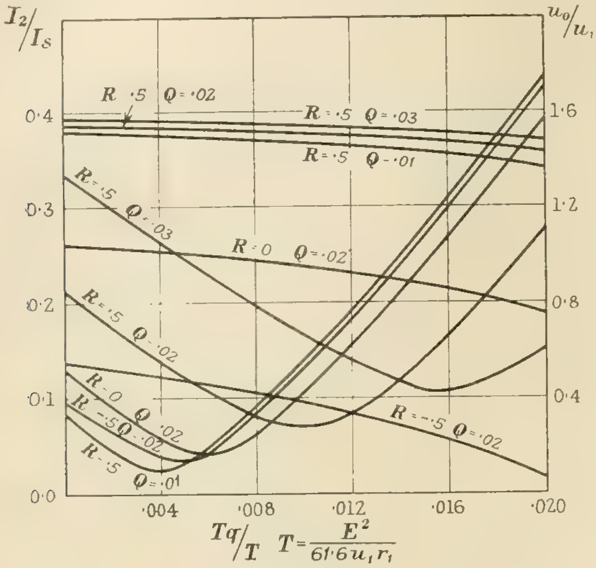


FIG. 8.

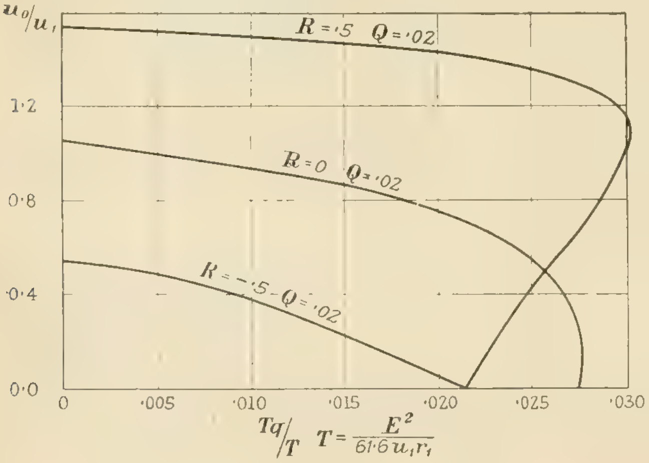


FIG. 9.

STARTING TORQUE.

At starting $s=1$, and henec if $R=-1$ the starting torque is zero. This is the "no load" position for the motor.

In Fig. 10 is shown a vector diagram for this case. (R_m is assumed to have a value $=0·5$). It will be seen that half the magnetising current I_0 is supplied to the stator and half to the primary of the variable ratio transformer, thus the rotor current is a wattless current and $=I_0$, *i.e.*, the magnetising ampere turns are supplied half by the rotor and half by the stator.

If R has a negative value greater than unity equation (15A) shows that the starting torque is again negative, *i.e.*, the motor starts up in a direction opposite to that of the rotating field. The no-load speed is, however, quite definite, being equal to $(1-R)u_1$.

Returning to equation (14) and inserting $S=1$, the starting torque becomes

$$T_q = \frac{E^2}{61·6\, u_1\, r_1\, (1+\tan^2\alpha)} \cdot \frac{1+Q(K+\tan\alpha - Q)-R^2}{(r_1/x_0)^2+(x_1/x_0+2)^2} \quad . \; . \quad (16)$$

This vanishes when

$$R = \pm\sqrt{1+Q(K+\tan\alpha-Q)}.$$

the + sign corresponds to the "short circuit" position and the − sign to the no-load position. It should be observed, however, that the rotor current in the no-load position is no longer equal to $I_0/2R_m$, but considerably exceeds this value.

When R is negative and numerically greater than

$$\sqrt{1+Q(K-\tan\alpha-Q)}$$

the motor will start up in a direction opposite to that of the rotating field. In this case the compensating E.M.F. must be reversed and in the formulæ for the torque, current, and slip, Q will have a negative value.

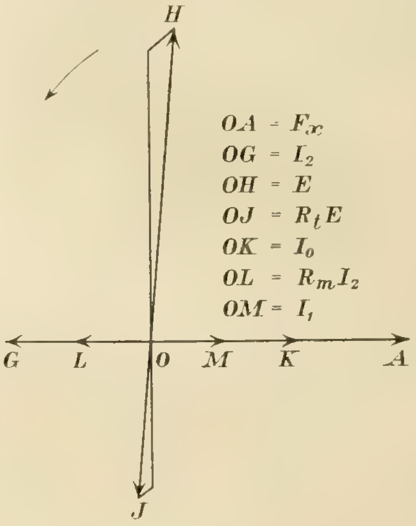


FIG. 10.

In Fig. 11 is drawn a vector diagram for the case of a motor whose rotor is running in the opposite direction to the field it being assumed that $R_m=0·5$ and $R=-1·5$. The no-load slip will thus approximate to 1·5, *i.e.*, the speed will be about 50 per cent. of the synchronous speed. The notation corresponds with that used in Figs. 6 and 7.

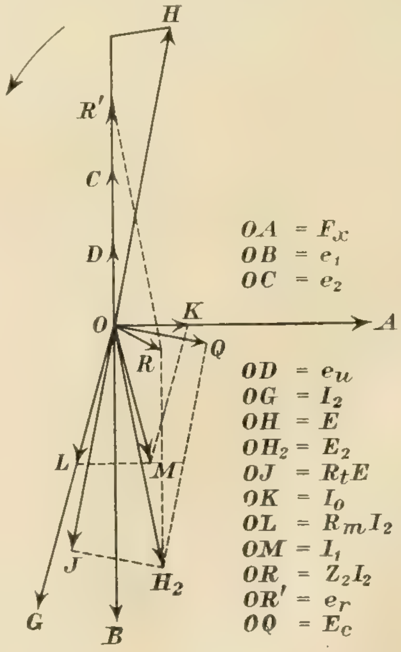


FIG. 11.

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* *See* THE ELECTRICIAN, Vol. LXXIV., p. 861, 1915, where this is pointed out by Dr. Wall and curves for torque and current as a function of speed are given.

CURRENT AND POWER FACTOR.

Expressions for the total current taken by the motor and for the power factor of the motor are easily obtained.

In Fig. 12 is shown a diagram for the various components of the current drawn by the motor from the mains. The figure is drawn for the case of the motor running at a speed below synchronism. The rotor current I_2 induces in the stator a current $R_m I_2$, and in the primary of the variable ratio transformer a current $R_t . I_2$. The phase relation between this latter current and the primary impressed E.M.F. must be the same as the phase relationship between I_2 and $R_t E$.

The value of the current drawn by the compensating transformer from the line is $E_c/E . I_2 = R_c I_2$. This current lags behind the supply E.M.F. E by the same angle as that by which I_2 lags behind E_c. Thus in the diagram the current $R_c I_2$ is shown lagging 90 deg. behind I_2. Lastly, there is the magnetising current I_0. Thus the current (star value) taken by the motor from the line

$$=I=I_0+R_m I_2(1+R-j.Q).$$

Substituting the values of I_0 and I_2 from equations (4) and (5) and inserting the complex numbers for $Z_1 Z_2 Z_0$ and E_2, it will be found that

$$I=E\,.\,\frac{\overline{(1-R}-jQ)(r_1+j.x_1)-(1+R-jQ)[j.x_0 S.+(R+jQ)(r_1+j.\overline{x_1+x_0})]}{[r_1+j(x_1+x_0\,.\,\overline{1+S})][r_1+jx_1]}$$

On rationalising and separating real and imaginary parts, this becomes

$$I=\frac{E}{r_1(1+\tan^2\alpha)}\left[\frac{\begin{matrix}(Q^2+R.\overline{1+R})[(r_1/x_0)^2+(1+x_1/x_0)^2]\overline{+1-}R[(r_1/x_0)^2+(x_1/x_0)^2]\\ -Q[\tan\alpha(1+x_1/x_0)-r_1/x_0]+S[1\overline{+R}(1+2x_1/x_0)\\ -Qr_1/x_0(\tan^2\alpha-1)+(Q^2+R\,.\,1+R)]+S^2[1+R-Q\tan\alpha]\end{matrix}}{(r_1/x_0)^2+(x_1/x_0+1+S)^2}\right.$$

$$\left.-j\,\frac{\begin{matrix}(Q^2+R\,.\,1+R)[(r_1/x_0)^2+(1+x_1/x_0)^2]\tan\alpha+1\overline{-R}.r_1/x_0(1+x_1/x_0)(1+\tan^2\alpha)\\ -Q(1+2x_1/x_0)+S[R(\tan\alpha-2r_1/x_0)+\tan\alpha(1+2r_1/x_0)+2Qx_1/x_0\\ +(Q^2+R\,.\,\overline{1+R})(r_1/x_0+\tan\alpha\,.\,\overline{1+x_1/x_0})]+S^2[1\overline{+R}\,.\,\tan\alpha+Q]\end{matrix}}{(r_1/x_0)^2-(x_1/x_0+1+S)^2}\right] \quad \ldots\ldots\ldots(17)$$

This expression gives the current I as the sum of two components, the one in phase with, and the other in quadrature with the supply E.M.F. E. The ratio of the quadrature component to the in-phase component is $\tan\lambda$ where λ is the angle of lag or lead of the current I behind or in front of the supply E.M.F. E.

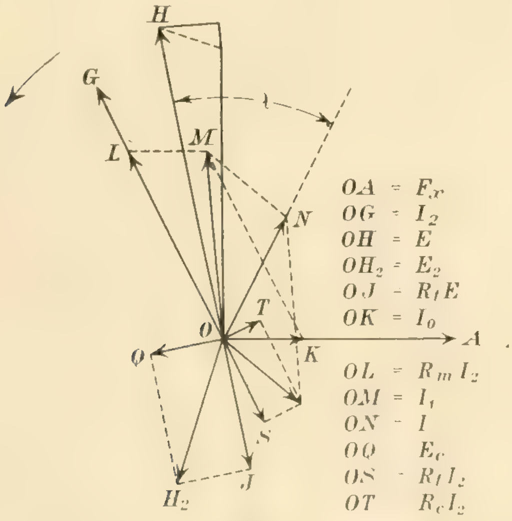

FIG. 12.

POWER FACTOR AT VARIOUS SPEEDS.

The values of the power factor at different speeds have been calculated for values of $R=0{\cdot}5$, 0 and $-0{\cdot}5$, Q in each case being equal to 0·02 and for $Q=0{\cdot}01$, 02 and 0·03, the value of R in each case being equal to 0·5. The results are shown in Fig. 13. The curves show that if the value of Q is constant, it is impossible to obtain a good power factor over a wide range of load and further that the load at which the power factor reaches unity varies with the speed range on which the motor is running. By adopting an appropriate value of Q however, it is possible to bring the power factor to unity for any predetermined values of the torque and speed. The curves in Fig. 14 show the value of Q required to bring the power factor to unity at any value of the torque for each of the speeds corresponding to $R=0{\cdot}5$, 0, and $-0{\cdot}5$. In the same figure are also drawn curves showing how the values of the rotor current and speed vary with the torque when the power factor of the motor is maintained at unity.

It will be apparent from an inspection of Figs. 6, 7 and 12 that in general when the motor is running at speeds below synchronous speed, the stator receives power from the mains, part of which is returned by the rotor to the mains; on the other hand, when the motor is running at hyper-synchronous speeds, both stator and rotor receive power from the mains. Further, an inspection of Fig. 11 shows that when the motor is running in the opposite direction to the field, the rotor receives power from the mains, part of which is returned to the mains by the stator.

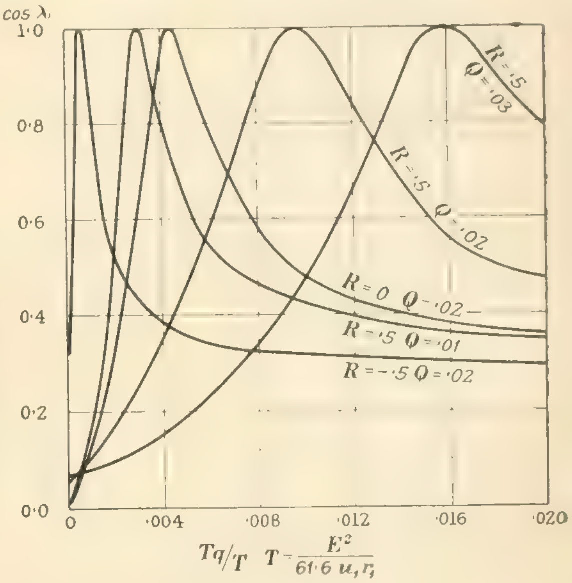

FIG. 13.

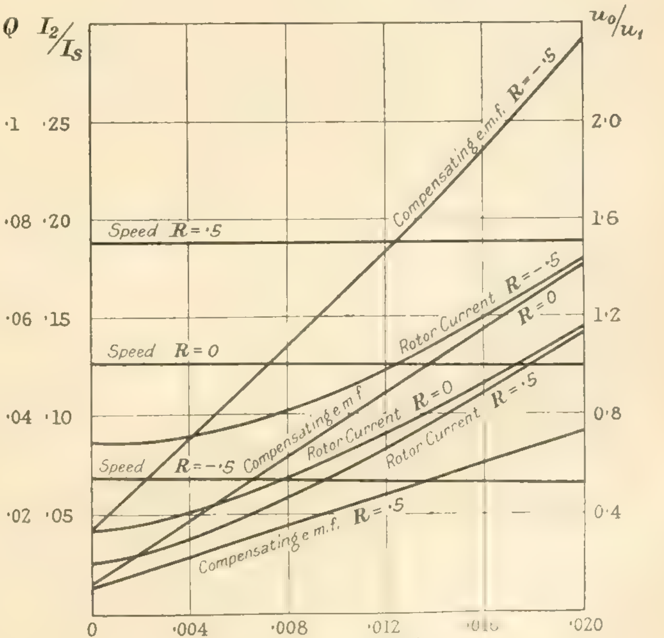

FIG. 14.

(*To be continued*.)

Magnetos for Ignition Purposes in Internal Combustion Engines.*

By **E. A. WATSON.**

Conditions to be Fulfilled.

A magneto must supply at regular intervals a sudden spark between a pair of points in the engine, usually about 0·5 mm. apart, which are surrounded by gas at a pressure as high as 6 or 7 atmospheres. In order to produce a spark, a definite minimum voltage must be generated depending upon: (*a*) the gap between the plug electrodes; (*b*) their configuration; (*c*) the pressure and temperature of the surrounding gaseous mixture.

A peak voltage of 10 000 V when the engine is turned by hand or by the electric starter is necessary. The engine speed may approximate 100 revs. per min. for cars of small and moderate sizes. The corresponding magneto speed depends on the ratio of the gearing between the engine and magneto. Four-cylinder engines usually employ a magneto giving two sparks per revolution at engine speed. Two-cylinder engines generally employ a magneto running at half engine speed. The speed of the magneto will be only 50 revs. per min. Consequently, various devices are employed, such as geared starters enabling the engine to be rotated more rapidly, &c.

Speed Voltage Curves.

Typical speed/voltage curves are shown in Fig. 1 for (1) a 4-cylinder, (2) a large motor-cycle magneto normally used on single-cylinder 4-stroke engines, (3) a small motor-cycle magneto usually fitted to small 2-stroke engines. The upper limit of speed is rarely encountered, except in aeroplane engines. In this case conditions as regards voltage required are usually less severe here than at low speeds, and 8 000 V is an outside figure, 5 000 to 6 000 V being more usual. On the other hand, plug leakage is more likely to occur. The standard testing speed for aeroplane magnetos is 3 500 revs. per min. Adverse conditions due to leakage may be due to various causes, *e.g.*, moisture deposited in a film on the surfaces of plugs, or on the insulation of the magneto; dirt on the insulation of the magneto; defects in cables and wiring; carbon deposit, charred oil, &c., on the interior of the sparking-plug; and leakage through the body of the insulator of the plug itself. Some porcelains show well-marked leakage at quite low temperatures. Mica, on the other hand, shows practically nothing up to 500°C. With satisfactory sparking-plugs such a temperature should rarely occur.

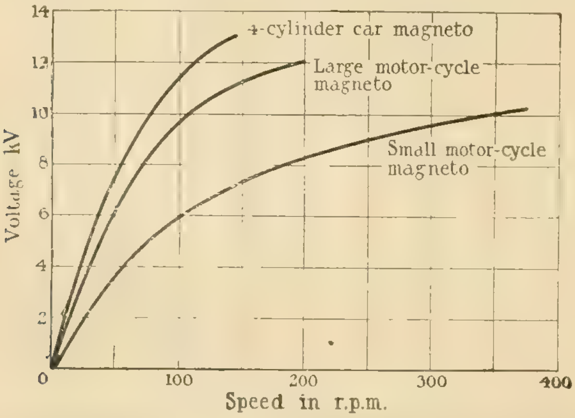

Fig. 1.—Performance of Various Magnetos at Low Speeds.

Sparking a Leaky Circuit.

The capability of a magneto for sparking a leaky circuit is a function of the energy which the magneto can supply in the spark discharge which consists of two portions, (1) the energy stored in the capacity of the leads and terminals discharged instantaneously across the gap, (2) a flame-like spark or arc, the duration of which is controlled by the electrical constants of the machine. The total energy in the discharge may be measured by various methods. Direct measurement of the current which the magneto can yield is difficult. Rough approximations can be made by an oscillograph, but it is best to compare different machines by shunting their terminals with a high resistance in parallel with a spark-gap. The value of the resistance necessary to stop sparking is a criterion of the capability of the machine for dealing with a leaky circuit. Such a test is generally called a "utility test," and the conductance or resistance required to quench the spark the "utility" of the magneto. A liquid resistance of 0·2-1 megohm is fairly satisfactory for laboratory purposes. Carbon rod resistances are useless. A step-down transformer working in conjunction with a resistance on the low-tension side yields satisfactory results.

Fig. 2 gives a series of utility figures obtained on various types of magnetos. These vary greatly, and there is no generally accepted standard of utility, but the author's firm have adopted the figure of 4 micromhos, and all high-speed testing gaps are shunted with a leak of this value.

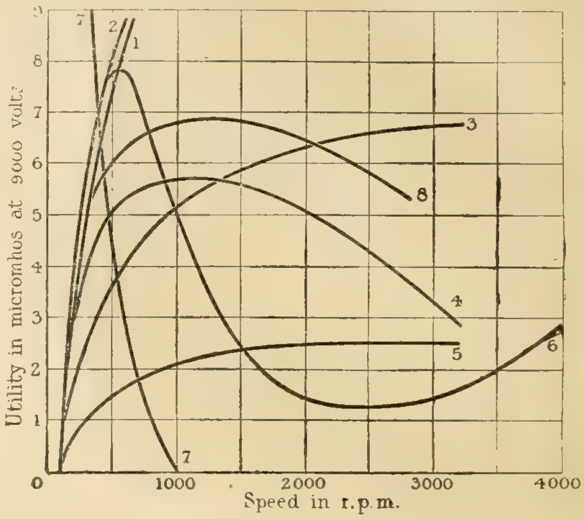

Fig. 2. Comparative Utility Curves.

Magnetic System as a Source of Energy.

The cycle of operations may be divided into two principal parts: (*a*) A period during which work is done upon the magnetic field in distorting it, and energy is stored therein; (*b*) a period during which this stored energy is returned to the circuit as a spark. The most usual arrangements of the magnetic circuit at present are (1) the ordinary revolving *H* armature, (2) the sleeve type, (3) the polar inductor type. The first class gives one complete flux reversal to each revolution, the second two, the third any desired number within certain limits.

Most magnetos belong to the first class, but the principle is the same in all. The author accordingly selects the ordinary *H*-armature 2-pole machine in studying the nature of the magnetic system. He traces and illustrates the typical curve of open circuit voltage comprising a sharp peak between 60 and 120 deg. above the base line, and a similar detached peak between about 240 and 300 deg. below the base line. The construction for the working flux in the magneto, relating *B* and *H*, is next given, and an expression for the available energy stored in the distorted field is obtained. A construction for the available energy follows, and finally the actual flux changes in the arch of the magnet when the magneto is running is depicted.

Magnetic Data for Various Steels.

Until a year ago the range of magnetic properties of available steels was somewhat restricted. With tungsten containing about 6 per cent. of tungsten and about 0·6 per cent. carbon a figure for $(BH)_{\text{max.}}$ of from 220 000 to 300 000 was obtainable. Great use is made in America of chromium steels which will give a $(BH)_{\text{max.}}$ of 240 000 to 250 000. A plain carbon steel will not usually exceed 200 000. Recently, however, the range has been extended by the introduction of the new cobalt steels. With 35 per cent. of cobalt, values of $(BH)_{\text{max.}}$ as high as 900 000 can be reached, the value of B_{rem} being from 10 000 to 10 500 with a value of H_c of about 200 to 240. Such a steel is naturally expensive, but a much smaller amount is required. The higher coercive force opens up possibilities of simplification of design, owing to the permissible reduction in magnet length.

Proportions of Magnet.

The preceding data allow us to estimate the total volume of the magnet, but do not indicate its proportions. Specially severe conditions may be introduced by:—(1) The armature being permanently short-circuited when running at a high speed, due to (*a*) short-circuiting of the sparking plugs by charred oil, carbon deposit, &c., or (*b*) the normal operation of the cut-out is used for stopping the engine. (2) The armature being removed from the tunnel without the use of any keeper, *e.g.*, when the machine is dismantled for examination or overhaul.

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* Abstract of Paper read before the Institution of Electrical Engineers.

It may be laid down as a condition to be fulfilled by the design that the removal of the armature shall not take the magnet appreciably beyond the point of $(BH)_{\max}$. It is useful to express the proportions of the magnet in terms of the magnetic potential between its extremities. This is zero when the magnet is short-circuited, and should never exceed the value corresponding to the optimum value of BH. The quantity ranges from about 600 for very small motor-cycle magnetos, to 1 200 for machines intended for lorry and similar work. Ordinary tungsten steels have the optimum value of BH at about $H = 40$, corresponding to a length of from 15 to 30 cm.

The effect of both armature and air-gap reluctance is to reduce the available amount of stored energy. Hence the air-gap is kept at a low figure, usually about 0·1 to 0·15 mm. measured radially. The density in most machines is from 12 000 to 15 000 lines per square centimetre, and the corresponding magnetic potential between the pole-faces with armature in zero position is approximately 100 C.G.S. units, *i.e.*, 8 to 16 per cent. of the value corresponding to storage of maximum energy.

Effect of Armature Resistance.

The effect of armature reluctance may be relatively small, but armature resistance has an important bearing upon the operation of the machine, especially at low speeds. For low speeds of rotation and long cycles the total flux change is much less than for short ones, this causing diminution in the stored energy. The spark energy rises with speed up to a maximum at which the amount of flux leaking back is small compared with the total. This maximum generally occurs about 2 000 revs. per min., and is clearly shown in Fig. 3, which gives curves taken for representative machines. A method of calculating the amount of flux distortion at any speed and armature position is given in the Appendix of the original Paper, indicating that the cross-sections of the primary winding must be as great as possible and its length of mean turn a minimum. Machines employing a separate transformer have an important advantage in that the whole of the space on the armature can be filled with short-circuited winding.

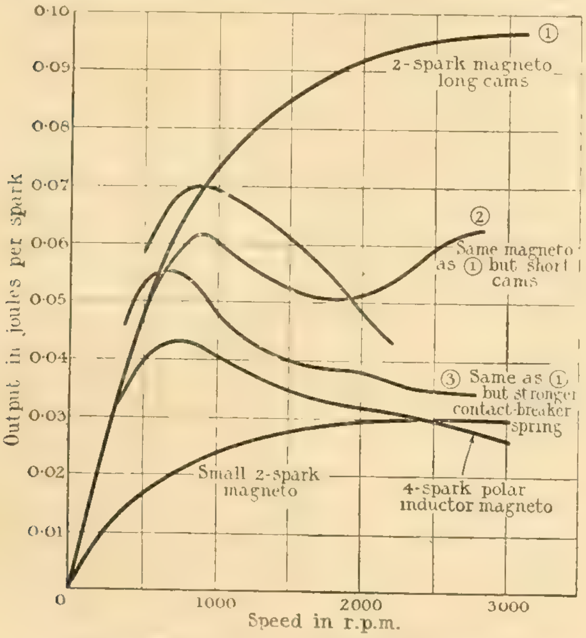

Fig. 3. Typical Magneto Spark Energy Curves.

In the original Paper the author presents diagrams showing the way in which the performance of a magneto at low speeds varies with changes in the copper cross-section of the primary winding, and also with the shape of the pole-shoes. Fig. 4 shows the way in which the position of maximum utility varies with the speed and angular position of the armature. At low speeds the maximum occurs near the mid-position of the armature. At high speeds its position moves round in the direction of rotation.

In order to obtain a variable point of ignition the position of the armature can be fixed with relation to the pole-shoes at which the spark occurs, and variations in timing obtained by altering the angular relation of the magneto. This may be done by several forms of special coupling. Another device consists in swinging the whole magneto about its axis, while a largely used device utilises a sleeve which carries the pole-shoes and which can be rotated, the magnet itself remaining fixed. This device gives very good results, but is expensive. Another device to improve the performance of the machine at low speeds is the impulse starter coupling, using a spring connection between the magneto and its driving shaft.

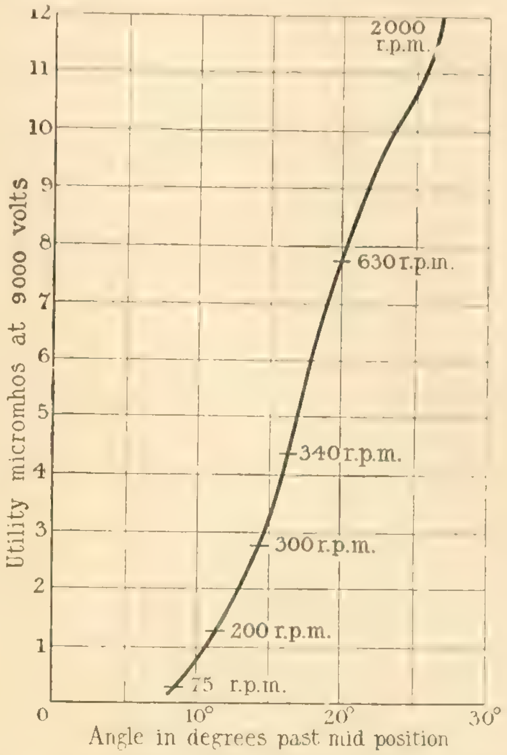

Fig. 4. Curve Showing Variation in Position of Maximum Utility with Speed of Machine.

Transforming Magnetic to Electrical Energy.

Having traced the storage of energy in the stretched magnetic field, the author next considers the transformation of this energy into that represented by a current flowing in the high-tension circuit.

In practice eddy currents in the armature core and pole-shoes retard the movement of the flux, and lessen the secondary voltage which a given flux-change can produce. Again, there is capacity associated with both primary and secondary windings, which also interact on one another. It is important to make the necessary flux-change as small as possible, for on this the performance of the machine at low speeds primarily depends. Correct lamination of the magnetic circuit is of obvious importance. It has always been the practice to laminate the armature core carefully, and now the majority of British firms are fitting laminated pole-shoes to their new models. Fig. 5 gives comparative tests made on the same machine with solid and laminated pole-shoes, and shows clearly the advantage to be gained by their use. In the past the difficulty of making a satisfactory mechanical job of laminated pole-shoes was a difficulty, but this has now been largely overcome.

Effect of Condenser.

The condenser may be regarded either as a device for suppressing sparking at the contact-breaker points, or as forming one element of an oscillatory circuit inductively coupled with the secondary. In practice the rupture of the primary circuit can never be instantaneous, and there is a definite relation between the sparking voltage between the two points and the time that has elapsed since they commenced to separate. In practice, however, the rate of pressure-rise and maximum voltage developed are independent of the cam shape, so that the mechanical conditions of break do not appear to be of great importance. A voltage of about 350 V appears necessary for a gap of 0·1 mm., rising somewhat as the gap is reduced to 0·001 mm., and then falling again. Hence, provided the voltage had not attained a higher figure than 350 V during the first 0·001 mm. travel of the points, sparking should not occur; actually the capacity must be more than corresponds to this rate of rise in order to suppress sparking.

Sparking should be independent of the material of which the contact points are made, whereas only certain metals, such as platinum and iridio-platinum, which do not form oxides when heated, can be used. Even so sparking is largely affected by the condition of the points, *e.g.*, the presence of small traces of dirt and impurities.

The problem, therefore, is not so much the suppression of true sparking as the suppression of arcing. Generally speaking, the conditions existing at the moment of break are little understood and a carefully conducted research into them would be well worth while. Sparking falls steadily as condenser-capacity is increased, but a compromise is necessary to reconcile this requirement with the capacity giving the best low-speed performance.

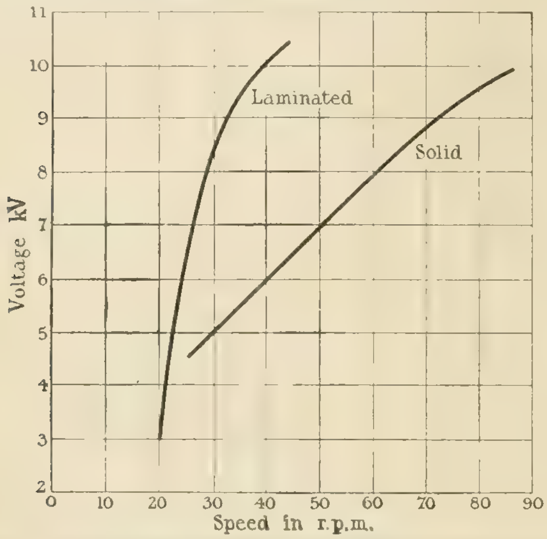

Fig. 5.—Comparative Low-speed Performance with Solid and Laminated Pole-Shoes.

The author discusses in some detail the theoretical considerations involved in the choice of capacity, and the consequences of close inter-linking of primary and secondary windings. But in many directions practical experience qualifies theory. Complete extinction of the spark is controlled by three factors, viz., (1) the time available, *i.e.*, speed of rotation and length of cam; (2) resistance of spark-circuit; and (3) inductance of the secondary winding. To make extinction complete we desire as long a cam as possible. The second factor is not greatly under control, but additional spark-gaps are sometimes inserted in the secondary circuit, thus reducing the spark duration. The third factor is largely controllable by modifying the shape of the pole-pieces.

In general the following principles form a basis for the correct relationship between the various factors concerned: (*a*) The number of secondary turns to be the least which will satisfy low-speed conditions; (*b*) the reluctance of the flux path to be such that under the worst conditions of high speed and maximum flux distortion the point of maximum *BH* is not exceeded; (*c*) the duration of open circuit of the primary winding to be as large as possible, *i.e.*, the points should be held open from the sparking position until the axis of the **H** armature is across the pole-faces or slightly beyond this position. This in most machines corresponds to a duration of "make" of 100 deg. and of "break" of 80 deg., the break occurring at approximately 10 deg. past the mid-position of the armature. These angles have been standardised by all the British magneto manufacturers.

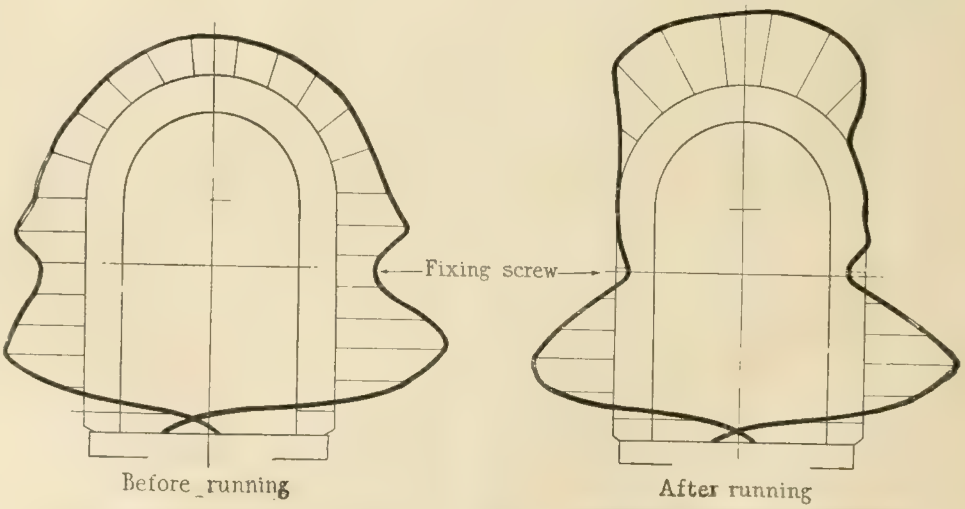

Fig. 6.—Distribution of Magnetic Potential in Horseshoe Magnet of Magneto.

Relation Between Electrical and Magnetic Characteristics.

The author summarises the results of his reasoning as follows:—

1. *Low-speed Voltage.*—Dependent upon available magnetic energy, primary resistance, speed of rotation, number of secondary turns, energy losses and condenser capacity. Increases with increasing speed up to a limiting value, which increases with increase in available magnetic energy.

2. *Utility.*—At high speeds proportional to magnetic potential of distorted field and inversely proportional to number of secondary turns. At low speeds dependent upon speed and primary resistance.

3. *Energy in Initial Spark.*—At high speeds proportional to available magnetic energy. Dependent upon losses in iron of armature, &c., and, partly, on condenser capacity. If losses were absent the energy would be independent of the voltage, but, owing to their presence, the energy decreases as the voltage is raised. At low speeds it is dependent upon speed and primary resistance.

4. *Total Energy in Spark and Flame.*—This follows the same law as the energy in the intitial spark, but is greater in value. Theoretically the total energy may be twice that in the initial spark. This energy is approximately that stored in a magnetic field of value $2B$ at a potential of H and is, therefore, $2BH/(8\pi)$ or $BH/(4\pi)$. If, instead of allowing this field to collapse sudenly, we do work on it, maintaining the potential H until $B=0$, additional work $BH/(4\ )$ will be done upon the field, and the total available energy will be $BH/(2\pi)$.

5. *R.M.S. Value of Current in Secondary Circuit.*—Depends upon characteristics of magneto itself and also upon spark-gap resistance. A magneto may be made to give almost any reading desired upon a hot-water ammeter, by altering the constants of the circuit. In particular, adding capacity to the terminals will increase the reading several fold.

Trend of Development in Magneto Design.

The following points always form the basis of development:—(1) Improvements in material available, including the use of cheaper but equally effective substitutes; (2 better utilisation of existing material; (3) improved mechanical design, tending to longer life and greater reliability in service; (4) simplification of parts, reducing cost of construction and elimination of difficult manufacturing problems.

In some cases these points are to a certain extent incompatible, notably (2) and (4), and a compromise has to be effected. We have already noted under (1) the use of the new cobalt steels in place of tungsten steels. Much might be done in the production of a satisfactory substitute for platinum for the contact points. Tungsten is certainly not equal to platinum, having shorter life and much higher contact resistance.

Under heading (2) we have already dealt with the use of laminated instead of solid pole-shoes. Much might be done in the direction of improved insulating materials and methods of insulation, so as to enable a better space factor to be obtained. There is room for improvement in the magnetic circuit. Examination of the armature reaction shows that certain portions of the ordinary horseshoe magnet are extremely ineffective. Fig. 6, which gives the distribution of potential along a typical horseshoe magnet after running, shows to what uneven demagnetising forces the metal is subjected, and how badly it is employed. Owing to this and other reasons, the energy given as a spark is only about 25 per cent. of that theoretically available.

Under heading (3) great progress has been made, particularly as regards the contact breaker and its actuating cams.

Under heading (4) much has been accomplished of late by the use of die castings, produced both in aluminium alloys and in alloys with a zinc base.

An Appendix to the original Paper is devoted to the calculation of flux in armatures.

Carrier Current Telephony and Telegraphy.*

By E. H. COLPITTS and O. B. BLACKWELL.

(*Continued from page 453.*)

Harmonic Generator.

In order to insure that the carrier current applied to the demodulator in the above system, employing suppressed carrier, is of exactly the same frequency as that used for modulation at the sending end, an arrangement has been devised whereby both of these frequencies are derived from the same source. For this purpose at one terminal of the system a vacuum-tube oscillator generates a frequency somewhat above the voice range say 5 000 cycles. Current of this frequency is applied to the input of another vacuum tube in such a way as to overload it. This "harmonic generator," as it has been termed, is so arranged that the current in its output circuit has a distorted wave-form containing prominent components whose frequencies are exact multiples of the applied frequency. The various harmonics of the base frequency (in this case 10 000, 15 000, 20 000 cycles, &c.) are separated by suitably designed selective circuits and led into individual circuits where they are amplified, and made available for use as carrier currents, each in connection with a different channel. At the same time, current of the base frequency from the controlling oscillator, in this case 5 000 cycles, is amplified and transmitted over the line to the other terminal. Here it is separated out by a filter, amplified and applied to a second harmonic generator, which produces the same series of carrier frequencies as does the harmonic generator at the controlling station already referred to. These regenerated harmonics may not only be used for demodulating the transmissions received from the controlling terminal, but may also be used in connection with balanced modulators which send in the reverse direction. The demodulators at the controlling station are supplied with carrier current from the harmonic generator at that terminal.

Advantages of the Suppressed System.

The suppressed carrier system, besides employing smaller line currents, has two other important advantages. One is the absence of audible beat notes resulting from interaction in the demodulating circuits between the carrier frequency normally present, and others which may be present through cross-talk or lack of perfect balance. Where all of the carrier frequencies are generated separately, these combination frequencies may in certain cases give rise to disturbing tones within the voice range. With the harmonic arrangement, on the other hand, the only possible frequencies are differences of the base frequency itself and its harmonics, all of which are above the normal voice range, and accordingly are suppressed by the low-pass filter in the output circuit of the demodulator. As a matter of fact, this harmonic arrangement is practically essential where the same frequency range is used for both directions.

The second advantage arises from the fact that variations in the attenuation of the line, due to weather changes or other causes, have less effect on the transmission equivalent of the system where the carrier frequency itself is not transmitted. This will be clear when it is recalled that the magnitude of the voice current in the output of the demodulator is proportional to the product of the amplitudes of the carrier and side-band currents. If, therefore, the change in line attenuation is such as to increase or decrease the side-band current by a given ratio, the carrier current when transmitted will in general also be changed in the same ratio, and the resulting voice current will be changed by the square of this ratio. In the suppressed carrier system, on the other hand, while the side-band is changed as before, the carrier is increased or decreased—not by the change in attenuation which occurs at the carrier frequency, but by the changes, in general much smaller, which occur at the base frequency, so that the voice current is less effected in this case.

Repeaters.

The great importance of amplifying apparatus at intermediate points on a line employing carrier frequencies will be evident. The conditions require that repeaters for this service differ quite considerably from standard voice frequency repeaters.

In the first place, on a multiplex carrier current circuit a single repeater installation must handle the energy associated with a number of independent conversations. This could be accomplished by making the installation include a number of repeaters in parallel with suitably associated filter combinations, but it is at once obvious that it is much preferable to install but one repeater channel capable of amplifying all the carrier transmission. The requirements for the repeater set are made still more severe by the fact that modulation in the repeater tubes, which tends to increase with the load, introduces disturbing factors in carrier operation which are not serious in ordinary repeater operation. The reason for this is that the combination frequencies resulting from the interaction of the currents in two channels may lie in the frequency range of a third, in which case they are transmitted through the selective circuits of that channel and appear as an interfering noise or tone at the subscriber's station. To obtain sufficient energy-carrying capacity, and to overcome to some degree this difficulty of intermodulation, a number of tubes in parallel in the so-called "push-pull" arrangement are used. The circuit of the push-pull amplifier is similar to that shown in Fig. 7, the transformer marked T_2 being omitted.

In this arrangement the input voltage is applied in such a way as to increase the grid voltage of one tube with respect to its filament at the same time that the grid voltages of the other is diminished. The plates are connected with the output circuit by a differential transformer, so that the useful amplified currents from the two tubes are added, while the more troublesome interfering components due to modulation are equal in amplitude and opposite in phase, and hence are balanced out.

If the same frequencies are used for the transmission in both directions, the lines on either side of the repeater must be balanced and the same general type of repeater circuit used as for voice-frequency telephone repeaters. If, however, different frequencies are employed for transmission in the two directions, filters may be used to prevent the currents sent out in one direction from passing into the input circuit of the repeater set which receives energy from that direction.

While the telephone currents at voice frequencies may be amplified in the same repeater along with the carrier currents, it has been found convenient for reasons of plant flexibility to separate voice-frequencies frmo carrier-frequencies by line filters similar to those used at the terminals. Due to the fact that the attenuation of voice-frequencies is much lower than that of carrier-frequencies, it is frequently unnecessary to install a voice-frequency repeater at all the points where carrier-frequency repeaters are installed. A number of arrangements are illustrated in the sections dealing with commercial systems.

Signalling over Carrier Circuits.

Signalling over carrier circuits is accomplished by two distinct methods in the two types of system employed. In the type where carrier current is transmitted over the line, the ordinary 16-cycle ringing current is made to operate a relay which disconnects the source of carrier current from the modulator, thereby stopping its transmission over the line. At the distant terminal there is associated with the demodulator an auxiliary rectifier tube, the direct current from which normally maintains a relay in its operated position. When transmission of the carrier current ceases this relay falls back, connecting 16-cycle ringing current to the line associated with the particular channel.

In the system where the carrier current is suppressed, the 16-cycle ringing current from the low-frequency line operates a relay which applies, over the speech channel, a current of 133-cycle frequency. This is transmitted over the carrier circuit resulting, when demodulated, in a similar current at the receiving terminal. This current operates a relay tuned to this frequency, and this relay sends out 16-cycle ringing current over the associated line.

Transmission of Telegraph Signals.

In transmitting telegraph signals by the carrier method, the signalling current, as received from the local telegraph trunk or from a connecting long-distance telephone line, operates a relay which controls the application of carrier current to the high-frequency line. The usual arrangement is such that high-frequency current of uniform amplitude is sent out during the marking intervals only. At the receiving terminal this high-frequency current is rectified, generally after amplification by a vacuum tube. The resulting rectified current operates a relay, which, in turn, sends signals over the connecting telegraph circuit or loop.

As in telephony it was shown to be necessary to transmit a band of frequencies equal in width to the voice-frequency range, similarly in carrier telegraphy it is necessary to transmit a band of high frequencies corresponding to the important frequencies present in the direct-current telegraph signals. Reasonably good signals are secured, however, if those components are preserved whose frequencies are a few times the fundamental interruption-frequency.

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*Abstract of a Paper presented at the 1921 Midwinter Convention of the American Institute of Electrical Engineers.

The upper limit of this essential frequency band varies with different types of apparatus and with different grades of service required, but it is for any one set of conditions roughly proportional to the speed of signalling. For the cases so far met with in practice it is of the order of 100 or 200 cycles. It follows, therefore, that satisfactory operation requires the transmission of a band of frequencies equal only in width to the essential frequency range of ordinary telegraphy. In case of multiplex-carrier telegraph operation, the non-essential frequency components are accordingly suppressed by the selective sending-circuits, so as to prevent them from interfering with other channels.

Multiplex Operations.

Referring to the question of multiplex operation, it may be mentioned that where the carrier-frequency is of the order of several thousand cycles, the percentage difference in frequency between the extreme edges of the side band is so small that it is not so readily possible to design circuits to suppress one of the side bands, as can be done in the case of telephony. For this reason the frequency range assigned to a carrier-telegraph channel has been twice that of the essential frequency-range of the direct-current telegraph channel. As is obvious from previous consideration, the advantages of band filters largely disappear for narrow transmission bands at high frequencies, and in telegraphy it has been found more convenient, for the signalling speed so far met with, to use loosely coupled resonant circuits.

"Full-duplex" working is secured by the use of different carrier frequencies for the two directions. Transmissions in one direction occupy a range of frequency from 3 300 to 6 000 cycles, and those in the other direction from very slightly above 6 000 to 10 000 cycles. By proper terminal arrangements this will provide on a single pair of wires the equivalent of 10 full-duplex telegraph channels and there is left still available a substantial frequency range which may, if desired, be used to provide either other telegraph, or additional telephone, channels.

Frequency Assignments.

What assignment of frequency to the various channels is best suited to a particular installation depends upon the engineering and economic considerations involved. It may be economical to go to considerable expense in securing sufficient uniformity on the line to enable its impedance to be readily balanced by artificial line networks, thereby making it possible to use the same range of frequency for the two directions in a two-way telephone channel. On the other hand, considerations of cross-talk may make it highly desirable that different frequencies be used for operation in the two directions. Under this condition it is not necessary to secure the uniformity of line-impedance which is required when the same frequency is employed in both directions.

A very workable assignment of frequencies to telephone and telegraph on the same pair is shown in Fig. 8. The arrows at the lower part of the figure indicate the positions assigned in the frequency scale to the different types of transmission. Beginning at zero frequency there is assigned to the direct-current telegraph a narrow band. The range extending from 200 to 2 000 cycles and represented by the horizontal arrow is the frequency band of ordinary telephony. In the interval between 3 333 and 6 000 cycles is a group of eight one-way carrier telegraph channels indicated by vertical arrows. In the interval between 6 000 and 10 000 are the eight oppositely directed channels, which with those of lower frequency may constitute eight full duplex telegraph circuits. The frequency range above 10 000 is assigned to three two-way carrier telephone channels. These are each designated by a vertical arrow indicating the position of the carrier frequency and the direction of transmission, and a horizontal arrow indicating the position of the side band with respect to the carrier frequency.

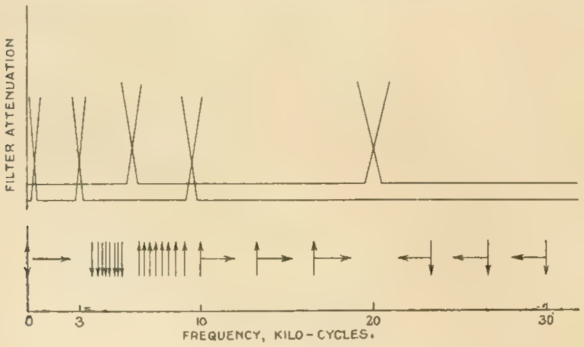

Fig. 8.

Above there are given, one above the other, the idealised attenuation characteristics of a pair of separating filters for use with this assignment of frequencies. The lower of the two is so designed that each filter transmits only those frequencies which are assigned to one particular purpose. Such filters would be used for separating into individual circuits the currents used for carrier telephony, carrier telegraphy, ordinary telephony and ordinary telegraphy, and thus facilitating their distribution in the central offices. The filters shown above are used for separating in the carrier currents circuits the currents transmitted in opposite directions.

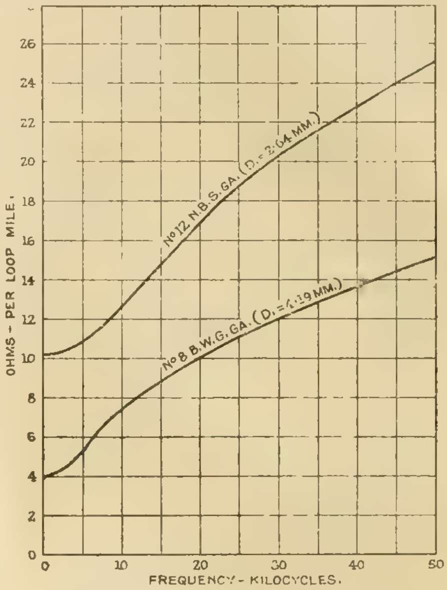

Fig. 9.—High-Frequency Resistance of Standard Copper Wire Sizes as used in Bell System.

Line Problems.

It is pointed out that with the high frequencies used, attenuation and interference are much greater with carrier currents than with ordinary speech currents. For this reason it is most economical to use the frequency range immediately above the voice range. The same factors make carrier transmission particularly dependent upon the use of repeaters at frequent intervals. To operate the

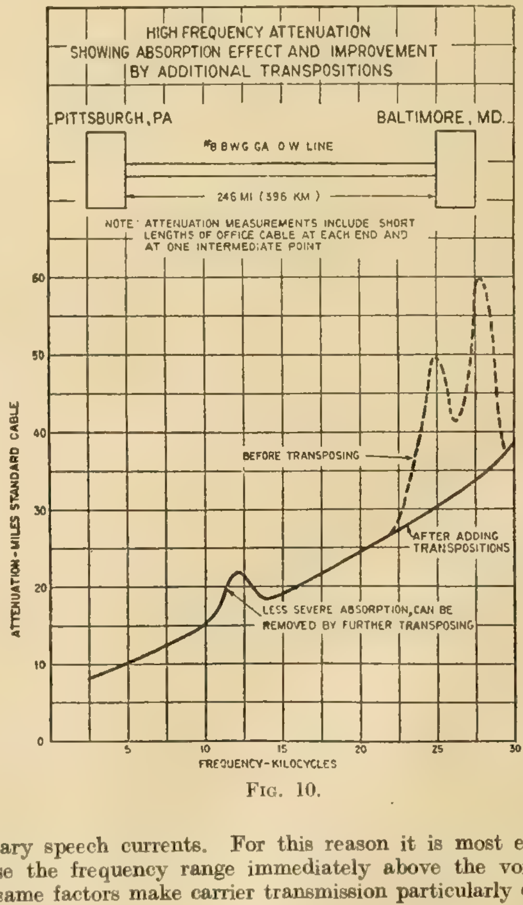

Fig. 10.

highest frequency channel in a particular 750-mile line, 60 kW would be necessary. By the use of repeaters the high frequency power at no point exceeds 0·1 watt.

The authors correct the misconception that has existed with some experimenters that at these frequencies, the energy being contained in electro-magnetic waves guided by the line wires, the energy losses are small. As a matter of fact the attenuation is even greater than the ordinary formulæ, used with the ordinary values for the line constants, would indicate, on account of the increased effective resistance and leakage. Curves are given showing the attenuation of typical open-wire and loaded and unloaded cable circuits.

It is found that the constants L and C are practically the same at high as at low frequencies. R may be computed by the usual "skin effect" formulas. Its rapid increase in value with increase in frequency is shown in Fig. 9.

The determination of G represents a more difficult task since no theoretical relation has been established between the effective conductance between the wires and frequency. In computing, the value of G was taken from measurements of the effective insulation of a group of glass line insulators exposed to ordinary weather conditions, and assumes therefore that the effective leakage occurs only at the insulators. The conductance, for example, at 25 kilo-cycles, under normal dry weather conditions, is found to be roughly 200 times that measured with direct current. The curves computed with the values of the constants so obtained are checked very closely by the actual field measurements.

Since the leakage plays a large part in determining the attenuation, substantial changes in attenuation occur for varying weather conditions. Under wet weather conditions the attenuation will rise materially higher than that shown in the curves.

Attenuation and Impedance.

The apparent attenuation of a circuit may be largely increased by the setting up of induced currents in adjacent wires carried on the same pole line. This is illustrated in the curve of Fig. 10, which is for one of the circuits employed in the operation of the first commercial carrier telephone system between Baltimore and Pittsburgh. The dotted curve represents excess attenuation originally found in the circuit due to such absorption. After additional transpositions had been cut into the circuit it finally gave the attenuation shown in the full-line curve. The smaller attenuation hump shown in the curve at about 12 000 cycles was not eliminated, as its effect was not considered sufficiently serious to justify the expense of further transpositions.

Curves are given showing the impedance of different types of circuit at frequencies up to 30 000 cycles. For open lines the impedance is practically a pure resistance with negligible reactance for all frequencies.

Transmission over cable is discussed only in connection with the unavoidable use of short lengths of cable in passing through cities, &c. The transmission loss and impedance irregularities introduced by cable can to some extent be overcome by loading or by auto-transformers. Some illustrations of this are given in the original Paper.

(To be continued.)

The Institution of Electrical Engineers.

The Theory and Practice of Magneto Design.

If the attendance at the Institution meetings this session were taken as a measure of the concern of members in various branches of electrical engineering, some interesting, but rather unexpected, results would be obtained. On this basis, the technical side of telephony would seem to be the matter in which the industry is most interested, while it is least concerned with magneto design. The attendance at the meeting of the Institution on Thursday, April 14th, at which Mr. E. A. Watson's Paper on "Magnetos for Ignition Purposes in Internal Combustion Engines" was discussed, was indeed so small as to be a very poor compliment to the high quality of its contents and to the real interest of a subject to which electrical engineers might well pay more attention. Perhaps, however, the smallness of the attendance was due to other causes, among them the Daylight Savings Bill, which makes the illumination in the Civils theatre more garish than usual, and the threatened railway strike.

Mr. Watson took rather longer than usual in presenting his Paper to the meeting, and by way of half-apology for this said it was the first Paper on magnetos which had been read before the Institution. He added the fact that it was not altogether his own, but might be called the result of joint discussion between the technical staffs of various firms, a joint discussion which had been necessary to build up the British magneto industry under the stress of war-time conditions.

Empiricism v. Science.

The **President**, opening the discussion, said it was remarkable that a piece of electrical apparatus of such enormous vogue as the magneto had been brought to so nearly approaching perfection by empirical means. Empiricism was the hallmark of the pre-war Continental magneto, due probably to the fact that it came mainly from the Nuremburg industrial area. Localised products of this kind were often of a very high quality, but it was nearly always found that when attempts were made to manufacture them elsewhere grave alterations in method were required. Directed research in this case had meant great development on more scientific lines and had resulted in the birth of a British-made magneto as good as any in the world.

A Waste of Energy.

Mr. C. C. **Paterson** said that the characteristics and design of the magneto were determined not by the conditions necessary to produce ignition, but by the need for overcoming defects that developed in the sparking plugs and cables. Practically all the energy which a magneto was called upon to supply went to the counteracting of the leakage in the plugs and cables so that the necessary potential between the points of the plug could be obtained. In conjunction with Dr. Campbell he had shown that as regards actual ignition, the amount of electricity passing between the plug points was unimportant and that whether a spark was "fat" or otherwise had no effect on the power obtained from the engine. For ignition solely about 1/1 000th joule was required, or about 1/70th of the energy supplied by the magneto. The first portion of the discharge which did the work did not last more than one millionth of a second.

The Efficiency of Magnetos.

Dr. N. W. **McLachlan**, who plunged into his subject in a breezy manner, discussed at some length the determination of the efficiency of magnetos. Dr. Taylor Jones had shown that this was the ratio of the electrostatic energy stored in the secondary to the electro-motive energy stored in the primary just before the contact points opened. This gave an efficiency of about 20 per cent. under ideal conditions. Experiments which he himself had conducted showed that the whole of the loss was due to the hysteresis and eddy currents in the iron. More information with regard to such losses could probably be obtained by building the armature laminations into some form of non-metal fitting. He had found also that there were two sets of oscillations, one of low frequency and high amplitude, and one of lower amplitude and fairly high frequency, and the inductance depended on the value of these two frequencies. A decrease in inductance also meant a reduction in the secondary peak voltage and therefore in the efficiency. An efficient magneto was an ignition apparatus which would explode a charge under adverse conditions, and they were, therefore, chiefly concerned with the maximum voltage it gave and not with the rate of rise of that voltage. If the voltage was high enough the necessary ionisation at the gap was a function of the voltage and of its time of application. But the voltage required to produce the necessary ionisation was greater the more rapidly the voltage rose, as breaking the primary circuit decreased the inductance so causing the rate of rise to increase, though there was a corresponding reduction in the maximum secondary voltage. For any given value of plug leakage there must, therefore, be a compromise between the maximum voltage and the rate of voltage rise.

Dr. McLachlan displayed an enthusiasm which was as refreshing as it was unusual in the discussion of a highly theoretical subject. A second bell was required to pull him up.

Minute and Detailed Testing.

Prof. E. W. **Marchant** was a victim of the shadow of the threatened railway strike, as some information which he had intended to give the meeting had not come to hand. In his view one of the most interesting things in the Paper was the way it showed how important minute and detailed testing of materials was. Some oscillograph records which he had made of the potential difference in the gap and of the current flowing in the primary circuit of a magneto when it was in operation on a small motor cycle engine working with different mixtures indicated that there were large differences in the peak voltage under different working conditions. The curves shown that evening for laminated and for solid pole shoes crossed and it was difficult to see why they should.

The Properties of Magnet Steel.

Mr. J. F. Kayser gave a short dissertation on magnet steels, comparing the advantages of tungsten and cobalt steels for this purpose. The first step was a determination of the demagnetisation rates of the two steels; then a determination of the flux of the two magnets must be made. The total energy given by a tungsten steel magnet could be readily determined, and dividing this value by the maximum energy per cubic centimetre of the cobalt steel magnet gave the necessary value for obtaining the same result. The original area of the tungsten steel magnet multiplied by the flux density at which it was working divided by the flux density at the point at which the cobalt steel would give its maximum available energy gave the new cross-sectional area necessary. Mr. Kayser complained that magneto makers made a great and unnecessary fetish of remanence. Practically, remanence was useless, though academically it was interesting. After reading the Paper everyone would agree that the only criterion of magnetic worth was $(BH)_{\max}$.

What the Air Ministry has Done.

Capt. A. B. Burgoyne assured the meeting that the Air Ministry was most anxious to help magneto manufacturers to produce an equipment which would meet the requirements of the Air Service. Conditions on aeroplanes were obviously much more severe than on ordinary internal combustion engines. Not only was a higher voltage required, but the apparatus had to perform in air of rare density and low temperature, though the magneto itself might be exposed to considerable heat. As electrically it was necessary to screen off the wireless gear, metal-braided high tension cables had to be used, introducing additional leakage into the circuit. A specification which had been drawn up by the Ministry in conjunction with the Magneto Manufacturers' Association laid down that a magneto must be capable of firing a plug with a leakage of 200 000 O, and the magnet running at 3 000 revs. per min. This was a good deal more severe than the author's utility test, especially as the magnet must also work properly after running over 48 hours in a saturated atmosphere, while after working at a temperature of 120°F. it must run for 500 hours and give satisfactory performance at 200 revs. per min. His considered opinion was that all British magnetos were better than the best American magnetos, while the "Bosch" was excellent in workmanship, but not so good in design, and its electrical performance was rather indifferent. The workmanship of the British magneto was often poor, though the best of them were at least equal to the "Bosch." The extended use of cobalt steel should reduce the size and also the price of the magneto.

Mechanical and Electrical Design.

Mr. A. P. Young began by calling attention to the complications of the subject, whether one considered it theoretically, technically or from the manufacturing side, and he agreed with the author that the magneto was well worthy the study of the electrical engineer. Mechanically, the problem of the contact-breaker was very interesting. This part consisted of a little rocking arm which oscillated backwards and forwards through a very small distance a very large number of times a second. It moved most quickly when the whole of the breaker came in contact with the cam, and if it moved with a simple harmonic motion when the magneto was running at 300 revs. per min. the force at the moment of impact was about 7 lbs. A great deal of light would be thrown on the subject of contact breaking if what happened just before and just after the contact separated could be discovered. The densest metals were the best for use at the contact points; but arcing could be eliminated by making the condenser sufficiently large. The use of laminated poles was now general. Tests showed that there was a certain critical gap between the edge of the armature and the leading edge of the pole-piece, which gave the lowest maximum sparking speed, and it followed that in an ordinary machine the sparking was of inferior quality when the machine was retarded. The use of laminated poles enabled the size of the machine to be reduced for the same performance, and also the energy to be maintained over the whole range of speed. Most magnetos gave 50 times as much energy as was theoretically necessary, but he did not think that this extra energy was unproductive, for when the engine was cold the explosive mixture contained globules of petrol, and a certain amount of heat energy in the spark was therefore beneficial for igniting them, though this excess energy should not be so great as to burn the plug electrodes.

Discussion at Manchester.

A discussion on Mr. Watson's Paper also took place recently in Manchester, when it was generally agreed that its most notable feature was the revelation of the work being done at Sheffield on the new cobalt steel invented by Prof. Honda. The properties of this steel were first published in The Electrician of December 17th, 1920. Unfortunately, more time than usual was taken in expounding the Paper and in opening the discussion. Manchester contributed its quota towards the magneto output during the war, and the time might, therefore, well have been spent in a more representative discussion. The influence of Mr. Evershed's Paper on work dealing with permanent magnets was evident.

Properties of Cobalt Steel.

Prof. E. H. Crapper, of Sheffield, agreed with the author that remanence, coercive force and the product $(BH)_{\max}$, associated with the quality of permanent magnets, sufficed for magneto design, but thought that the suitability of a material could only be satisfactorily determined when the relationship between these constants was known. Remanence and coercive force were functions of the saturation value of the intensity of magnetisation. It was necessary, in testing magnet steels, to take the magnetising force to a value sufficiently high to produce saturation. There was a linear relation between reluctivity and magnetising force. Prof. Weiss, of Zürich, was the first to show the beneficial effect of cobalt on iron, and a maximum intensity was produced with about 35 per cent. of cobalt. Cobalt steel was now being made in Sheffield, and the curves already obtained indicated that it was magnetically three times as effective as tungsten steel, hitherto the best steel for permanent magnets. The coercivity varied from 200 to 240 units, and remanence corresponded with that of tungsten steel. There was a relationship between the magnetic and elastic properties of a material, and changes in a magnet through external influences depended on the rapidity with which molecular movement took place.

Mr. J. W. Naylor said that the author had been responsible for introducing cobalt steel to Sheffield, and that a suitable material had now been worked upon for eleven months. He trusted that the co-operation between magneto designers would continue. When cobalt steel was taken to full saturation value, it gave a coercive force of 246, a remanence of 10 400, and a $(BH)_{\max}$ product of 960 000.

Difficulty of Obtaining Economical Designs.

Mr. J. F. Kayser pointed out that it was easy to obtain a magnet to function satisfactorily in a magneto, but to get an economical design the author's reasoning had to be applied. He repeated his remarks in London on the remanence fetish. He had obtained a $(BH)_{\max}$ as high as a million with cobalt steels, but such steels were not at present commercial possibilities, owing to the high price of cobalt. Steels containing chromium and cobalt giving $(BH)_{\max}$ of 700 000 were being commercially produced, and were much less costly. These were air-cooled steels, and this eliminated any tendency to produce hardening cracks.

Dr. C. C. Garrard asked the author for information as to why it had been found necessary partially to demagnetise the magnets of measuring instruments to obtain really permanent magnets.

War Experience in Magneto Production.

Mr. G. A. Cheetham said that finality in magneto design could not be achieved until the problems relating to the electrical ignition of explosive mixtures were solved. In the early days of the war British magneto designs were based on existing types, built to fulfil the standard performance requirements for magnetos established by the Air Board. With reference to magnets, some of the early difficulties lay in obtaining agreement between various manufacturers for remanence and coercive force. This was due mainly to varying methods of magnetic measurement, the air gap usually included in the magnetic circuit causing the results to be approximate only, depending upon the shape of the curve between the limits of remanence and coercive force. A Committee of the B.E.S.A. was now sitting to standardise commercial measurements of permanent magnets. It was now conceded that a third measurement, the maximum product of B and H, was essential, this approximating to the maximum energy available. He had found that magnets from one maker enabled the Air Board Specification to be met better than those of others, although the figures for remanence and coercive force were similar. Some experiments were tried by increasing the air gap, and the results indicated that a higher open-circuit voltage across the primary winding could be obtained at a given speed with a larger air-gap, providing the magnet was running under short circuit conditions for a brief period before the test. The voltage curves obtained before the short-circuit conditions were imposed showing reduced values with increased air gap, as expected. It was felt that the fine tolerance allowed in the air gap could be increased considerably without harm to the performance. Was the voltage increase due to the fact that the machine was working above the maximum energy point on the BH curve? Condensers also failed occasionally under running conditions even though tested to voltages giving a large factor of safety. In a series of questions he enquired whether the author could give the magnitude of the voltage obtained across the primary winding at the instant of break; whether the cathode ray oscillograph had ever been used to measure the type of transient phenomenon; if any suitable non-hygroscopic material had been found to replace the fibre bush; if it was still difficult to ensure the cam being concentric with the armature after assembly without special machining? The price of cobalt-chrome steels, he remarked, ranged from four to five times that of tungsten magnet steel, and in view of this it was doubtful whether improved performance resulted.

Mr. H. D. **Symons** hoped that this Paper would help to establish the conviction that the British magneto was equal to the Bosch. Car users were hypnotised by the so-called extraordinary efficiency of the Bosch magneto, yet the bibliography did not mention it. The strongest proof of the soundness of the British magneto was the courage displayed in publishing information such as that given in the Paper.

Influence of Weak Sparking.

Mr. G. F. **Sills**, speaking from the user's point of view, was surprised at the author's remark "as long as there is a spark satisfactory ignition is obtained." Many troubles had been put down to a weak spark such as was obtained with a fully retarded contact breaker. Magneto manufacturers should send out magnetos with a "flick" starting device, so that an engine could be started with a minimum amount of effort. Incorrect cam grinding resulted in trouble, and the gradually rising cam described by the author was preferable to the suddenly rising type.

The **Chairman** (Mr. J. Frith) asked what cost reduction would follow from the use of cobalt steel in view of the reduction in size of magnet and machine. Some sparks were better than others! He had a car that had covered 25 000 miles on battery firing without trouble.

Mr. E. A. **Watson**, in reply, said that what the average man called a "fat" spark was often a spark followed by a large flame, which was not any good in firing a charge. The energy was required in the first rush. The price of cobalt steel per magnetic unit was certainly higher than the price of tungsten steel, which was about 1s. 7d. per lb. Cobalt steel having a $(BH)_{\max.}$ three times as great cost considerably more than three times the price. On the other hand, machines could be made both lighter and smaller. In many cases the dimensions of the machine were controlled by the dimensions of the magnet. To be a commercial proposition the magneto had to be redesigned. He agreed with Mr. Cheetham that aero-engine practice influenced magneto design. English machines designed on Bosch lines and also Bosch machines failed in English aeroplanes, owing to the higher speeds and larger number of cylinders. It was difficult to get a standardised method of testing for all commercial magnets. It was possible in many designs to increase the air-gap considerably without affecting performance. The working point of pre-war magnets was not taken at $(BH)_{\max.}$ Condenser breakdowns were usually due to mechanical reasons, vibration or faults or cracks in the mica. Many firms were now using bakelite brushes in preference to fibre, as it is non-hygroscopic. It was common, though magneto makers did not like to admit it, to do some kind of correcting operation on the complete machine to secure concentricity of the cam. The best method with the profile ground cam was to rotate the magneto on its own spindle, turn up the seating and grind the cam. Ensuring concentricity of the cam had been the most serious mechanical problem the industry has had to face. The design of American magnetos was not bad, but the execution was very poor. The result of work at the N.P.L. for the Air Board proved that if the spark was obtained—no matter how—the engine developed power and speed

A Wide Range of Electrical Manufacture.

The progress of electrical science has been so rapid that the manufacturer as well as the engineer has required considerable adaptability to meet the constant changes for the better which are continually being made. The number of firms who started in the early days of electrical work and who are still to the front in turning out present-day electrical gear is very few. We deal with one in this article, for the business now owned by the **Park Royal Engineering Works, Ltd.**, was founded in 1857, at a time when 100V was a proposition to be handled with care! In the development of the business the management have carried out some important public work, including, for example, the electrical equipment for signal purposes of the City and South London Railway, Central London Railway and the Great Northern and City Railway. More recently they have confined themselves especially to switchgear and instruments, and their manufactures in this line now include oil switch cubicles, dealing with a rupturing capacity of 500 000 kVA. On a recent visit to the firm's headquarters at Park Royal we had the opportunity of seeing what is being done by them in this direction.

Fig. 1.—General View of the Park Royal Engineering Works.

Works Details.

The works themselves are contained in an extensive building laid out in the most modern style, natural daylight being obtained by a well arranged system of saw-toothed roofing. The lay-out followed permits of the progress of the material and parts in a natural way from machine to machine, from machines to assembly bench and from assembly bench to test bed and finished stores without any criss-crossing or mutual interference.

The administrative and drawing offices stretch across one end of the works building, while the test room and a number of bay rooms where such operations as dipping and plating, polishing and enamelling are carried on are placed along one of the long sides of the main works. The machine tools and other equipment are driven by motors supplied from the mains of the Willesden Urban District Council, while heating is carried out by anthracite stoves placed along two of the longer sides of the works in groups of two back to back. These are kept on continuously during the winter months, and being fitted with four regulators allow a very even heat to be obtained, so that the comfort of the workpeople in the coldest weather is well ensured. A view of the exterior of the works is given in Fig. 1.

Standard Cubicle Switchgear.

Turning to the products of the firm more particularly we may first mention the standard switchgear cubicle, a number of which are now being manufactured for several corporations. An illustration of this cubicle is given in Fig 2. while a more detailed view of the oil switch used in connection with it is shown in Fig. 3.

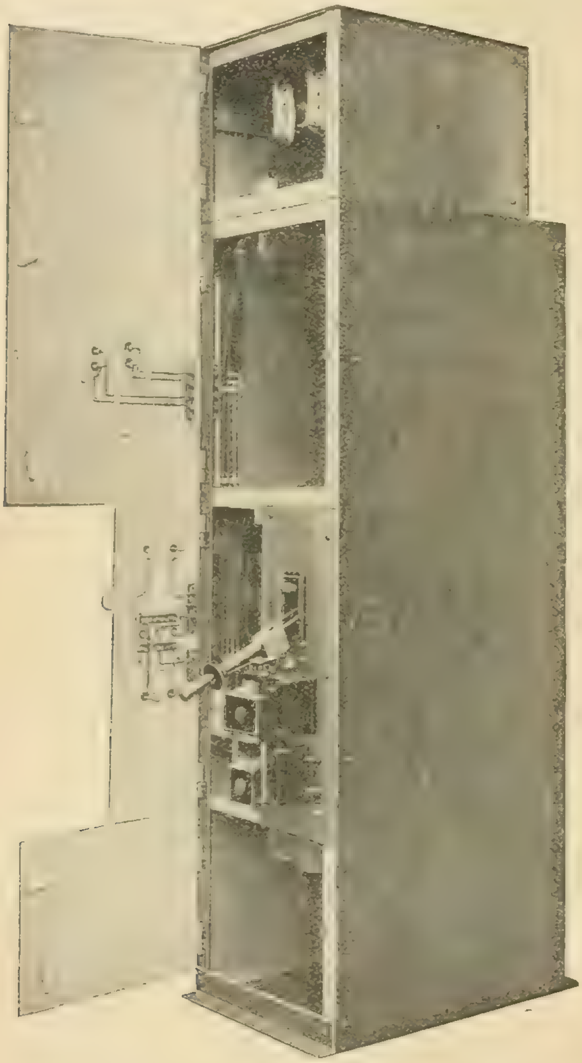

Fig. 2 —A "Park Royal" Switch Cubicle.

The carcase of the cubicle consists of an angle iron frame work to which boiler plate screens or doors are attached where required. It is divided into two main compartments, the lower one containing the oil switch and current transformers and the upper one the isolating switches and the busbars. Where a potential transformer is fitted this apparatus with its high-tension fuses is placed in a separate extra cubicle which is bolted to the top of the main cubicle as indicated in the illustration (Fig. 2). A small door at the top of the oil switch chamber allows the mechanism to be inspected while a larger door lower down is provided to facilitate removal of the switch and oil tank. Two explosion doors are fitted at the back of the cubicle. These are hinged on the two outer sides and close on each other at the centre, being held closed by a bullet spring catch. An explosion forces them open so relieving the high pressure within from damaging the structure in any way.

Oil Switch Details.

The oil switch is supported on a substantial framework of angle iron while the isolating switch is bolted to two pieces of strip iron which are carried on the cubicle framework, thick asbestos board fillets being used as separators between the phases. The connections between the 'bus bars and the isolating switches are of strip copper and between the isolating and oil switches round copper, the latter passing through a porcelain insulator where a division between the two chambers occurs. The instrument wiring is carried on porcelain cleats which are secured to the cubicle framework. This arrangement allows the cubicle screens and doors to be easily removed without a number of disconnections being necessary. The incoming and outgoing wiring passes through porcelain insulators, the cables being held in position inside the cubicle by cable cleats and racks. The high pressure leads to the potential transformers are covered with pertinax tape and are supported where necessary on porcelain insulators.

The oil switches employed in connection with these panels are fitted with a triangular contact bar which is forced up between the finger contacts. This not only allows good connection to be made, but has the further advantage that the subsidiary contacts are easily renewable. The final break is taken on the end of this bar between special copper contacts which are also, of course, easily renewable. Indeed, it may be said that a special point of studying sliding contact design is made by the Park Royal Engineering Works, and all the equipment is tested by millivolt drop in accordance with the British Engineering Standards Association specifications. The switches which we have described are designed for operation on 6 600-V circuits and a normal carrying current of 300 A. As will be seen, the oil tanks are fitted with draw-off cocks and a special feature has been made of the wooden lining of these tanks, which is built up of moulded 3-ply. The switches are operated by a link motion and are fitted with overload and no volt releases. There is an ammeter switch for current on each phase and it may be mentioned in this connection that a number of the low-tension oil switches now being made by the firm are fitted with a mechanical indicator, indicating the position of the switch. A similar indication will probably be fitted to the high-tension switches in future as it has definite advantages over the usual lamp device if the lamp in the latter goes wrong for any reason.

An Interesting Switch Fuse.

Attention may next be called to the switch fuse made by the Park Royal Engineering Works. This is so arranged that the case cannot be opened when the switch is on and the switch cannot be closed when the case is open. This measure of "fool-proofedness" is obtained by fixing a movable strip on to the cover of the switch which passes down the front and over the top of the cover. This strip is fitted with a keyhole shape opening so arranged in conjunction with a boss on the top of the case that the strip can only move when the switch is off. The joint between the switch case and the cover can be made either water-tight or gas-tight for mining work. The contacts are carried on an H-shaped insulator of reinforced hightensite, the contacts themselves being of brass. The case is lined

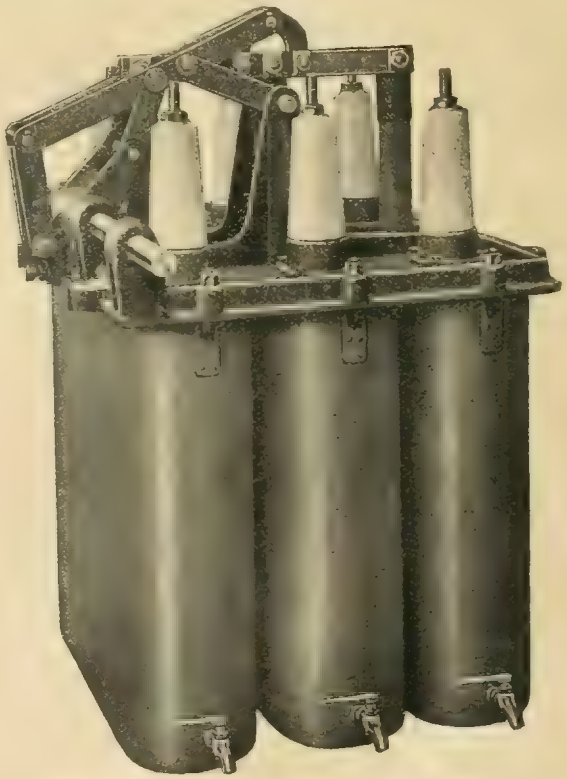

Fig. 3.—Exterior View of the Oil Switch made by the Park Royal Engineering Works.

with fireproof and insulating compound. The fuses can only be renewed when the cover is opened in a horizontal position. The connections inside the box are of the round socket Admiralty type and are directly underneath the holes which are drilled in the case itself for the admission of the wiring. This allows the incoming wires to be soldered into these sockets, which can then be easily passed through the lid of the box, where they are secured in position with one single screw. The switch contacts are mounted on porcelain bases with asbestos dividing pieces between the poles. The action of the plungers which force the fuses into position is made positive by steel balls and springs which are fitted in the lid. This arrangement permits a certain amount of adjustment, which is, of course, not necessary very often.

A NEW VOLTMETER SWITCH.

An interesting voltmeter switch is also made by the Company. This is of the double-pole pattern with either three or five contacts. The switch is totally enclosed in a special insulating material known as hightensite, which has the same coefficient of expansion as brass or gunmetal. A definite position on one or other of the contacts is ensured by employing two balls and cups over which the contact jumps, being assisted in this action by springs fitted underneath the balls. These springs force out two moving contacts, which permit of a very small voltage drop on the contacts, an important point in voltmeter switches which also gives a very necessary cleaning action. The outward appearance of the switch is designed to correspond with that of the instrument covers turned out by the Company, while every precaution is taken to ensure protection from dirt.

Electrical Advertising.

A Rejoinder to "Electrocynic."

By "TUT-TUT."

> "The captious critic must himself be sure
> That in his gibes there is no equal fault
> To those he mocks, lest he perforce abjure
> His scorn, and in his tale there be no salt."

I have ventured to use marks of quotation for the four lines with which I have begun my "Rejoinder," because I am sure that if no poet, budding or otherwise, has already written them, one will some day think of them, and will put them into a real live poem; and I should not like to deprive him of the ensuing credit, such as it is, or may be thought to be.

"Any statement which is not absolutely grammatical is less easy to understand than it would be if expressed in correct form. The degree of ambiguity or incomprehensibleness may be very slight, but, on analysis, it will be found that mistakes in the construction or punctuation of a sentence inevitably diminish its clearness." That, again, is a quotation, this time from the writings of "Electrocynic." I cordially accept the correctness of the contention, and I would couple with it other golden words from the same source, namely: "It is advisable to have at least a vague acquaintance [with the meanings of long words] before weaving such expressions into the delicate fabric of one's prose," adding only this, that the meanings of short words are just as important as those of long words, even when the short words are used by one who has "a natural love of polysyllabic writing."

AN AMBIGUOUS TITLE.

With all humility, and without in any way daring to be certain of it, as "Electrocynic" is certain of the horrible offences that are perpetrated against the language they use by the writers of advertisements in engineering journals, I suggest that the article by "Electrocynic" is more full of examples of wrong grammar and wrong uses of words than could possibly be expected to be the case with more than a very few of the advertisements that he so severely criticises. What of his very title? It is hopelessly ambiguous; taken literally, it is likely to be read as connoting rather the advertising that is carried out by electrical means or devices, such as sky-signs, than the advertising of the products of electrical engineering, just as "mechanical advertising" might consist in ringing a bell in the street to draw attention to someone's pills that the ringer happened to be swallowing at the moment, and would never be thought of as referring to a statement about the manufactured articles turned out by Belliss & Morcom, or by the tinsmith round the corner from where I live. What would "civil advertising" be? I do not pursue that question, however; I prefer to ask "Electrocynic" if he can imagine what a civil critic is? One thing I know, in the welter of things unknown and unknowable he will not see the reflection of one if he looks at a mirror. But I leave him to his reflections, and I proceed to examine his "ungrammatical and illogical copy." It is not often that one falls so deeply into the unseen snare as "Electrocynic" has done in his sub-title. "Ungrammatical and illogical copy by 'Electrocynic.'" How absolutely (not relatively) splendid!

Are such expressions as "sales influence" and "sales value" really good English? And ought not "Electrocynic" to have written: "The English that is meant to be serious," instead of: "The English which is meant to be serious"? Again, "Electrocynic" is at sea, I fear, in his ideas about the correct place in a sentence of the word "only." The rule about it (may I venture to quote a rule about the construction of sentences to so expert a person as "Electrocynic"?) is that it should always immediately precede the very words to which it refers, otherwise there may be ambiguity. Take, for example, three sentences:—

I am only hoping to stun him;
I am hoping only to stun him;
I am hoping to stun only him;

And see how the meaning is changed by changing the position of the word "only." "Electrocynic" more than once misplaces "only," and, although in spite of his error he "conveys his message in a perfectly understandable fashion," he has, unfortunately for himself, cut himself off from all possibility of the use of that excuse in his defence.

AN EXCURSION INTO SYNTAX.

I now turn to the section of "Electrocynic's" singular article that is headed "Singular or Plural," and I find him referring to the subject of a sentence as a "part of speech." But the subject of a sentence is not, as such, a part of speech. A part of speech may be the subject of a sentence, as when I say: "Critics are liable to find themselves in the soup sooner or later," but I should like "Electrocynic" to tell me what part of speech the subject of the sentence: "Whom the Gods love die young" is. In a somewhat clumsily, and probably incorrectly, expressed sentence, "Electrocynic" says: "These parts of speech . . . invariably [disagree] with the literary digestion of the reader." But no! It is not the parts of speech (or rather the subject and the predicate) that disagree with the literary digestion; it is the lack of agreement between them that upsets the equilibrium. I fear "Electrocynic's" words imply (whatever his meaning be—but I have referred to that excuse before) that he confuses things as such with the relations between things.

"James or John are bad boys." This is not quoted from "Electrocynic's" article, but it might have been, to judge from the first sentence of the second paragraph of the section called "Gods and the Goods." And this, again, from one who elsewhere writes of copy-writers, who by the time they have reached the verb have always forgotten whether the subject is singular or plural! "Electrocynic" may argue that it is correct to say that this *or* that *are* common errors, but the "high-brow," the literary purist, and the man who cares for logical and grammatical phraseology will all, I suggest, at least hesitate before they agree with him; and, as I have ventured to say before, we are not now in the company of those who dare say: "What does it matter if the English isn't quite accurate?"

A DEFENSIBLE DESCRIPTION.

"First in Originality" is, I am sure, perfectly defensible as a description, and I suggest that it is only a lack of acquaintance with the finer meanings of words as conveying ideas that could lead anyone to say that "First in Originality" is the same thing as "First in Firstness," as "Electrocynic" implicitly, if not explicitly, says it is. Does the literary purist say, "The matter is given consideration"? I hope not. See, then, the third line from the foot of the second column of the article. Ought not the perfect critic to say, "The copy should receive a proportionate amount of consideration"? And when "Electrocynic" says, "It is, for obvious reasons, impossible to give actual examples of badly written advertisements" (which, read in one perfectly straightforward way, implies that there are no such things as badly written advertisements), and when he says, "Neither can the non-technical copy-writer produce satisfactory copy on technical or semi-technical subjects," I suggest that he is using the words "impossible" and "neither can," which are absolutely exclusive, instead of such words as "inadvisable" and "neither does . . . usually." In other words, he is using the absolute when he means the relative, which is just as great an error as trying to qualify the unqualifiable.

THE REASONS FOR THE REJOINDER.

I have written this "Rejoinder," not because I believe that there are no faults in the construction of advertisements, but because I wish to indicate that it is almost hopelessly difficult to avoid falling into error, and to suggest that to write an article merely pointing out the faults of others, as "Electrocynic" has done, is not to help those others at all. Presumably "Electrocynic" will think he has me on the hip there! For what have I done but compose an article (probably as full of faults as his own) pointing out certain lapses from strict correctness in what he has written? Yes, but I do not wish only to point out his errors; I desire, rather, to suggest to him that his pen, softened in its expression of criticism by a realisation of the faults in himself, might be applied to the writing of some helpful constructive suggestions that would enable better work to be done by writers of advertisements than they now do, instead of merely to the spouting forth of the suggestion that they are all no good at all, and that things will never be right until some imaginary super-copy-writer appears on the scene. Even the super-copy-writer will have to be trained, and it may be presumed that many of the despised present writers of advertisements are as ignorant of their liability to error as "Electrocynic" apparently is of his—often enough because they do not know what the errors are. "If thou hast understanding, answer thy neighbour; and if not, let thy hand be upon thy mouth."

The Psychology of Commerce.

By ERNEST J. P. BENN.

When questioned in the House of Commons at the beginning of the war on the propriety of some of the recruiting posters issued by the War Office, Mr. Tennant, then Under Secretary of State for War, excused himself on the plea that "Advertising was a Recondite Study in Psychology." This happy definition, which will be remembered as long as the war itself, applies not only to advertising but to commerce and trade generally. The science of psychology, as applied to industry, offers a field for research and study which has so far been almost entirely neglected.

A Study in Paradoxes.

The other day a paragraph appeared in the newspapers announcing that the Bexley Urban District Council had succeeded with an experiment in rapid house building, and that the walls of a pair of houses were erected to the roof level in less than nine days, the roof timbers were put on in a couple of days more, and the slating completed within a fortnight from the first work at the foundations. This announcement, striking, startling and exceptional as it is, appeared rapidly upon the declaration of the Ministry of Health that it would undertake responsibility for no more housing schemes. Here surely is a study in paradoxes. So long as the Government was prepared to give unlimited orders for houses, so long as there was no fear of any shortage of orders, and so long as employment was assured for an indefinite time ahead, nothing could induce builders to build except at a snail's pace. The moment that there is any fear of orders falling off, as soon as the market shows signs of weakening, then building speeds up, costs tumble down and things begin to move. One would imagine that the socialistic theory of making the work go round would be applied with added force so soon as the principal buyer of houses announces his intention or retiring from the market. But theory seldom works out in business, and that is where socialism fails.

Commercial travellers know more about the psychology of commerce than all the rest of us put together. The salesman who presses does no more good than the golfer who commits the same offence. The aim of the expert commercial traveller is to assume just that degree of independence and indifference which will generate the necessary amount of desire in the breast of his would-be victim. The salesman who is independent up to a point, who avoids the display of anxiety, who knows just how far to rely upon his customer to do his work for him, will achieve successes which are altogether beyond the reach of the man who carries his determination to sell upon his coat-sleeve. Here is a subject which, so far as I am aware, has never been analysed, dissected and reduced to first principles. In fact, it is doubtful whether there are any principles which could be evolved from it; your old traveller would tell you that it is "Personality, Sir," and he is probably right. There is, of course, a certain amount of business done by pressing; there are energetic salesmen who succeed in forcing goods upon an unwilling market and invariably spoil that market with the result that they have to move on to another. That is not to say that there must be a willing buyer before the salesman is wanted, but the salesman who presses the willingness into the buyer instead of extracting it from him, makes the greatest blunder of all.

A Hiatus in our Controllers.

The total absence of a knowledge of psychology in commerce displayed by those who were called upon to control and regulate us during the course of the war, produced some altogether extraordinary effects, and caused many unnecessary ills. The rationing of bread may be given as an illustration. When the needs of the war made it evident that great efforts must be made to economise in bread, the vast majority of the people reduced their consumption to the minutest minimum. Many people, especially among the elderly folk, discontinued entirely the use of bread in any form, and great was the delight of those who, of their own free will and effort, were thus able to do some little bit of real war work. Then the theorists, impossible and unpractical people, came upon the scene and compulsory rationing was put upon us. The immediate effect was that everybody ate the full amount of their ration and wanted more, and to this day it is doubtful whether the psychological effect of the substitution of authority for voluntary effort was not to increase rather than to diminish the strain upon the food resources of the country.

The Guide of Price-fixing.

Psychology has been ignored completely by those who, in recent years, have indulged so freely in the modern game of price-fixing. This applies, not only to Government Departments, but to trade unions and to trade associations. The fixing of a price and the removal of the excitement of bargaining by taking the elasticity and life out of a market automatically diminishes the trade done in that market. Since business was first invented, prices have fallen and prices have risen; falling prices were designed to create a desire to buy, and rising prices were invented by the same designer of economic law for the purpose of stimulating a desire to sell. Our modern price-fixers are unaware of the damage which they do, not only to Labour and Capital, but consumers, by their meddlesome interference with this very human and essential natural process.

Here again we get an excellent illustration of the difficulty, if not the impossibility, of reducing the psychology of commerce to an exact science, for a study of some markets shows that the proposition outlined above operates at times in the opposite direction. Stock Exchange experience is perhaps the best illustration. When prices fall, by the above rule, we ought to buy, whereas the exact opposite is the invariable experience. The moment prices of stocks and shares show signs of breaking, then holders rush on to the market in order to unload before figures go lower still. Many a fortune has been made from the opposite tendency. Experience shows that when the price of a share stays round about a normal figure, business is slow and inactive; but the moment, however, that the price begins to rise, business becomes more vigorous, and this influx of interest pushes the price still higher, so buyers become more numerous, until at last a boom is created and exhausted with all the usual results. The psychology of stocks and shares would, therefore, seem to be rather different from the psychology of the building trade.

The Only First Principle.

In the search for first principles, which are so dearly loved by our theorists, the only principle which emerges with any distinction from the study of psychology is, that initiative in industrial or commercial matters must be a natural impulse rising in the mind of some individual. If that natural impulse is allowed perfect freedom, commerce and industry achieve a maximum of activity; any attempt, whether on the part of buyers or sellers, to limit, control, restrict or hinder the operation of that personal initiative must tend to weaken markets, to damp down activity and to defeat the very objects of those who invent these devices.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Office on receipt of published price, plus postage.]

"The Engineers' Year Book for 1921." 28th edition. (London: Smith, Kempe & Smith.) Pp. ciii.+2697.

"Die Prufung der Elektrizitäts-Zahler." By Dr. Ing. Karl Schmiedel (Berlin: Julius Springer.) Pp. viii.+130. M.42.

"Electro-Deposition of Copper." By C. W. Denny. (London: Sir Isaac Pitman & Sons.) Pp. xii.+108. 2s. 6d. net.

"Arithmetic of Telegraphy and Telephony." By T. E. Herbert and R. G. de Wardt. (London: Sir Isaac Pitman & Sons.) Pp. vii.+187. 5s. net.

"Tidal Power." By A. M. A. Struben, O.B.E. (London: Sir Isaac Pitman & Sons.) Pp. xii.+115. 2s. 6d. net.

"Relativity and The Electron Theory." By E. Cunningham, M.A. (London: Longmans, Green & Company.) Pp. vii.+148. 2nd edition. 10s. 6d. net.

"Electrical Engineering." By T. F. Wall. (London: Methuen & Company.) Pp. xi.+491. 21s.

"Meteorology." By A. E. M. Geddes, O.B.E. (London: Blackie & Son.) Pp. xx.+300. 21s. net.

Multi-speed A.C. Motors.

At the informal meeting of the Institution of Electrical Engineers on April 11 a discussion was opened by Mr. F. CREEDY on "Some Characteristics and Applications of Multi Speed Alternating-current Motors." Mr. CREEDY began by saying that he proposed to leave aside the cascade and other methods of speed variation and confine himself to the pole changing type as developed by himself. This type, he claimed, under certain conditions was the best that had been found to date. For motors having a gradual speed variation, the commutator motor was the only possible type, and there might be a field for these in sizes up to 50 h.p. They could, however, hardly be considered commercially practicable.

He explained in detail the windings and switchings which give the variable speeds and urged that speed ratios for the required duty be carefully studied when the type of motor was under consideration. Broadly speaking the relative advantages of the cascade and pole changing methods depended mainly on the ratio of speeds; some ratios being very complicated for cascade and easy for pole changing.

The meeting was hardly prepared for the line taken by Mr. W. E. M. AYRES who next spoke, but must have been grateful to him for opening out the range of discussion. He stated that the call for variable speed motors was often mistaken and that it could be met by simple arrangements of ordinary motors. He told of a 100 h.p. colliery fan of 2-speeds which it proved better economy to rewind as a single speed type and run with resistances during the week-ends. He also criticised the Scherbius and Kramer methods on account of the complicated switchgear.

Mr. J. K. SMITH spoke from actual experience of the Creedy pole changing machine. He had found this satisfactorily fulfilled duties in connection with heavy machine tool drives previously operated by direct-current motors. He pointed out that in view of the substitution of polyphase for direct-current supply some form of variable alternating-current motor was essential.

Mr. W. L. WREFORD and Mr. G. J. D. SCOTT spoke of very definite demands for variable speed motors, notably on printing machines and air compressors. Mr. B. P. WALKER also referred to their application to express lift service. Mr. W. E. BRRADSHAW and Mr. H. COOCH also spoke.

Mr. CREEDY, in reply, reminded the meeting that the pole changing alternating-current motors, under review, had the same torque at all speeds, while direct-current motors through weakening the field need to be built for the maximum h.p. at the lowest speed required, resulting in a larger machine than is the case with the alternating-current constant torque multi-speed motor. With regard to the question of power factor he pointed out that although the power factor suffered at low speeds the actual wattless current taken from the line was constant at all speeds. The power factor reductions were, of course, due to the watt component being reduced at the lighter load corresponding to reduced speed.

The Failure of Lead Sheathing on Telegraph Cable.

In a Paper on the above subject presented before the Faraday Society, Mr. L. ARCHBUTT discusses some rather curious effects in lead sheathing for cables, involving cracking but not corrosion. A sample of cable, laid in 1896, which had suffered in this way was examined in 1908. Analysis showed that the lead was almost chemically pure, lead forming 99·94 per cent. of the material. In 1910 a sample of the only lead sheathing which, in his experience, had not shown signs of deterioration, was furnished by Mr. Sayers, Telegraph Superintendent of the Midland Railway, who had also provided the defective specimen. The lead in this specimen was also of remarkable purity. Samples of other cables, with more or less defective sheathing, were subsequently received.

It was at first thought probable that the cracking which was evidently due to want of cohesion between the crystalline grains and not to brittleness in the lead itself, might be due to minute traces of lead oxide. But the amount of oxide in new lead sheaths was not less than in those which had become cracked, and the traces existing might have been accounted for by surface oxidation.

The author visited the works where the cables were prepared and describes the method of pressing and extruding the lead coating, under controlled temperature. Attention was next devoted to the micro-structure, and in the original Paper photographs showing the appearance of sections of the material are presented. In the defective parts the crystals are usually larger and with straighter and smoother boundaries than in the undamaged part. The cracks follow the course of these boundaries. Tests showed that the tendency towards cracking is accentuated by continuous vibration (such as is experienced to a greater or less extent in the vicinity of railways). Similarly, the process may be hastened when a cable is in a continuous state of stress.

Dr. Rosenhain has suggested that such failures can be explained on the theory that an intercrystalline cement exists in metals which can be caused to flow under stress leading to gradual separation of the crystals, one from another. It is concluded that long-continued action of a stress in lead, much less than that necessary to cause immediate elongation, will cause the crystals gradually to lose their cohesion and come apart, and this type of failure seems to be connected with a weak type of crystalline structure. No doubt the peculiar type of structure observed in several of the defective sheaths is developed in the process of extrusion, and cable makers should investigate to discover the conditions which give rise to it.

A New Registering Microphotometer.*

By Dr. W. J. H. MOLL,
University of Utrecht.

A diminished image of a slit, on which the filament of a half-watt lamp is focussed, is projected by means of a microscope objective on the photographic plate or other object of which the absorption is to be measured. A second similar objective focuses an image of the slit, magnified up to its original size, on a second slit behind which is mounted a sensitive thermopile of the author's own design connected to an improved D'Arsonval galvanometer. By suitable gearing to an electromotor the photographic plate is given a slow motion at right angles to the beam of light, and at the same time a drum of photographic paper, on which the spot from the galvanometer is focussed, is caused to rotate at a suitable rate. A record is thus obtained of the density of the plate at different parts encountered by the beam of light. The arrangement is dead beat and so quick in response that intensity curves of close spectrum lines, Zeeman triplets, &c., are accurately recorded.

Discussion.

Mr. R. S. WHIPPLE thought that the dead-beatness and quickness of the apparatus were unequalled. There was a beautiful feature of the records to which Dr. Moll had not referred; they showed the actual texture of the photographic plate as ripples on the base line. He believed the author was engaged in another research which would throw light on some important problems in connection with the blackening of photographic plates. It would be difficult for most of those present to imagine that the record of the Zeeman effect shown had been taken inside half a minute. It was a triumph of experimental skill.

Prof. RANKINE said he had had the privilege of being about during the last few days when Dr. Moll and Prof. Ornstein had been erecting the apparatus. He had suggested that the instrument might be used to settle the question of the existence of the canals on Mars. In this connection Dr. Moll had told him that the eye saw many things which did not exist and missed many things which did. An example which might be of interest to radiologists present was the case of an X-ray photo of a square hole in an opaque screen. It was frequently asserted that the intensity was greater at the edges of such a square than at the centre. The thermopile showed that this was wholly an illusion.

Mr. GUILD said he could only express the greatest admiration for the instrument they saw before them. He was particularly interested in the galvanometer. They had recently been installing radiometric apparatus in the Optics Department of the National Physical Laboratory, and were using a Paschen galvanometer. They were troubled so much with the zero changes due to stray magnetic fields from the adjacent electric railways and from sources within the laboratory that the advantages due to the sensitivity of the galvanometer were largely nullified. He looked forward with very great interest to the advent of Dr. Moll's thermopiles and galvanometers on the British market.

Dr. J. S. ANDERSON said he had had the pleasure of hearing Koch describing his microphotometer. He had thought the chief objection to Koch's instrument was the variability of the photo-electric cell. The modern forms were much less variable and probably the objection did not now hold to the same degree. Dr. Moll was, however, to be congratulated on so successfully employing the much more easily manipulated thermopile for the purpose.

Mr. C. R. DARLING thought the instrument would be readily adapted to form a recording radiation pyrometer.

Mr. F. E. SMITH said he would like to know how Dr. Moll had made such an excellent thermopile. Through the kindness of Mr. Whipple he had had the pleasure of working with one of them, and there was no question of its excellence, but he had not been able to see how it was made.

Dr. MOLL, in reply, said the secret of his thermopiles consisted of getting the junctions which received the radiation to be of very low heat capacity. With most thermopiles the bulk of the heat capacity was due to the solder at the junctions. His method of avoiding this was as follows: He took two thick plates of the metals to be used, constantin and manganin, and soldered them end to end, scraping off the excess of solder. The metals already joined in this way were then rolled out to the desired thinness, and cut into strips. In this way strips only 2μ thick were obtainable with no excess of solder at the junctions. The other junctions were made of large heat capacity to give constancy of temperature of the "cold" junctions. As regards the galvanometer, the principal modification which he had introduced was to have the coil held by two strips of bronze in tension instead of suspending it by the upper strip in the usual way. This gave greatly improved constancy of zero.

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* Abstract of a Paper read before the Physical Society of London.

Reviews.

Electrical Handling of Materials. By H. H. Broughton. Vol. I., Electrical Equipment. (London: Benn Brothers, Ltd.) Pp. xiv.+200. 25s. net.

This is an ambitious work—its comprehensive title indicates as much; the authorship of it, however, could not very well be in better hands, and we feel certain that Mr. Broughton's book on electrical handling of materials will be read widely by electrical engineers throughout the world. The author has a reputation for directness and clarity of style in writing the works he has already published,,and the reader will find that these qualities are also embodied in this new work.

The subject of this review is Vol. I.—"Electrical Equipment"—and in it the contents are, as far as practicable, divided into 11 considered groups: Introductory, electric motors, intermittent rating, controllers, resistors, brake releasing electromagnets, lifting magnets, switchgear and collectors, power distribution and wiring, power required and load equalisers. Chapter I., although only introductory, contains much food for thought, and the carefully selected material used cannot fail to stimulate the reader to greater effort in invention and design of labour saving appliances for the handling of materials electrically. All the sections of this volume are excellently put together, and it is not easy, therefore, to select one for special mention.

Chapter II., on motors, occupies 33 interesting pages, and we observe that the author favours the adoption of mill type motors for crane work, and gives figures to prove their advantage over crane type machines. Whilst we are in agreement with his arguments, we consider that, on account of its very much higher price, the mill type motor will continue to be fitted only on cranes and such apparatus where their use has been specified by the consultant, or where the user is prepared to pay largely for these machines, and for the accommodation of their larger frames, in order to secure the better service which they offer. When on this subject we would also take the opportunity of expressing our agreement with the author's remarks on page 50 regarding contactor control for cranes as being ideal, but it seems to us that the reasons for its non-adoption are the same as mentioned above for mill type motors.

The chapter on intermittent rating of machines form a good addition to this much involved subject, the subject being fully discussed from the point of view of cranes, hoists and winders, load factor, root mean square and time rating being each separately dealt with and their accuracy compared. Many interesting proofs and examples are given. We are pleased that the author's opinion that the R.M.S. method is generally speaking the most accurate coincides with our own views. We observe, however, that in using this method of arriving at the rating of, say, a motor for a winder or hoist the accelerating and retarding times are credited in the book with 75 per cent. cooling value, whereas we know of many engineers, including ourselves, who consider these values rather to the high side, and use figures of two-thirds and one-third for these respective times. We know, on the other hand, of at least one firm in this country who were willing to cut in with 100 per cent. cooling value for all times. The author has apparently adopted what he considers a sort of happy mean in this most important direction.

There is an excellent chapter on controllers for cranes and hoists, but we consider that the value of the description and comments on liquid controllers would be much enhanced if actual drawings had been chosen instead of schematic diagrams of these important and widely used pieces of apparatus. On page 84, under skip hoist controller, occurs the statement: "Blast furnace hoists are of the balanced or two bucket type." There is evidently a typographical error here, and the correct reading is probably "Blast furnace skip hoists are of the balanced two skip type, and also of the balanced or unbalanced single skip type." The use of the term bucket is confusing when referring to skip hoists for blast furnaces. Bucket chargers being of the single drop bottom bucket type with balance weight.

Reference is made on page 85 to a particular example of an American hoist with slack rope device. This is an ancient device, originally fitted, we believe, to the old Sprague equipments 15 or 20 years ago, and is still fitted to most passenger elevators. We do not see that any useful purpose is served by the inclusion on page 142 of Tables XXV. and XXVI. We observe that the author generally puts his "old love," the crane equipment, in the forefront, and we consider that in Vol. I. more space might have been given to hoists of different types, including mining hoists and winder equipments, and the attached problems.

The above short discussion of some of the contents will, no doubt, serve to indicate the general nature of this fine book, and we recommend it to every engineer, both as filling a distinct demand and as a standard work of reference.

Chas. E. Raeburn.

Correspondence.

HEATING OF BURIED CABLES REPORT.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read with interest Major Taylor's letter in your issue of April 15th, and can only say that the results appear to me extraordinary. So far as I know they are entirely at variance with all various experiments on the same subject and with the Buried Cables Preliminary Report, which distinctly states that tests were made both with alternating current at 50 cycles and with direct current, and that there was no appreciable difference in heating.

Suppose we consider a 0·15 sq. in. 20 000 V cable carrying 230 A in each core, a 120 deg. sector of lead on this cable would be about 0·244 sq. in., so that the current required in this sector to equal 62½ per cent. of the corresponding core loss would be 29 per cent. of the core current, *i.e.*, 67 A, which does not seem reasonable.

Again, suppose we make a perfect transformer between two cores and two lead sectors, then all the flux generated by cores A and B will interlink the sectors so that mutual inductance will be equal to the self-inductance of cores. This works out to roughly 1 millihenry per mile, and at 230 A the voltage induced in the secondary will be $2{\cdot}25 \times 230 \times \frac{1}{1000} = 36{\cdot}1$. The resistance of the secondary is about 4 O per mile, so that neglecting reactance the induced current would be about 9 A under ideal conditions instead of 67.

The above figures are only rough and are based on the temperature rises given by Major Taylor in his remarks on the Heating of Buried Cables Report.

With regard to eddy current losses in the lead sheaths of single conductor unarmoured cables, Messrs. Clark & Shanklin in their Paper on "High Tension Single Conductor Cable of Poly-phase Systems," summarised their results, one of which is given as follows:—

> By testing lengths of lead-sheathed cable, and then repeating the measurement after the sheath was removed it was clearly proved that the additional loss due to eddy currents in the open circuited sheath was too small to be detected.

It is to be hoped that Major Taylor will publish details of the cable used for his tests, and his methods of making these experiments.—I am, &c., J. A. Morton.

Prescot, April 4th.

The following is Major Taylor's reply to Mr. Morton's letter :—

TO THE EDITOR OF THE ELECTRICIAN.

Sir : With reference to Mr. J. A. Morton's letter to you on the heating of buried cables, I should like to make a few remarks to avoid any possible misinterpretation of the letter which appeared in your issue of the 15th by your readers, though I regret I cannot at the moment reply fully. I think, however, it will avoid confusion if I state as briefly as possible the points which have, I believe, been demonstrated by the experiments referred to by me.

Firstly, let me say, with reference to Mr. Morton's quotation from Messrs. Clark & Shanklin's Paper, that I agree that in the case of unarmoured single-phase cables the increased loss over that of direct current is inconsiderable. I regret, also, that in my letter published in The Electrician of the 15th I inadvertently quoted Monsieur Capelville's results as supporting my own figures. These results, at the time of writing, I took to be made with cables having wire armouring, which greatly affects the results. Moreover, they refer only to single-phase currents.

The point I wish to make is that, assuming there is nothing demonstratively wrong in the tests which I have been permitted to put forward, the loss in a 3-core armoured cable, due to the *rotating* field produced by the polyphase current as distinct from the loss due to the *pulsating* field in each individual conductor, is some 50 per cent. above the rise due to a uniformly distributed continuous current, when tested at 25 periods, and is considerably less when tested at 50 periods. If, however, the cable is stripped of its armour, the losses are greater in each case (25∼ and 50∼), but are still considerably less with 50 periods than with 25 periods. It is, no doubt, very difficult to separate the loss due to the rotating field from that due to the pulsation of the current, but the fact that with 3-phase currents the losses in unarmoured cables are in each case greater than those in armoured cables, coupled with the fact that with single-phase currents in the same cables the losses in armoured cables—particularly at 50 periods—are enormously greater than in unarmoured cables, proves, to my mind, conclusively that the first-mentioned (*i.e.*, the loss with 3-phase currents) is a loss caused by the *rotating* field, while the second mentioned (*i.e.*, the loss due to single-phase currents) is a loss due to the *pulsating* field.

The above assumption of the loss due to the rotating field is, I think, further borne out by the fact of the losses due to this cause being less at 50 periods than at 25 periods. If we think of the lead sheathing as being a closed secondary circuit and consider, for example, that in the case of 25 periods a magnet having a given strength is rotated inside that closed circuit, there will be a certain reduction of the field due to that magnet by the reaction of the 25-period eddy currents induced in the lead sheathing. If, now, we rotate a magnet of exactly equal strength at double the speed, the eddy currents would tend—for the unreduced field—to cancel the flux due to the magnet with double the force that they did in the first case, and the resultant of the action and reaction would be a considerably reduced field with consequently reduced loss. If the speed of rotation were infinite there would be no field at all, and no loss.

The fact that, with an armoured cable and with 3-phase currents, the loss is *less than with an unarmoured cable* can, I think, be explained on the assumption that when there is no armouring the rotating field is more or less concentrated on a diameter of the cable, and that the lines of flux pass through the lead sheathing normal to the surface of the same, whereas when there is a steel wire armouring, two parallel magnetic return paths are formed, closely contiguous to the copper cores, and the lines of flux no longer enter the lead sheathing normal to the surface, but they branch away from the diametral line in both directions and pass through the lead sheathing at quite an easy slope, corresponding more nearly to that which obtains when a single-phase pulsation takes place from a centrally situated core.

I regret that at this time I cannot give details of any of the tests, as to do so would be to take up too much of your valuable space and would interfere with other work which I am engaged upon, but I hope later to be in a position to contribute these tests to the Institution files.

The whole of the argument in Mr. Morton's letter is on the basis of proving that the losses due to single-phase currents with unarmoured cables at 25 periods are negligible, and as I am virtually in agreement with him on this point, I will not attempt to controvert his arguments. I may say, that when the "Buried Cables Report" came out I compared one or two observations with the figures which I possessed and that where the buried cables were not tested in ducts, but in the open, the results seemed to agree pretty closely. I have not, however, looked again at these lately, but will do so at an early date.—I am, &c.,

A. M. Taylor.

Birmingham, April 8th.

RESISTANCE WITHOUT SELF-INDUCTANCE OR CAPACITY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : We were interested in Mr. Madson's letter appearing in The Electrician for April 15 concerning a method of winding resistances, to avoid the effects of inductance and capacity. We trust, however, that it is appreciated that the suggested method is by no means new, and has been in use for at least 10 years.

It is frequently necessary to compare the ohmic value and current carrying capacity of a given sized unit when wound inductively with a single layer of resistance wire, and when wound non-inductively in the way suggested. Our experience shows, that where it is possible to obtain a gauge of wire having exactly half the sectional area of the single one, the reduction in ohmic value is about 30 per cent., whilst the current carrying capacity remains the same, but when very high ohmic values are required, necessitating the use of the finest gauges of resistance wire, then a change from the inductive method of winding to the non-inductive-capacity-free method, frequently reduces the total non-inductive ohmic value to a quarter of what it would be in the ordinary way.

We have thought it advisable to mention this point as we find that clients requiring non-inductive and capacity-free resistances of high ohmic value are frequently surprised to learn that this method of winding necessitates so large a reduction in the ohmic value, which would otherwise be obtained when using a single wire.—We are, &c.,

Zenith Manufacturing Co.

London, N.W., April 15. L. F. Fogarty.

"THE ELEMENTS OF ELECTROTECHNICS."

TO THE EDITOR OF THE ELECTRICIAN.

Sir : I may perhaps be permitted to comment on the review of my book "The Elements of Electrotechnics," which appears in The Electrician for April 1st. Mr. J. Paley Yorke says the book flings "information" at the reader "as from a machine gun." I thank him for the simile. One of my main objects in the treatment of my subject was to obtain some kind of logical sequence of ideas, although it would be too much for me to hope that I have unfolded my subject with such mathematical precision and certainty as that with which the stream of bullets emerges from the machine gun in Mr. Paley Yorke's "striking" analogy.

Mr. Paley Yorke makes some caustic remarks about the "information" contained in my book. I should like to be permitted to say something about the "information" he gives in his review, concerning the subject matter and general arrangement of the offending volume. So far as I can determine by reading his review, Mr. Paley Yorke's method of attack is first casually to glance through the book ; then pick out hastily a few isolated statements ; and finally, after jumbling these facts in his own mind, set out to record, in a very cleverly written review, his impressions of the book, rounding off his diatribe by virtually exclaiming : "There you are. It's all hotchpotch, and no better than a pocket book."

But let us examine more closely some of Mr. Paley Yorke's criticisms. He is apparently upset that I should state that electrical power is EI. The obvious implication is that I do not explain this. True, in Chapter I., this bold statement is made, but your reviewer has doubtless overlooked the derivation of this formula from first principles, which appears in its proper place on pages 203 to 205 of Chapter VII., devoted to "Systems of Units."

Then again, the statement is made in the review that "the copper and aluminium output of different countries are hurled at us all ready made." I make no mention of the aluminium output of different countries, but give copper output figures on page 29. And why not, in a chapter dealing with "Conductors of Electricity"? Surely it is of value for those engaged in electrical work to know something of the origin and production of the metals with which they are mainly concerned, in addition to being acquainted with such purely electrical characteristics as specific resistance and temperature coefficient.

Mr. Paley Yorke further states that "expressions for eddy currents and hysteresis losses *rapidly give place* (the italics are mine) to an expression for the damping force of an eddy current brake." Considered as a mere statement of fact, this is incorrect, because the eddy current brake is dealt with first on pages 169 to 173 of Chapter VI., entitled "The Production of Electricity from Magnetism," and the offending expressions for eddy current and hysteresis losses do not appear until page 229 is reached in Chapter IX., entitled "Magnetisation of Iron." Again, why not? In any case, the transition is by no means *rapid*, as some 56 pages intervene between the two events.

For some inexplicable reason, Mr. Paley Yorke is upset by my stating that the E.M.F. of self-induction is $-L\frac{(di)}{(dt)}$. The impression that he obviously wishes to convey is that I suddenly confront my reader with the mysteries of the differential calculus, and again do not attempt to "explain." The statement in question appears on page 164 of Chapter VI., and immediately following it, I write :—

"$\frac{(di)}{(dt)}$=Rate of change of current in amperes per second. If we knew the shape of the current curve, the latter expression in brackets can easily be calculated for any particular moment by determining, *in the way already indicated*, the slope of the curve at the corresponding point on it."

There is much other explanatory matter appearing both before and after the expression $-L\frac{(di)}{(dt)}$, and I am of the opinion that any impartial reader studying this portion of the book in the natural way, would have a clear conception of what is meant by the E.M.F. of self-induction, even though his mathematical knowledge were meagre.

Finally, the reviewer states :—

"Graphic methods of finding accelerations and curves showing displacement, velocity, and acceleration *switch us off* (the italics are mine) to electric traction." Once again Mr. Paley Yorke's "information" is hardly accurate. The displacement, velocity, and acceleration curves occur on page 195, very naturally, I think, in a chapter devoted to the "Systems of Units," in which an attempt is made to show the interconnection existing between the fundamental, mechanical, and electrical systems. The very brief reference to electric traction occurs nearly at the end of the book on page 309 to 312 in Chapter II., dealing with "The Electric Motor." Three chapters and some 113 pages intervene between the two events —hardly a sudden "switch off"!!

It is evident that Mr. Paley Yorke thinks I do not "explain" anything in my book. This is a matter on which we very naturally disagree, and I am fully prepared to leave the decision of this question to those of my readers for whom the book is intended. So much depends on the point of view, and as indicating the purpose of the book, I perhaps may be permitted to quote from my preface as follows :—

> The whole subject has been treated from an engineering standpoint, and it is therefore hoped that the book may appeal, not only to the student about to embark on an electrical career, but also to the large number of men engaged in the electrical industry, who are not directly associated with its technical side, and who, perchance, may not have the advantage of a technical education.
>
> The electrical industry is now developing with such rapidity that it is quickly permeating every other industry. This means that every engineer, no matter what his sphere of activity may be, is finding, in an increasing degree, that he must concern himself with electrical problems and appliances. It is felt that the engineer in this category may find portions of the book of interest and value.

But after all, I may be taking Mr. Paley Yorke's criticisms a little too seriously, because it is just possible that when he wrote his review, he had a shrewd idea that his contribution would appear in the issue of your journal dated April 1st!!—I am, &c., A. P. Young.

Coventry, April 12th.

THE ENGINEERS' CLUB.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : The proposal for an Engineers' Club in London is meeting with a large amount of enthusiastic support. Over 1 000 applications for membership have been received so far, and every post is adding to the number. The greater the membership the easier will become the negotiations for suitable premises, and I ask those engineers, who have not already done so, to send me their forms. Full information and application forms can be obtained from me.

Some will have received duplicate forms, and for this I apologise, but a certain amount of overlapping is unavoidable.

Support to the movement is coming from every part of Great Britain, Ireland, and the Channel Islands, and applications are now beginning to arrive from overseas. Members are joining from S. Africa, India, Australia, Spain, France, Holland, Norway, Belgium, Italy, &c.

If everyone will help, by joining himself, and getting friends interested, the movement must be a success, and will give engineers throughout the world a fit and abiding home for the great profession that they represent.—I am, &c.,

London, April 13th. Edmund Hill,
Temporary Hon. Secretary.

The Building Trades Exhibition at Olympia.

This Building Trades Exhibition, which is now being held at Olympia, London, seems so far as the electrical industry is concerned to be a case of a lost opportunity. Granted conditions in the industrial world are not all that they should be, it must yet be borne in mind that as far as we know the world is not coming to an end just yet, and the architect cannot, therefore, fail to be one of those people who are largely concerned with progress and development in the future. Electricity, moreover, is destined to have a considerable effect on the building industry, and it is therefore to be regretted that due advantage has not been taken of this chance of bringing to the notice of the builder and the architect the many advantages offered by the latest developments in electric lighting, power and heating.

Meagre Electrical Exhibits.

Many people look upon the architect as a secluded type of individual difficult to approach, but architects, whatever their other curious habits, will visit this exhibition, and it therefore was a good opening for attracting their attention to new electrical apparatus and materials. The gas industry, of course, recognised this, and we found many exhibits dealing with gas appliances for the home and office. The electrical exhibits consisted merely of lifts, of which there were two makers, electric suction cleaners and fans by one firm only; electric heaters and cookers comprised two exhibits, and there were two exhibits of petrol-driven electric lighting sets. After this electricity was mainly noticeable for the use made of it in lighting the stands. Here it was almost universally adopted. Lighting fittings, wiring systems, domestic appliances, &c., were conspicuously absent.

A Few Exceptions.

The following exceptions may, however, be noted. The Carron Company had a good display of cooking and heating appliances, both for domestic and restaurant use. The other exhibit of electric cookers was at the stand of Messrs. Robt. Jenkins & Company, who displayed the "Ecco" Tricity Combination Cooker. This apparatus is an ingenious combination of an electric cooker with an anthracite or coke hot-water boiler. The boiler is so arranged that it can be connected to an existing hot-water supply system, and is fixed to a cooking oven in such a way that the heated fumes from the stove warm the oven as well as heating the water tank. The oven is provided with a set of "Tricity" elements for "topping up" or for using the oven independently of the coke stove. A Tricity boiling plate and grill are also provided as extras if desired. A larger coke stove can be employed where it is desired to heat rooms by hot-water radiators, as well as to obtain a supply of hot water for domestic purposes.

Messrs. **Sturtevant Engineering Company, Ltd.**, were exhibiting a 4-h.p. portable turbine-operated industrial cleaning appliance, together with a range of their smallest domestic and office suction cleaners, and a representative selection of all types of electrically-driven ventilating fans.

LIFTS.

In addition to a model electric lift on their stand, Messrs. **Waygood "Otis"** had a full-size passenger lift conveying passengers from the ground floor to the gallery.

The **Medway Lift Company** were also exhibiting electric lifts, both fitted for push button control, and for control by the usual switch handle operated by a lift attendant. Since the war this firm have completely reorganised their works and have redesigned many parts of the control gear fitted to Medway lifts. The gate-loading and interlocking mechanism has received particular attention, and it seems that the claim that it is "tamper proof" can now be made with full justification.

Of the lighting sets exhibited, that shown by Messrs. **Fredk. Sage & Company, Ltd.**, was of the belt-driven type allowing for the use of the engine only for power purposes if desired, whilst the set exhibited by Messrs. **Cliffords, Ltd.**, was a direct-coupled engine and dynamo on one bedplate. In either case petrol or kerosene could be used as the fuel, and the sets were offered complete with switchboard and battery.

THE NEED FOR A MODEL ELECTRIC HOUSE.

A representative stand for the electrical industry—for example, a **Model House**—installed with every modern electrical appliance, would have provided a good object lesson of what can be done by employing electricity. Perhaps when the B.E.D.A. has had a little longer life, and gained further support from the industry, both financial and otherwise, such an exhibit may be forthcoming, and used at this and similar exhibitions in the future. The view of the exhibition from the gallery was distinctly pleasing. There seemed to be more finish about the stands and more solidity than is usually seen. Untidy back views of name boards, poor sign painting, &c., were conspicuously absent, and with the exception of about three stands the whole exhibition was ready at the time of opening. The space was fully occupied, so evidently the proposal of changing the exhibition from a bi-annual one to an annual one has been justified by the results obtained in getting exhibitors to take space.

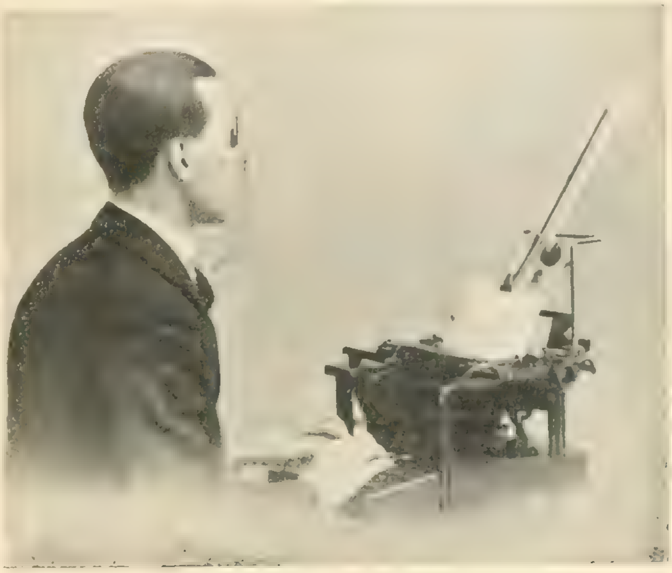
Satisfactory Typewriting for War Heroes.

Necessity, as the mother of invention, has never been more exemplified than in the case of a blind war hero, who is now undergoing secretarial training at St. Dunstan's. Faced with difficulties, when operating the typewriter, this unfortunate gentleman, Mr. **Gamble**, who lost his sight on war service, has at last overcome all obstacles and can now work any machine without any alteration to the keyboard by employing the device which we illustrate herewith. This device is Mr. Gamble's own invention and gives him full control over any machine. It accurately predetermines the depth of matter required on each sheet, and is a tremendous improvement on the crude methods which have been adopted in the past. Indeed, it may be said that it enables the blind to undertake typewriting in a serious way.

The actual keyboard is, of course, memorised, and to help, a Braille scale is fitted to the carriage of the machine in place of the printed scale found on the ordinary typewriter. This scale is fitted with "stops" which operate the bell and give warning when the end of the horizontal line is reached. The chief difficulty, however, was found in easily determining when the end of the paper was being reached, and in doing tabular matter, as well as in taking out a confidential document and re-inserting it in exactly the same position.

Some audible warning is obviously necessary, and the attachment shown in the photograph (for which Letters Patent have been applied for) gives this just the same as in working from left to right of each line. It is made from an aluminium stamping, flanged at each side, and is trough-shaped in section. Down the trough works a flat clock-shaped spring, its upper end being wound round the wheel at the top. To the lower end of the spring is fixed a clip of the same shape as the office Bull-dog clip, only instead of a spring to close the jaws, there is a screw, so that the top end of the paper can be inserted into it after it has passed under the typewriter roller. On the clip is a projection for obtaining absolute squareness of the paper, and a tiny point sticks in the paper for determining the exact position, should the letter have to be taken out and re-inserted in the machine. With the spring, and its clip holding the paper, typewriting can proceed in the usual way, and when the end of the paper is approached, the clip above referred to touches another stop with suitable trip-levers and operates the bell which is shown on the right of the photograph.

The stops and clip are adjustable so that the exact position, working from top to bottom, can always be ensured, thus permitting tabular matter to be done perfectly. Braille characters (marked out in inches) are stamped at the side, so that the parts can be adjusted according to the actual length of matter required. It may be pointed out that the device is as useful to an ordinary typist as to one who has lost his sight.



The "Gamble" Typewriter Attachment.

The case of the inventor of this device is particularly sad. Previous to the war he was acting as electrical engineer to a suburban corporation. He resigned his position to join the Royal Naval Divisional Engineers in 1914, and subsequently, after a very serious operation, was discharged as medically unfit. He then took up his old position, but felt that he was not taking his fair share of the country's obligations, and therefore offered his services to the Ministry of Munitions. He occupied special posts of importance with the Ministry, until finally he was nominated as chief electrical engineer to the National Steam Car Company, who were then engaged on the manufacture of steel castings for munition work. It was here that he met with an accident through the bursting of a coal calorimeter which deprived him of the sight of both eyes. This immediately precluded him from serious work. Sir Arthur Pearson took his case up, and in view of the circumstances, was kind enough to give him an entry into St. Dunstan's, where he is at present training with a view to taking up secretarial work. It is a deplorable fact that the Government have not found it necessary to furnish Mr. Gamble with any form of pension.

We are indebted to Mr. Pringle, of 140, Bishops Road, Chelmsford, for the photograph and the above description.

We learn that Marconi's Wireless Telegraph Company are conducting WIRELESS TELEPHONE EXPERIMENTS between London and Birmingham with a system which involves some entirely novel principles. It is hoped that the new system will eliminate the possibility of tapping messages, and that it will be so easy of manipulation that it will offer no obstacles to the ordinary telephone user.

The Truth About Electric Cooking and Heating.

A cynical friend once remarked that when a firm was called the British something or other company its title was probably the most home-grown thing about it. Pushing the idea a little further, we have come to the conclusion that when an article is headed the truth about something or other, most of the truth it contains is concentrated in the title. We were rather confirmed in this idea when during a recent visit to the provinces we found certain gas interests using a pamphlet headed "The Truth about Electric Cooking and Heating," by Mr. W. O. Horsnaill, A.M.I.E.E.—not that there is anything particularly surprising in the subject, but from internal evidence it is obvious that the matter was written about the year 1913, since when several things have taken place even in the gas industry.

Stereotyped Arguments.

The arguments in this pamphlet follow on the stereotyped lines of gas publicity; that is to say, they prefer to attack electricity than to support gas, and they revolve around the theoretical calorific contents of definite quantities of coal, gas and electricity, in all of which respects, of course, they offer nothing new.

Going into the points used in more detail, however, we note that the opening paragraph in the pamphlet is as follows:—

> "Wherever a public supply of electricity exists, householders are deluged with circulars, and worried by canvassers, with the object of convincing them of the benefits following the use of electric current for cooking and heating. Not only are the advantages, such as cleanliness, ease of regulation, absence of fumes, &c., emphasised, but the bold statement is made that electricity at 1d. per unit is actually cheaper than gas at 2s. 6d. a thousand feet, or coal at the market price."

The only comment we can make is that probably E.D.A. wishes the statement were true, and that, in any case, it flatters the supply engineer too much. In fact, in season and out of season we preach, not that there is too much propaganda, but that there is too little. So far, therefore, we have not unearthed much truth.

"Kolossal" Ramblings.

The author next rambles about a good deal amongst "kolossal" figures of British Thermal Units usually associated with coal or gas. Incidentally he states that a pound of coal contains 14 700 B.Th.U. (householders frequently wish that it did)—goes on to observe that in some towns electric current is sold at a halfpenny for heating and cooking—a price which entails loss on the supply undertaking—a statement, apart from others in the pamphlet, which places the date of its origin and suggests that the writer, an associate member of the Institution of Electrical Engineers, has something more to learn about the economics of electricity supply. Indeed, we are not sure that he has not laid himself open to the charge of unprofessional conduct.

He next turns to the old and much debated question of loss of weight of joints roasted electrically. Here he is quite sympathetic by admitting that in the ordinary gas cooker roasting meat is exposed to gases and the flow of drying blasts of air. But the loss, he states, is only water, which has no nourishment in it. This is a very open question. We have heard said that the vendors of cooked meats like the electric process because there remains to them after cooking a larger net weight of material which can be sold at a high price per pound. The fact that the customer is glad to purchase cooked meats which are plump and tasty, even at two and three shillings per pound, and does not insist upon their being dried up or concentrated, as the author of this pamphlet suggests, rather leads one to suppose that the water, or whatever it may be remaining in the meat, really represents food value, or is at least agreeable to the consumer. As a matter of fact, it seems highly probable that it contains some of the most active and valuable elements of food.

The author of the pamphlet, looking ahead, suggests that it is possible to arrange a gas oven so that the meat does not come in contact with the fumes; in the interval this has been done, and very good gas cookers of the jacketed type are obtainable to-day. Those who sell them put forward some claims which are rather amusing to the electrical engineer. Having imitated his oven as closely as possible with gas, they then proceed to show that it is superior to all the usual types of gas oven in use because there is no opportunity for dirt to be drawn in at the bottom by a draught, sweepings of the floor do not arrive upon the joint, neither can mice nibble away the dry fat during the course of a quiet night in the kitchen.

Misleading Figures.

Under the heading of "Misleading Figures" the author complains that someone has told him that a dinner for a small family was prepared in electrical cooking apparatus for 1½d.—this at a 1d. per unit—against 2½d. for similar food with a gas oven. He goes on to state that such figures are impossible with gas at 2s. 6d. and electricity at 1d. where gas ovens are carefully used. Experience during the last eight years shows that such figures are far from impossible. It is generally recognised that small families cooking by electricity get through for about 1 unit per head per day, say, 4 or 5 units per day, and one-third of that, or 1½ units, might very well represent the cooking of a simple meal electrically. It is well to remember in all these debates which so frequently refer to the efficiency or otherwise of the oven that roasting and baking operations only represent a comparatively small proportion of the total cookery carried out during the year.

In conclusion, amongst other things, the author states that electricity for cooking is quite as convenient as gas, for which much thanks. And still one wonders why an associate member of the Institution of Electrical Engineers should write such stuff.

Electrical Machinery in the Malay Peninsula.

In the past the amount of electrical plant that has gone to the Malay Peninsula has not been very great; but with the development of the industries of the country there is reason to believe that its requirements of machinery will increase. In 1917 the value of the imports of electrical machinery into the Straits Settlements was £60 525, in 1918 it was £55 189, but in 1919 it rose to £153 590. Some of the electrical goods sent out find their way into the Federated and Unfederated Malay States—in 1917 to the value of £14 823, in 1918 £10 317, and in 1919, £22 818.

Source of Supplies.

Electrical engineers and manufacturers in this country will be glad to know whence British Malay draws its supplies of electrical goods, and the following figures of the values for 1917, 1918 and 1919 are interesting:—United States of America, £17 293, £9 179 and £74 593; United Kingdom, £28 569, £17 028 and £50 430; China, £422, £7 674 and £4 651; Australia, £796, £792 and £1 074; Italy, £1 753, £933 and £857; Japan, £8 195, £13 806 and £811; Hongkong, £1 231, £1 688 and £592. In 1919 French India, which supplied nothing in 1917 and 1918, sent in goods of the value of £16 643 in 1919. The imports from Hongkong and the China coast ports may be merely transhipments from Japan, the United States or elsewhere.

Statistics of Existing Plants.

In the Federated Malay States, the supervision of electrical machinery is intrusted to the Senior Warden of Mines, and from Mr. W. Eyre Kenny's report for 1919 it appears that the number of installations of generating plant in these States was as follows:—1917, 100 installations (8 976 kW); 1918, 106 (9 360 kW); 1919, 109 (9 544 kW). In addition, there were 20 self contained lighting plants installed in private houses and plant of about 1 300 kW was in course of erection at the end of 1919. The aggregate horse-power of motors employed was 9 320 against 9 660 in 1918, and a census taken in December showed that motors totalling 3 400 H.P. were available as spares, but were not connected. The capacity of all electrical generating plant employed in the Federated Malay States in 1919 was as follows:—Mining, 8 758 kW for power and 189 kW for lighting; agriculture, 68 kW and 216 kW; general, 110 kW and 146 kW; Government, 131 kW and 2 537 kW, or a total of 9 067 kW for power and 3 088 kW for lighting. The horse-power of motors employed for all purposes aggregated 11 560 compared with 11 900 in 1918.

Systems of Supply.

Like other countries, many different frequencies and voltages are in use on mines, and Mr. Eyre Kenny thinks that mine owners would be well advised to adopt British Standard frequencies and voltages. For three-phase power installations a frequency of 50 and a voltage of 400 or 500 at motor terminals would meet requirements in the majority of cases; for continuous current plant a voltage of 500 is in general use and may well be adopted. For lighting a voltage of 115 or 230 is practically in standard use in Malay and the Straits Settlements, and although not British standard it would be advisable to adhere to these pressures. In the Malayan Collieries at Rawang, Selangor, three new 300-kW steam-driven generators were installed, a 98-inch "Sirocco" ventilating fan was brought into use, two storage battery electric locomotives for underground use were imported and have rendered good service, and a long wall electrically-driven coal cutter with an electrically-driven coal conveyor were being installed at the end of the year.

In the report of the Director of Public Works (Mr. R. O. N. Anderson) it is stated that the Gombok section of the Kuala Lumpur electric light installation gave a great deal of trouble during the year, and there were many stoppages, the chief reason being the wearing out of the generator coils. It has been impossible to get new ones anywhere, and there is no apparatus for carrying out repairs locally. The revenue from the sale of current was £23 567 against £24 047, and the gross profit was £12 519.

The Nash "Fish" Invention.

On Monday, the Royal Commission on Awards to Inventors commenced the hearing of the claim of Mr. G. H. Nash, chief engineer and a director of the Western Electric Company, and of Mr. Nash's assistants (Mr. E. R. G. Penny, Mr. R. A. Mack and Mr. B. B. Grace), for an award in respect of the user by the Admiralty of hydrophone equipment devised by them, incorporating the Nash "fish," a construction similar in shape to a torpedo, and about 15 ft. in length.

Mr. HUNTER GRAY, K.C., who (with Mr. Barrington Ward, K.C., and Mr. Caradoc Rees) appeared for the claimants, gave a sketch of the claim. The Nash "fish," he said, was a system embodying several instruments, was used very largely for the detection of submarines, and in some cases enabled them to be destroyed by depth bombs. From November, 1916, until July, 1917, Mr. Nash turned his attention to the problem of dealing with the German submarine, and he and his colleagues developed a system eminently useful for that purpose. By October or November, 1917, there were 180 trawlers, many of which were built for the surface, and all of which were fitted with the Nash apparatus. Later, there were three patrols—the North, South, and the Adriatic Patrols—manned by staffs which had been specially trained. In working out the problem, Mr. Nash began with the microphone, which would be affected by the sound of a submarine and this would then be communicated to a telephone receiver. He next had to get a microphone which would be affected on both sides. Some other scientific men had solved that, but not to the knowledge of Mr. Nash. The vibration in the water affected the diaphragm on the side from which the sound came, and if the diaphragm were turned—and this could be done by a handle on board the vessel—until it was in a line with the submarine, there were vibrations on both sides. It was also necessary to know whether the submarine was on the right or left; the next problem was to make the instrument unidirectional, and the system adopted was the provision of means for turning the microphone until it was got into the line along which the sound travelled, the result being that there was no noise at all on the telephone. Another microphone was also arranged, and on one side of it was put a baffle. This other microphone was so arranged that when the silent microphone was pointing in one direction the baffle microphone was always pointing at right angles to it, and when the zero microphone was right the baffle microphone received the sound. The operator listened to the sound, turned the baffle microphone 180 deg. and listened again. If the sound was then louder than it was in the other position he knew the baffle was away from the submarine and the naked side of the diaphragm towards it. A problem before the Nash "fish" was devised was water noises. Mr. Nash constructed the "fish" to contain the instruments, and made holes in it sufficiently large to allow the water to penetrate, and the vibration in the instruments took place in spite of their being enclosed. If such a device were suspended from the ship there would be trouble from the noise of the engines and from the surging of the water upon the ship, and Mr. Nash's next step—which was absolutely original—was to suspend his "fish" at the extremity of a long rope containing all the necessary conductors and about 200 ft. in length, and tow it behind the ship. The mechanism on the ship for dropping and raising the "fish" was also the result of a great deal of experiment. Operators could tell within 10 per cent. the distance of the submarine from the ship, and depth charges were dropped where the submarine was supposed to be. To keep the "fish" horizontal, so as to avoid shifting of the carbon particles in the microphone, Mr. Nash used a weight attached by a rope. Movements of submarines could be detected three miles away, and considerably more in calm water. At the time Mr. Nash devised his mechanism it was recognised, and he was told by the Authorities that no single device had succeeded in overcoming the water noises. He submitted that the effect of this device on submarines was practically to destroy their danger, whereas at the time this invention was brought out, the submarines were the hunters and could never be hunted.

"Eye Rest" Fittings.

A new catalogue of "Eye-Rest" fittings recently issued by the British Thomson-Houston Company illustrates a variety of neat designs, in both metal and moulded composition, and in a range of sizes to take Mazda lamps from 60 W (vacuum) to 500 W (gasfilled). All these fittings are equipped with the well-known X-ray silvered glass reflectors, the use of which accounts for the high efficiency of this method of lighting. The B.T.-H. "Eye-Rest" system of indirect lighting has been installed in buildings of all kinds, including picture galleries, offices, public halls, stores, theatres, and private houses, and in all cases it has given the utmost satisfaction. The complete invisibility of the light sources, coupled with the soft and uniform diffusion of the illumination, produce an atmosphere of comfort and repose which is incompatible with the older forms of lighting equipment.

Another advantage of "Eye-Rest" lighting lies in its effect upon the appearance of the room in which it is installed. Ordinary direct lighting, by concentrating the illumination in a downward direction, is apt to throw the ceiling and upper walls into shadow, and to obscure architectural and decorative details. In effect, direct lighting makes the room look lower and smaller, but indirect lighting, by diffusing a relatively uniform illumination throughout the whole cubic area of the interior, shows the room in its correct proportions. The effect in respect to the softness of shadows, the delineation of relieved ornamentation, mouldings, &c., and the apparent solidity of furniture, is practically similar to diffused daylight. Indirect lighting is especially valuable for illuminating art galleries and private rooms containing paintings, statuary and other articles of vertu. With "Eye-Rest" fittings and Mazda gasfilled lamps this method ensures a natural representation of form and tone values, and thus assists the eye to appreciate the merits of any artistic achievement. Copies of the catalogue (No. 10550—B) may be obtained from The British Thomson-Houston Company, 77, Upper Thames-street E.C.4.

Mersey and West Lancashire Electricity District.

It is announced that the Electricity Commissioners, having considered the evidence taken at the recent inquiry into the two schemes submitted respectively by the Conference of Mersey and West Lancashire Electricity Authorities and by the Corporations of Wallasey and Birkenhead, have arrived at the following conclusions :—

1. The area provisionally determined is confirmed, subject to the inclusion of the Urban Districts of Lymm, Haydock, Northwich, Middlewich and Winsford, and the Rural District of Northwich.

2. A Joint Electricity Authority will be formed for the whole district, subject to a reservation concerning the Wirral.

A TEMPORARY WIRRAL COMMITTEE.

3. The advantages to the local authorities of the Wirral area of independent combination will for some years outweigh those of inclusion in the scheme for the whole area. Subject to liaison with the Joint Electricity Authority, a separate committee will be established representative of the local authorities for the County Boroughs of Birkenhead and Wallasey, the Urban Districts of Hoylake and West Kirby, Bromborough, Higher Bebington, Lower Bebington and Neston and Parkgate, and the Rural District of Wirral.

Although the Commissioners have arrived at this conclusion after a critical comparison of the estimates submitted by the promoters of the two schemes as subsequently amended by the Commissioners, they are of opinion that it may be found advantageous to merge the Wirral Committee in the Joint Electricity Authority at some future date.

CAPITAL STATION AND TRANSMISSION LINES.

4. A capital station in the neighbourhood of Liverpool, and a transmission system connecting it with Liverpool, Bootle, Prescot and St. Helens, is immediately required, and will be of advantage to the neighbouring districts.

5. The fullest and most efficient use should be made of the generating plant of the Mersey Power Company. This company, by arrangement with the Joint Electricity Authority, and with the approval of the Commissioners and subject to suitable conditions, may be empowered to extend their operations by bulk supply or otherwise into neighbouring districts. The company will have separate representation upon the Joint Authority, to which it will elect one member.

6. The areas of the Wirral Committee and the Mersey Power Company should in due course be linked up with the remainder of the area.

DRAFT OF ORDER.

The Electricity Commissioners have accordingly decided to prepare a draft order providing (*inter alia*) :—

(*a*) For the establishment of a Joint Electricity Authority for the whole district, including the additional areas enumerated in paragraph 1 and the Wirral area.

(*b*) For the establishment of an independent committee for the Wirral area.

(*c*) For any consequential modifications in the constitution of the Joint Electricity Authority proposed in the scheme of the Conference of Mersey and West Lancashire Electricity Authorities. The Wirral Committtee will elect one member of the Joint Electricity Authority.

(*d*) For the inclusion of outlines of the technical schemes to be undertaken by the Joint Electricity Authority and the Wirral Committee respectively, but will provide that modifications thereof may be made with the approval of the Commissioners.

(*e*) For the Joint Electricity Authority and the Wirral Committee respectively being required to submit, within a period of two years from the date of their formation, proposals for giving or securing a supply in unoccupied areas where there is a reasonable prospect of such supply being remunerative.

(*f*) For the *administrative* expenses of the Joint Electricity Authority being met by contributions from each of the interests represented on the Authority; and for any deficiency on revenue account which may arise from the supply of electricity being, by a re-adjustment of charges or otherwise, met only by those undertakings which are connected with the Joint Authority's transmission system.

(*g*) For the necessary financial powers being conferred on the Joint Electricity Authority and the Wirral Committee, subject in the former case to the enactment of the Electricity (Supply) Bill now before Parliament.

TEMPORARY ARRANGEMENTS.

Pending the establishment of the Joint Electricity Authority and the Wirral Committee, the Commissioners will ask the parties concerned to form two small provisional committees, with whom the Commissioners may consult from time to time with regard to any development of supply in the electricity district and the Wirral area respectively. The observations of the parties represented at the recent inquiry will be invited on the clauses of the draft Order before the Commissioners hold the further inquiry required by Sec. 5 (4) of the Electricity (Supply) Act, 1919.

X-Ray Lighting at Palmer's Green.

In connection with the lighting of shop windows, little difficulty is experienced in persuading big stores to install up-to-date systems, but small traders are not so easily convinced of the advantages of scientific design and suburban shops are generally pathetic examples of obsolete equipment. Here and there one may see windows lighted adequately and artistically; and yet more rarely a small community of well-illuminated shops may be discovered. Such an aggregation is to be seen at Palmer's Green, where Messrs. J. Prosper & Sons, a local firm of electrical contractors and lighting enthusiasts, made themselves a useful basis for successful propaganda. By equipping their own shop window with X-ray reflectors and Mazda gasfilled lamps, and thus distinguishing it from the windows on either side, Messrs. Prosper created a feeling of discontent amongst their neighbours, to such excellent effect that within a few weeks, 12 tradesmen in the same block had installed X-ray equipment.

Shop Window Lighting.

We give an illustration from a photograph of a shop of this group. X-ray reflectors of the "Hood" type are used, each reflector being fitted with a 100-W Mazda gasfilled lamp. It is an excellent example of the advantage of this method of lighting in highly trimmed windows in a music shop containing tickets and other printed matter. The music titles are clearly visible, but if the window had been lighted in the ordinary way by lamps hanging in the line of sight, the reflected light from the white surfaces of the music would have produced halation on the photograph, and the printed matter would have been illegible. Four X-ray "Hood" reflectors and 100-W Mazda gasfilled lamps are used in the window—by no means an extravagant allowance in view of the results obtained—and the lighting units are concealed by the narrow curtain at the top of the window. The photograph was taken at night, solely by the light of the X-ray units, and has not been retouched in any way. The materials for the 12 installations were supplied to the contractors by the British Thomson-Houston Company's Illuminating Engineering Department.

Engineering Training at Birmingham.

In connection with the appeal for £500 000 which is now being made by the Birmingham University authorities an invitation was recently extended to representatives of the engineering industry in the Midlands, with the object of making them better acquainted with the work the University is doing in training the student for the Engineering profession. The guests, under the guidance of Profs. Burstall and Cramp were taken over the various electrical and mechanical departments. In the advanced electrical laboratory a considerable amount of testing was in progress, and Prof. Cramp explained how the students had to make all their own connections from the machine under test, to the switchboard instruments and other apparatus, the idea being to make the student think and being a great improvement on the old system where a board was provided with a row of terminals, marked commutator, &c. A considerable amount of interest was shown by the visitors in the collection of early type dynamos, and also in a twin-coupled enclosed Brown-Boveri motor, taken from a German Submarine, and supplied to the University by the Admiralty.

In the Metallurgical testing house, interest was displayed in two very large testing machines, one capable of testing up to 300 tons tension and compression, and the other up to 50 tons. In the power house a De Laval Steam Turbine was seen under working conditions, and various types of generating machinery, both old and new, were on view.

The machine shop contained a fine display of modern workshop machinery. Particular interest was manifested in a micrometer which Prof. Burstall explained was capable of recording measurements accurately to the twenty-five thousandth of an inch.

The Telephone Inquiry.

Further evidence on the administration of the Post Office Telephone system has been heard by the Select Committee of the House of Commons.

Sir Henry Bunbury said that if the whole telephone system were non-existent and had to be established now the capital cost would be enormously higher than the amount at which it stood to-day, and to that extent users were benefiting by the outlay of the past. In regard to the method of working out costs of works in a term of years, he said they paid a certain amount per annum into the Treasury which was used as a set-off against advances made from time to time by the Treasury.

Mr. Holmes suggested that a fairer method would be to have a fixed equation of capital and interest, so that there would be an equal amount paid over the whole life of the plant, instead of a larger amount with the first years and a smaller amount towards the end of the period.

Sir Henry said it might be worth considering for new expenditure. The price of materials and plant would fall considerably in the next five or six years, but not to pre-war level.

In reply to questions as to the £200 000 a year which it was proposed to set aside as special depreciation between 1920 and 1925, witness said that the Post Office was committed to an enormously heavy extent on renewals and extensions during this period. During the past few years large numbers of prudent commercial concerns had written off large sums for depreciation.

Mr. Richardson asked what was the justification for the telephone staff having such enormous amounts awarded as war bonus as well as an increase in wages—wages up as high as 297 per cent.—when cotton and hosiery and woolworkers had only about 125 per cent.

Sir Henry Bunbury said that was not a matter within his knowledge. He admitted he was a sort of critic and adviser with somewhat vague instructions. There was a fundamental difference between a national undertaking and one managed wholly from a commercial standpoint, and he would say with all reserve that the difference was to some extent reflected in the attitude of the staffs towards the administration. The supervision of engineering staffs all over the country was costly, but the Department was seriously investigating with a view to its reduction. The amounts for work done for the Admiralty or the War Office during the war were debited to expenditure and credited to revenue; it did not in any way affect subscribers. The abolitionof the flat rate alone would represent an increase of over £1 000 000 per annum in revenue.

On Monday Mr. H. C. Robbins, joint general manager of the Press Association, and joint manager of the Press Association and Exchange Telegraph Company's joint telephone services in the provinces, said those services spent last year over £20 000 on trunk calls and on local telephones. In addition, they had a large number of instruments in London, and the two agencies contributed in telephone revenue over £25 000 a year, so that the new tariff would be very detrimental. The Central News also made considerable use of the telephone, and the views expressed by witness were shared by Mr. W. P. Forbes, manager of that agency. The flat rate was convenient but the Post Office would not have it even at an increased subscription of about 150 per cent., and the Department was out to kill the flat rate, though it was quite susceptible of a reasonable increase. As there were over 121 000 flat rate subscribers, an increase of 40 per cent. would bring in nearly £700 000 more. The Post Office put the loss on the flat rate at £1 200 000, but that was based on estimates of expenditure which were already decreasing and which should decrease still more as time went on. About 7 000 telephones were given up in February and March, and one heard on all hands of people surrendering their instruments where they were not an absolute necessity, because they were not worth the new price. He doubted the wisdom of such large capital commitments as the Post Office contemplated in the next five years, especially in view of the present difficult financial position.

Alternative Charges.

Recognising that the telephone administration must have more money, the Newspaper Conference suggested a temporary alternative to the official scheme pending the investigation of the whole subject by an impartial body: All round increase of 50 per cent. in the flat and measured rate; increase of 50 per cent. in the old rental for the message rate, or the rental might be untouched and the charge per call increased from 1d. to 1½d.; increase of 40 per cent. in trunk fees up to 100 miles, between 100 and 180 miles 33⅓ per cent., and above 180 miles 25 per cent. They also suggested that the present half-rate charge or double-time allowance on trunk calls after 7 p.m. should apply after 2 p.m. on Saturdays and on Sundays. The Press would benefit from the Saturday afternoon arrangement, as they then use the trunks for football and cricket reports, and there would probably be increased business.

Witness said the alternative charges suggested by the Newspaper Conference would bring in £830 000 per annum, and he thought the actual estimated loss would be covered by that amount. It seemed extraordinary that the service required one supervisor for every eight operators, and no other business outside could stand that.

Commercial Topics.

Valuation of Stocks.

The Chancellor of the Exchequer met representatives of the Federation of British Industries and of the Association of Chambers of Commerce yesterday (Thursday) for the purpose of discussing the VALUATION OF STOCKS and other questions arising out of the termination of the E.P.D.

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Latin-American Trade.

In order to assist in the development of trade with the countries of South and Central America, the British and Latin-American Chamber of Commerce have established at their new premises in Bedford-square a permanent exhibition of British products and manufactured goods. The exhibition is due to the suggestion of Sir James Kemnal, President of the Chamber, and at the official opening last week Sir James said that 50 firms were now exhibitors. Every effort was being made to get the South American Republics actively interested, and to get them to exhibit specimens of their native products.

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Income Tax Administration Changes.

Important changes in the law relating to the assessment and the machinery for the collection of income tax are proposed in the new Revenue Bill. It is intended to abolish the office of assessor, to permit the surveyor in certain cases to make assessments, while the clerical work now performed by the clerks to the Commissioners is to be done by the surveyors of taxes. It is to be feared that the alterations will not be favourable to the unfortunate taxpayer, and that beaureaucratic control will be left without any check. Certain changes are also suggested in the methods of assessment and in the schedules under which the tax is levied. In the majority of cases, including trades and professions, the assessment will be based on the profit of the preceding year. The salaries of public officials and of employees will be taxed on the remuneration of the year of assessment. The whole subject is so important that we hope it will be thoroughly discussed and considered in all its aspects before the contemplated changes are adopted.

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Hydro-Electric Development in Norway.

Norway is mainly dependent upon water power for running its industries, and owing to the scarcity and high price of coal in recent years great attention has been paid to hydro-electric development. In 1918 a commission was appointed by the Storting to report upon a proposal to give a supply of electricity to the whole of the country on broad national lines, and though this committee has not yet completed its task it has been decided to set up an electricity board of nine to control and superintend the work of developing the numerous waterfalls of the country. In addition to a Director-General there will be three technical directors and five members will be chosen by the Storting. Of the technical directors one will deal with questions concerning watercourses, the second will be in charge of waterfalls, and the third of electricity supply. The majority of the schemes have been developed by municipal councils or by the Government, and in 1920 no new power private scheme was initiated.

According to a report on the industrial and economic situation by the Commercial Secretary to H.M. Legation at Christiania, only a few new municipal power schemes were initiated during 1920. The Municipality of Drammen completed the extension of the Labro station, and were considering a further extension of the 3 600 kW. Bergen Municipality were considering the question of procuring 6 000 kW from the Herlandsfos. The Christiania Municipality received an offer of 12 000kW from Rjukan, and also an offer of 20 000 kW to 60 000 kW from Tysse. If the latter offer be accepted the transmission voltage would be 156 000.

The following municipal power schemes were also completed during the year: Honefos and Norderhov installed 8 000 H.P. at Honefos Mill; Haugesund harnessed the Etne watercourse; Christiansund N., the Skar watercourse; and the Vaagsfjord Power Company, a small watercourse for supplying power to Troms county. Progress is also being made with a number of other municipal schemes.

Government Power Schemes.

Work was continued on the harnessing of the waterfalls at Nore, on the river Laagen. The regulation of the Tunhovd lake was completed, and tunnelling was commenced. A strike among constructional workers interfered with the building of the railway from Kongsberg to the falls. Between 13 and 15 million kroner has been expended upon the Nore scheme, but the future depends largely upon whether it is decided to transmit power from Tyssefaldene to the east of Norway.

Work upon the Hakavik installation was interrupted by a strike of constructional workers. At Glomfjord, in Norland, the State completed the erection of two machines of 25 000 H.P. each. An extra pipe line was under construction to serve a reserve machine of 27 000 H.P., and it is probable that another machine of 27 000 H.P. will be installed. The power from the two existing machines is delivered to a zinc works.

The scheme for harnessing the waterfall on the river Laagen at Kongsberg was postponed in view of an offer of 18 500 kW, from the Rjukan power station. If this offer be accepted, 4 000 kW will be delivered to Buskerud county, 2 500 kW to the town of Drammen and 12 000 kW to Christiania. The Government would, in that event, complete the power line from Rjukan to Kongsberg, while the Buskerud county and the towns of Drammen and Christiania would construct the transmission lines for the remainder of the distance. In regard to the harnessing of Solbergfos on the river Glommen, the main dam and power station are being constructed.

Electricity Supply.

The Parish Council of CLYNE applied to the NEATH Rural Council for a supply of electricity for public lighting.

The MARKET BOSWORTH Rural Council has decided to oppose the application for a special order for Atherstone, Tamworth, Hinckley and Bosworth in so far as it affects its area.

On the advice of their electrical engineer (Mr. P. P. Wheelwright), BLACKBURN Corporation has decided to apply for membership of the British Electrical Development Association. The various rural districts are asking for a supply of current from the new station at Whitekirk.

SUNDERLAND Council has authorised extensions of the low tension network at an estimated cost of £15 928, and £676 will be met out of revenue account. Application is to be made to the Electricity Commissioners for sanction to borrow £20 000 for this work and for future requirements.

The FULHAM (London) Borough Council has been authorised to borrow £21 000 for extensions of plant, &c., at the electricity works, including £6 000 for replacing old economisers and £6 000 for new economisers for new boilers, £5 500 for building work and £2 000 for a centrifugal pump, with necessary pipes, valves, switchgear, &c.

The CARMARTHEN Electric Light Company recently applied to the Council for higher public lighting rates, and a committee was appointed to inspect the company's accounts. This committee has now reported that the average cost of electricity for the three years 1918-20 is about 70 per cent. over that for 1912-14, and the Council has agreed to an increase of 70 per cent. over the orginal contract.

Negotiations are proceeding between DOVER Corporation and Trinity House as to the supply of electricity to the South Foreland lighthouse. The estimated capital cost of the extension is £2 000, and Trinity House is being asked to find half of this and pay for the current at 10d. per unit for the first 5 000 units and 5½d. per unit thereafter, with a guaranteed minimum of 15 000 units per annum.

With reference to the proposal of NEWARK Corporation to establish electricity supply works at an estimated cost of £200 000, the principal engineering firms in the town who contemplated taking a supply have now decided not to avail themselves of the opportunity. They contend that the terms are not sufficiently attractive, and that the Council is committed to very heavy expenditure on a sewerage scheme.

The STRIKE OF ELECTRICIANS in SCOTLAND still continues and is now in its sixth week. The employers have been advertising for men at the new rate of 2s. per hour, and it is stated that there has been quite a considerable number of applications; some firms being already fully staffed. A considerable number of those who have applied are not members of the Electrical Trade Union, but members of the Union are also seeking employment at the new rate, and it is stated that the employees of two firms have returned at the new rate.

For some time past the OSWALDTWISTLE Urban Council has been anxious to get a supply of electricity from Accrington, but the Electricity Committee of the latter now state that until the Corporation obtain the necessary sanction from the Electricity Commissioners and the Ministry of Health to carry out the proposed extensions at the generating station, it will not be possible to give a supply. In reply to the Council's application for sanction to borrow money for extensions the Commissioners have intimated that in view of the establishment of the new Blackburn generating station at Whitekirk, the Council should consider the possible advantages of taking a bulk supply from them in preference to extending the existing station at Accrington. Negotiations with Blackburn are, therefore, to be opened by the Accrington Committee.

At Wednesbury Police Court last week a summons against the Midland Electric Corporation for Power Distribution (Ltd.), for an alleged breach of the Electricity Regulations was dismissed. It appeared that while alterations were in progress at the generating station in December last, a high-pressure switchboard required cleaning. While this work was being performed a report was heard, and a labourer, named Barsby, was found unconscious near the switchboard. Evidence was given that Barsby had no need to be at the particular part of the switchboard where the accident occurred.

The Stipendiary, after visiting the station, held that the alleged offence did not come under the section in respect of which the proceedings were brought. The work could have been done without danger if the proper man had done it, but the man who was injured was not told to do that work. He was only going to work with the man who had to do the job.

We cannot congratulate the CAMBERWELL Borough Council or its Public Libraries Committee on their methods of procedure. At a recent meeting of the Council it was decided that the work of wiring the Central Library should be carried out by direct labour. Prior to this, however, the Committee issued an advertisement inviting electrical contractors to supply a scheme and tender for the work. In response to this invitation 38 firms submitted tenders, and the Committee recommended the acceptance of the lowest tender, but by a majority of one the Council decided to remit back the recommendation, and to have the work done by direct labour. Naturally, the contractors who tendered are indignant at their treatment, and the Electrical Contractors' Association has intervened to no purpose, for the Committee report that they have fully considered the matter and had decided to proceed with the work by direct labour. The work was in hand, and the borough engineer had been empowered to obtain such expert advice as he considered necessary in connection with the work. The Committee's action has now been approved by the Council.

A report on the failures of electricity supply in November last was before the Wallasey Corporation last week. The Special Committee of investigation found that the breakdowns were due to the failure of the feed pumps, defects in which pumps seemed to have become apparent in the early part of 1920 and were reported by the station superintendent. There had been corrosion of an abnormal character, affecting the efficiency of the plant, but the failure of supply could have been avoided if a third pump had been provided and if periodic examinations of each part of the plant had been part of the normal station routine. The committee were of opinion that there had been neglect and disregard of duty by the staff, and also lack of proper supervision of the station and staff. Therefore, they recommended as follows: "That immediate steps be taken to reorganise the staff of the generating station; that the engineer's office should be removed to and adjoin the Poulton station, and that office accommodation should be provided for the station superintendent; that the electrical engineer should reside in the borough as near to the station as possible; that an expert be called in to investigate the primary cause of corrosion referred to, and that periodical chemical tests be made of the boiler contents; that the turbines should be so controlled as to ensure steam being out off when sets are standing; that the boiler feed pumps should be periodically tested and opened out for inspection; that the pumps should be so located that they could be easily examined and dismantled, and that an additional feed pump be installed." These recommendations are still under consideration.

Hereford Corporation has received sanction to borrow £34 750 for electricity supply purposes. A sum of £26 925 is for mains and is repayable within 25 years, and £7 825 for sub-station, transformers, &c., within 20 years. The latter is for extending electricity supply in the Ross and Lydbrook area.

The Treasury will advance the whole sum from the Development Fund, but any sums received by the Corporation from the Unemployment Grants Committee in connection with the scheme must be applied in reduction of the loan, which is to bear interest at 6½ per cent. per annum and to be repayable by annual instalments of principal and interest within a period of 20 years. The advance will also be subject to the same conditions as those imposed in respect of the recent loan of £19 857.

The Chairman of the Electricity Committee (Mr. Dymond) explained at the last meeting of the Council that since the last meeting a conference had taken place in London between the Electricity Commissioners, the coal-owners of the Forest of Dean, the Organising Committee of the Southern district, and representatives of the Corporation, when the question of the supply of electricity to the Forest of Dean mines was discussed. It was practically decided that if any supply was given it would be provided by Hereford Corporation, but a difficulty arose as to the cost of the lines. The Commissioners and the Organising Committee said they could not find the money. The representative of the Corporation also said they could not be responsible and it was left to the coal-owners to find the money.

Catalogues, Price Lists, &c.

Particulars of the "Magic" Suction Cleaner are set out in a leaflet which is being circulated by Magic Appliances Ltd., 151-9, Westminster Bridge-road, S.E.1. Prices of the cleaner and of various attachments, which are of British manufacture, together with some testimonials from users, are given.

Messrs. Hyatt Ltd., Thurloe-place, S.W.7, have issued a further sectional catalogue dealing with the use of Hyatt Bearings in countershafts and loose pulleys. Among the advantages claimed are lower running charges, lessened power consumption and freedom from heating or breakdown.

Recent trade literature by Messrs. Watson & Sons (Electro-Medical), Ltd., include Bulletin 32S, which contain particulars of duplitised X-ray films and accessory equipment, and a folder (33S) giving a description of the improved Sunic plate and of the "Impex" plate. Prices, sizes of plates and other information are included.

The catalogue of electric ware and automatic ranges, recently published by the Westinghouse Electric International Company, 2, Norfolk-street, contains particulars and prices of a variety of domestic appliances, including laundry irons, coffee percolators and urns, curling irons, toasters, radiators, water and air heaters, hot plates, stoves, ranges, &c.

A good deal of attention is being devoted to colliery lighting and miners' electric lamps at present, and in this connection it is interesting to note that Messrs. Simplex Conduits, Ltd., Garrison-lane, Birmingham, have issued a well-illustrated booklet on their new Colliery Lighting System. The Simplex system comprises a range of flameproof and water-tight fittings, which have been specially designed to ensure the maximum of efficiency, and also to comply with all the regulations governing the use of electricity in mines. Copies of the booklet may be obtained from the company.

Messrs. Ferranti, Ltd., have issued a four-page pamphlet (List G.A. 356) containing an illustrated description of the Ferranti-Hawkins System of Protection which they have recently placed upon the market. The protective gear is suitable for use in alternating-current systems, where, in the event of a breakdown of insulation, a current will flow to the earth through the faults, and by its use perfect discrimination is obtained between sound and faulty apparatus, only the latter being disconnected. Its chief advantages are freedom from accidental operation, simplicity and absence of parts subject to high tension.

Electric Traction.

Up to March 31, 1920, the sum of £872 047 had been expended on the P.O. Underground Railway for mails, and the balance of the authorised issue unexpended was £227 952.

Bradford Tramways Committee recommend the Corporation to apply for Parliamentary powers to construct and run super-trackless trolley omnibuses weighing 9½ tons and having six wheels.

Last year there was a net profit of £5 200 on the Blackpool tramways instead of an estimated £25 000. As additional revenue will be required, the Tramways Committee has applied to the Ministry of Transport for an order revising the statutory fares.

On the 14th inst. the House of Commons rejected the Bill promoted by the Durham County Council to improve transport facilities by providing additional tramways and motor omnibus routes. The estimated cost was over one and a half million pounds, and it was urged in opposition that it was a "grandiose" scheme to supersede private enterprise, instigated by the Labour majority of the Council. It is somewhat unusual to reject a Private Bill on the second reading, but in the present instance the proposals were somewhat crude.

The Minister of Transport has extended by one year from Feb. 15, 1921, the period limited by the Western Valleys (Mon.) Railless Electric Traction Act, 1913, for completing the trolley vehicle equipment and the road-widening authorised by the Act, and has also extended by one year from July 21, 1920, the period for completing the trolley vehicle equipment authorised by the Western Valleys (Mon.) Railless Electric Traction (Extension) Order, 1914.

The Highways Committee of the London County Council report that during the period from April 1, 1920, to March 31, 1921, the approximate aggregate expenditure on the tramways, including debt charges and half cost of renewals (less sundry receipts), was £5 464 339, while the traffic receipts were only £4 794 657, subject to adjustments under through running agreements, leaving an approximate deficit of £669 682 on the year. After taking into account receipts from other sources, such as advertisements, rents of lines worked under agreements, &c., it is anticipated that this deficit will be reduced to about £540 484.

The Birmingham Electric Supply Department has made alterations in the rates for electric vehicle charging and garaging, and the following will take effect as from the 1st July next: In the Department's Depots, subject to accommodation being available, garaging charges per vehicle will be as follows: 4s. per day, or 20s. per week (six or seven days), or 2s. per visit during day time for boosting purposes. The rate for current will be 2d. per unit metered into the consumers' batteries.

For vehicles charged on consumers' premises, provided arrangements are made for separately metered circuits, the charge will be 1¼d. per unit metered on the supply mains side of consumers' apparatus.

Sir Wm. Forbes, general manager of the London Brighton & South Coast Railway Company, who distributed the certificates at the Crystal Palace School of Practical Engineering on the 14th inst., referred to developments in the railway world during his forty-eight years' connection with it. He said he was specially pleased with the results of electric traction. There had been an increase of from 150 to 200 per cent. in passengers, and the same increase of receipts. He was contemplating extensions of the system for suburban traffic and possibly to the main line service, but the financial position made it difficult to get on with the work at present.

The Glasgow Corporation Superannuation Scheme for Tramway and Other Municipal Employees is to be amended: Instead of a flat rate contribution, it is proposed to adopt the following graduated scale: 2½ per cent. from wages of men receiving £4 and under, 2¾ per cent. from men receiving over £4 and not more than £5, and 5 per cent. from those receiving over £5. In the scheme, 30 years is proposed as the length of service before a man can go on the superannuation list, unless totally incapacitated. He must have reached the age of 60, and he will then be entitled to two-thirds of the average of his best seven years' wages. The proposals affect about 22,000 employees, of whom between 7 000 and 8 000 were workers in the tramways department.

Progress is being made with the new Leeds express tramway route from Harehills to Oakwood, and it is hoped to have it ready for use at the time of the great Yorkshire Show at Roundhay in July. The new route will be laid on a special track, and will be fenced off from the sidewalk. At two or three points there will be crossings for the convenience of the public and property owners. The rails, while connecting with the existing systems at Harehills and Oakwood, will be raised on sleepers, much in the style of a light railway, so as to allow of a greater speed. A similar form of construction has been adopted for the Middleton express tramway, on the south side of the city, where excavating work is also in progress. This line will be used for the conveyance of building material to the new housing site from Great Wilson-street.

The tramway extensions to Gosforth Park and Forest Hall station, Newcastle-on-Tyne, were recently opened for traffic. The work of constructing the lines, which was suspended in 1915 owing to the war, cost about £100 000, of which over £42 000 represented the increased cost of materials and labour. After the formal ceremony, Ald. R. Mayne, chairman of the Tramways Committee, explained that the Corporation Bills of 1911 and 1914 had added 15 miles of additional track to the tramways undertaking. The number of cars in 1911 was 186, against 228 at present; the number of passengers carried had increased from about 45 to 98 millions; receipts in 1911 were upwards of £206 000, and now £570 000 a year, but the expenses had increased from £114 000 to £493 000 per annum. The amount of money contributed directly to the rates up to 1911 was £19 730, but to date the sum was £159 100.

Imperial and Foreign Notes.

Messrs. Sir W. G. Armstrong, Whitworth & Company recently secured an important contract from the Crown Agents for the Colonies for the Ebute Metta Workshops, near Lagos, for the Nigerian Government Railways. The contract includes the supply, erection and equipment of new locomotive shops, carriage and wagon shops, an electric power station and sawmills.

The South African Railway and Harbour Administration announce a reduction on railway rates of 6s. 6d. per 2 000 lb. for bunker coal to Union ports and Delagoa Bay. A reduction of 1/0 has been made in existing net railway rates for export cargo coal and coal. The foregoing gives a total reduction of 15s. 5d. per 2 000 lb. on the rates in force prior to Feb. 7 last.

A syndicate was started in 1919 to experiment with a process for the treatment of the bauxite discovered in Gippsland (Victoria), and a company has been formed for the manufacture of sulphate of alumina, the intention being eventually to supply the whole of Australia's requirements. The bauxite ore obtained is said to be eminently suitable for the production of aluminium salts. The company also controls another bauxite deposit in New South Wales, but this ore is more suitable for the production of metallic aluminium.

The annual report of Mr. R. J. Strike, city electrical engineer, on the Launceston (Tasmania) electricity department for the year ended June, 1920, states that the gross earnings were £40 846, and total costs £23 552. After making deductions of discounts, &c., the gross profit was £13 883, an increase of £1 704, and the net profit was £2 757. Connections equal 6 845 kW, increase 599 kW, of which heating accounts for 403 kW. Units generated were 5 213 488 (increase 762 509). The revenue of the tramways department was £30 821 (increase £3 104), working expenses were £27 683 (increase £5 303), and after providing for capital charges, there was a deficit of £2 796.

The Sydney Press has been giving considerable prominence to various Sydney traffic improvements tentatively approved in 1913, and understood to be again under consideration by the New South Wales Government. The improvements include the construction of the Sydney Harbour Bridge and Electric Railway and the electrification of certain suburban railways. The bridge will cost approximately £5 000 000. The present street tramway and suburban railway systems have now reached a point where further expansion of the services, to meet the increasing demand for travelling facilities, is impossible. The authorities have come to the conclusion that the only solution of the problem is a loop system of electric railways running into and around the City. The proposed railway will be carried partly on viaducts, partly on the street level and the remainder underground. The estimated cost of the railway is approximately £3 750 000. The Chief Engineer anticipates that tenders will be advertised in October.

The sixth annual report of the chief engineer and manager (Mr. J. H. Butters, M.B.E.) of the Tasmanian Government Hydro-Electric Department, states that considerable progress has been made in the completion of the Great Lake scheme, the principal work being the continuance of the Ouse diversion canal, preliminary work in connection with the new Great Lake dam, widening of the Waddamana canal, preparations for receiving the third and fourth pipe lines, extensions to power station, location of second southern transmission line, location of Risdon sub-station, &c. The shortage of cement retarded the progress, and it is recommended that everything possible should be done to ensure the establishment in Tasmania of cement works capable of meeting the State's requirements. The work of completing the power station is being done in stages. The machinery for duplicating the Electrona substation has arrived, and when erected will bring its capacity up to 8 000 kVA, while the Launceston transmission line should be in operation by the middle of 1922. The operation branch paid interest on capital and put aside nearly £3 000 to depreciation. The Hobart district branch has met all working expenses, paid for its power, paid 5½ per cent. interest on capital, and transferred £2 443 to depreciation, 1 287 additional consumers being connected during the year. The Electrolytic Zinc Company is proceeding rapidly with its construction programme, with a view to taking 15 000 h.p. in a year's time, and 30 000 h.p. in about two years' time. As to water-power survey, the existence of practical water-power sites, totalling 216 000 h.p. in five schemes, has been proved. The sum of £35 100 will be required during the year, and the revenue is estimated at £74 000; whilst £649 800 will be required on capital account for the extension of the distribution system in Hobart and suburbs, the continuation of the extensions to the Great Lake scheme and the water-power survey.

The President of Brazil has signed a Decree authorising the Compania Radiotelegrafica Brasilena to instal and work high-power wireless stations in the country.

Our American cousins have a reputation for being up to date, and if the report that the Chicago policemen are to be equipped with wireless telephone apparatus be correct they are anxious to live up to their reputation. It is hoped that by means of the new equipment officers will be able to communicate direct with police and fire stations.

The owners of Norwegian factories and workshops producing Norwegian electro-technical products have decided to form the National Association of Electro-Technical Industries (Landsforening for electro-teknisk industri) for protecting their interests and for consolidating the position of the electrical industry. Only those firms capitalised with Norwegian money are to be members of the Association, whose head office will be in Christiania.

The Commercial Secretary to H.M. Legation at The Hague announces that, owing to the opposition of the Second Chamber, the Netherlands Minister of Transport has withdrawn for further consideration the Bill dealing with the scheme of electrification. It was urged that measures were required to ensure the supply of electricity at the lowest possible rate throughout the country, and the Chamber had not sufficient data to determine that that object would be attained by monopolising the production of the electricity in one centralised enterprise, as suggested in the Bill.

Apparently Germany has still an ambition to possess Submarine Cables, for it is announced that negotiations have been completed, by the new amalgamation of the Siemens & Halske, the Siemens-Schuckert and the A.E.G. with the Felten & Guilleaume Cable Works, to form the Deutsche Fernkabelgesellschaft, A.G., of Berlin, for the manufacture of telegraph cables upon an extensive scale. The new company intends to establish cable communication with the Rhineland and also to extend the newly-planned telephone service, &c. It is supported by the Government and by various German industrial interests.

Amongst the new companies recently registered in Argentina is Transradio, Ltd. (cia radiotelegrafica argentina), with offices in Buenos Aires. Duration of powers 35 years, and its objects are to erect and operate a high-power radiographic station, and engage in any industry or commerce related to wireless telegraphy or wireless telephony; to take over the concession granted by the Argentine Government to the Telefunken Company of Berlin. Capital: $10 000 000 in $100 m/n shares. Directors: Dr. Vicente C. Gallo (president), A. M. Delfino, E. Albert, E. Hermann, E. Huergo and Richard Diercks (managing director).

The Municipality of Concepcion del Uruguay (Province of Entre Rios, Argentina) recently issued a decree ordaining that the Anglo-Argentine Electricity Company is obliged to supply current to private individuals or to traders without the right of exacting any payment in advance as a guarantee, and also that the company is only entitled to cut off the current of persons who do not pay for it. According to the "Review of the River Plate" the decree lays down that "No contracts should be signed between the company and users of current because relations between the consumer and the company are governed by the contract of the latter with the Municipality."

The Uruguay Department of Posts and Telegraphs received only one tender (from the International Western Electric Company) for the construction of an underground telephone system in Montevideo. The company offers to lay the system and erect administrative offices, &c., for a maximum of $6 943 500 and a minimum of $6 647 000 (Uruguayan gold). The common battery system will be employed and provision will be made at the outset for 18 500 subscribers, with the possibility of extensions to serve 46 500. Regard is also to be had to the possibility of extending to all points of the country and connecting up with the Buenos Aires telephone system. The Company offers to finance the whole undertaking.

Business Items, &c.

The Commercial Cable Company has opened a new cable office at 75, Edmund-street, Birmingham.

Fredk. Garner and Fred. Mothersdill, trading as Saunders, Garner & Mothersdill, electrical, motor and mechanical engineers, 249, Regent-road, Salford, have dissolved partnership. Debts by Mr. Garner, who continues the business under the name of Garner & Company.

The professional practice of the late Mr. H. B. Ransom, M.Inst.C.E., 3, Victoria-street, S.W. 1, has been transferred to Messrs. Dolby & Williamson, consulting engineers, 8, Princes-street, Westminster, S.W. 1, to whom all correspondence should be addressed.

The partnership between Geo. Hy. Hanson, Wm. Chas. Carter, and Alfd. Hood Hanson, trading as the British Telephone Supply Company, 14, Snow-hill, Birmingham, has been dissolved. Debts by Messrs. W. C. Carter and A. H. Hanson, who continue the business under the same style.

The partnership between Lawrence Backhouse, Chas. Hy. Thornton and Albert Stanley Penn, trading as the Arc Electrical Company, 52, Corporation-street, Manchester, has been dissolved, so far as concerns A. S. Penn. Debts by Messrs. Backhouse & Thornton, who continue under the same style and at the same address.

The managing director of the City Electrical Company, Ltd., Mr. H. E. Ellis, is leaving England on the 29th inst. for the purpose of visiting the Company's agents in North and South America, Canada, Australia, New Zealand, India and South Africa. As a result of the tour, Mr. Ellis will be able to gain information on the spot, and form an unbiassed opinion as to trade conditions and prospects in the countries referred to above.

Messrs. George Nobbs, Ltd., 89, Cleveland-street, London, W. 1, have taken over the sole selling rights for the world of "Provol" composition. This compound is manufactured by the Electrical Insulating Composition Company, of Irlam, and the entire output has been absorbed for the last five years by about twelve leading British manufacturers of generators and motors and some telegraph, telephone and traction companies, &c. It is entirely British, and it has a very high dielectric strength and insulation resistance. Two leaflets have been issued giving particulars of the compound.

Institution Notes.

The annual general meeting of the Electrical Trades' Benevolent Institution will be held at the offices of the Cable Makers' Association, Sardinia House, Sardinia-street, Kingsway, London, W.C.2, on Monday, April 25, at 2.30 p.m.

The following is the list of persons who have been nominated to serve next session on the committee of the Liverpool sub-centre of the North-Western Centre of the Institution of Electrical Engineers: *Chairman:* Mr. G. H. Nisbett; *Vice-Chairman:* Messrs. B. Welbourn and E. M. Hollingsworth; *Hon. Secretary:* Mr. O. C. Waygood; *Committee:* Messrs. A. J. Eames, J. Hamilton, A. E. Malpas, P. Priestly and P. J. Robinson. Since the number of nominations corresponds to the vacancies, there will be no necessity for a ballot.

At the annual meeting of the Paisley Association of Electrical Engineers last week, the following office-bearers and committee were appointed for next session:—*President*, Mr. W. R. Scott (Messrs. James Kilpatrick & Son); *Vice-Presidents*, Messrs. Joseph Savage, R. W. Dodson and W. R. Bruce; *Hon. Secretary*, Mr. E. D. Anderson, 96, High-street; *Hon. Treasurer*, Mr. J. M. Barbour, Electricity Department Offices; *Committee*, Messrs. D. E. Craven, D. M'Kay, James Orr, W. Blair Smith and George Wright.

At the meeting of the Sheffield local centre of the Institute of Metals on Friday, Mr. H. A. Greaves read a Paper on a new direct resistance furnace which had been developed by Messrs. T. H. Watson & Company, a special feature of which was that the resistance was permanent, and was supported directly over the metal. This supporting resistance gave a higher efficiency because a greater amount of heat was put into the metal when it was directly overhead than when the resistance had to reflect its heat from the walls and roof. Three of the new furnaces, each of 2 cwt., capacity, which were installed in Italy, were doing excellent work. Their average power consumption on brass melting was only 250 kWh and had worked down to a minimum of 205 kWh per ton.

A meeting of the Electrical Power Engineers' Association was held at Leeds on Saturday, for the purpose of explaining its aims and scope to engineers holding responsible positions in connection with private plants in industrial works, collieries, institutions, &c. Mr. J. N. Waite, of the National Executive Council, gave an address on the need for all staff men to join a protective organisation; Mr. H. Edmonds, and Mr. G. W. Essex, also addressed the meeting, and it was stated that the E.P.E.A. had been able to secure a national schedule of salaries for its members engaged in electricity undertakings, because it could claim to represent practically 100 per cent. of the skilled engineers engaged therein. It expects to render equally good service to engineers in works and collieries, as soon as it can claim to represent the majority of such men.

Educational.

As a result of the Entrance Scholarship Examination held at Faraday House on the 12th, 13th and 14th inst., the following awards have been made:—To H. G. Spencer, Erith County School, the "Maxwell" Scholarship of 50 guineas per annum, tenable for one year in College and one year in works; to E. F. Smith, Emanuel School, Exhibition of 30 guineas, one year in College and one year in works; to E. W. M. Scott, Oundle School, Exhibition of 20 guineas, for one year in College and one year in works; to W. A. Bennett, Mundella Secondary School, entrance prize of 20 guineas.

We are pleased to notice that the London County Council has decided to make a grant of £10 000 a year to the City and Guilds of London Institute towards the maintenance of the Finsbury Technical College for a period of five years as from Aug. 1, 1921, to include any substantive grant payable by the Board of Education under the regulations for technical schools, and subject to the reservation of not more than 16 free places to the holders of the Council's scholarships and exhibitions, and to the Board recognising the expenditure falling on the Council as ranking for the 50 per cent. deficiency grant. This timely aid will assist in maintaining an educational institution which has rendered special services to electrical engineering in the past.

The authorities of the University of Bristol are making an earnest endeavour to secure financial support similar to the benefactions of the Wills family. With this end in view an inspection of the various buildings and laboratories was made on Thursday, April 7 and at a luncheon which followed the vice-Chancellor Sir Isambard Owen drew attention to the value of the laboratories and technical colleges during the war, and urged that it was a matter of grave practical consequence to an industrial country like Great Britain that the highest knowledge should be available to any youth who was capable of profiting by it. The great difficulty at present was finance, and though Government aid was welcomed, it was now time to provide working capital and this could only be obtained by private beneficence. A Government-supported university was not free, and history showed that its thought became barren and its output of original work in science materially diminished.

Obituary.

The death is announced of Mr. George Braulik, electrical accessories manufacturer, which occurred at Brighton on the 5th inst.

We regret to announce the death of Prof. A. W. Reinold, C.B., F.R.S., formerly Professor of Physics at the Royal Naval College, Greenwich. He was born in 1843 at Hull and educated at St. Peter's School, York, and Brasenose College, Oxford. He was elected a Fellow of Merton in 1866, and three years later appointed Lee's Reader in Physics at Christ Church. Prior to going to the Royal Naval College in 1873, he was Lecturer in Physics at Guy's Hospital. He had also acted as Examiner in Physics at Oxford and London Universities.

Miscellaneous.

A Co-partnership Exhibition will be held at the Crystal Palace between Sept. 1 and Oct. 22 in order to illustrate the progress made in developing co-partnership and profit-sharing schemes.

The concluding Social Evening of the Ediswan (Bristol) Staff was held at the Company's Showrooms, on the 6th inst., when a long and well varied programme was carried out by members of the staff and their friends.

We are informed that the Stock Exchange demands upon the London Paris wireless service are such that special relays of Marconi messengers have been provided at 75, Old Broad-street, Shorter's Court (American door), and New Court door between 10.30 a.m. and 3 p.m.

A semi-detached villa in Wensleydale-terrace, Gateshead, was opened on the 13th inst. as an "Ideal Home" Exhibition by Gullaxhen & Son, house furnishers. All the latest domestic electric time-savers have been fitted and the lighting fittings have been chosen to harmonise with the furniture.

The staff of the Midland Electric Manufacturing Company, Ltd., have formed a Staff Social Club, and held their first dinner and musical evening at The White Horse Hotel, Birmingham, on the 14th inst. Over 40 members spent an enjoyable evening, Mr. W. L. Barber, managing director, presiding.

An Open Competitive Examination for not fewer than 20 situations as Assistant Examiner in the Patent Office will be held in London in July next, commencing on the 12th of that month. The limits of age are 20 and 25, with extension for service in H.M. Forces. Regulations and Forms of Application from The Secretary, Civil Service Commission, Burlington Gardens, London, W.1.

While playing on Monday near where the Powell Duffryn Colliery electric transmission line, carrying current at 10 000 V, passes overhead, a Rhymney youth climbed up the framework supporting the cable. Touching the live wire, he received a bad shock and fell to the ground. His left leg up to the knee and the fingers of his right hand were burned clean away, and he died subsequently in Aberbargoed Hospital.

An account of a remarkable performance by a fire pump, manufactured by the Rees Roturbo Mfg. Company, of Wolverhampton, appeared in a recent issue of the "Indian and Eastern Engineer." We learn that at a fire at Sulkea, a trans-river suburb of Calcutta, a Leyland-Roturbo fire engine made what is believed to be a record in fire pumping. It ran continuously for 37 hours and pumped about 2 000 000 gallons of water.

The principle of industrial welfare is now firmly established and many firms have already introduced some form of service, either in the shape of facilities for recreation, education or thrift, or by establishing suitable canteens. Where welfare schemes have been introduced the results have usually been very satisfactory to both employers and employed. The Industrial Welfare Society, 51, Palace-street, S.W.1, which frequently receives inquiries on this subject, is organising itself on a basis which will enable it to render definite assistance to firms when required.

For some time the Bolton Town Council and the local Chamber of Commerce have been agitating for the erection of an automatic telephone exchange, but the Post Office Telephone Department now states that the request cannot be granted. The question of the most suitable type of equipment for an exchange is governed by the characteristics of the local traffic. Where there is a very high percentage of local calls automatic systems are economical and satisfactory, but where there is a substantial percentage of junction and trunk calls a large amount of manual operating is still necessary. As Bolton is a case of the second class, there is no option but to proceed with the installation of C.B. manual equipment.

Our attention has been called to the fact that a paragraph recently published in the "Iron Age" and reproduced in our columns regarding the number of Electric Steel Furnaces now installed in the United Kingdom omitted any reference to the well-known Electro-Metals two-phase furnace. We understand that there are about 30 of these furnaces installed in England, besides large numbers in the principal countries abroad. The Electro-Metals furnace was a pioneer among furnaces having conducting hearths, and in the earlier days of electric steel manufacture played a most important part in demonstrating that the highest qualities of steel, particularly high-speed steel, could be successfully made in the electric furnace. We understand that a number of important improvements have recently been made in the design of this particular furnace embodying the results of the experience gained with the earlier types during the late war.

At the invitation of the Mayor of Leigh (Mr. Geo. Holden), Callender's "Anchor" Works Musical Society recently gave two performances of Gilbert and Sullivan's Opera "The Pirates of Penzance" in the Leigh Hippodrome in aid of the local infirmary. This laudable effort resulted in the Mayor receiving a cheque for £301 11s. 6d., the gross proceeds of the evening's entertainment. The expenses (£110 3s.) were defrayed by private subscriptions, thus avoiding the heavy entertainment tax. In acknowledging the cheque the Mayor highly complimented the Anchor Works Musical Society on their excellent performances which spoke well for their training. The interest in the event was enhanced by the fact that with the Society's double set of principals, two "houses" were run during the evening to crowded audiences. Mr. Alec Hill (Conductor), Mr. Jos. Hull, A.R.C.O. (Accompanist), Mr. W. T. Thornley (Stage Manager) and Miss Castles (who was responsible for the costumes), together with the principals and chorus were the recipients of well merited congratulations. The arrangements were carried out by a town committee, with the Mayor as chairman.

Imports. The following are official values of electrical machinery, apparatus and material imported into this country (*a*) during March, 1921, and (*b*) the aggregate from Jan. 1 to March 31, with increase or decrease compared with corresponding periods of 1920 :—

Electrical machinery, (*a*) £71 853 (increase £14 371), (*b*) £246 916 (decrease £ 887) ; telegraph and telephone cables, submarine (*a*) nil (decrease £50), (*b*) nil (decrease £50) ; other than submarine, (*a*) £2 219 (increase £2 035), (*b*) £27 739 (increase 26 105) ; telegraph and telephone apparatus, (*a*) £33 739 (increase £26 414), (*b*) £88 432 (increase £55 502) ; other electrical wires and cables, rubber insulated, (*a*) £1 684 (increase £1 018), (*b*) £7 769 (increase £4 224) ; with other insulations, (*a*) £19 070 (increase £14 558), (*b*) £38 697 (increase £21 441) ; carbons, (*a*) £4 645 (decrease £5 196), (*b*) £33 071 (decrease £4 691) ; glow lamps, (*a*) £21 302 (increase £17 659), (*b*) £62 674 (increase £53 860) ; arc lamps and electric searchlights, (*a*) £60 (decrease £1 040), (*b*) £4 791 (increase £3 451) ; parts of arc lamps and searchlights (other than carbons) (*a*) £1 392 (increase £1 139), (*b*) £5 133 (increase £881 ; batteries, (*a*) £20 215 (increase £11 462), (*b*) £49 838 (increase £35 531) ; meters and measuring instruments, (*a*) £26 114 (increase £21 333), (*b*) £68 139 (increase £53 281) ; switchboards, (*a*) nil (*b*) £1 170 (increase £214) ; electrical goods and apparatus unenumerated, (*a*) £94 969 (increase £57 249) (*b*) £297 814 (increase £180 135). Total of electrical machinery, apparatus and material other than uninsulated wire, (*a*) £297 262 (increase £160 952), (*b*) £932 203 (increase £420 997).

Exports.—The exports of electrical machinery, apparatus and material (*a*) during March, 1921, and (*b*) from Jan. 1 to March 31, with increase or decrease compared with corresponding periods of 1920, were as follows :

Electrical machinery, (*a*) £417 153 (increase £266 762), (*b*) £1 254 811 (increase £807 768) ; including railway and tramway motors, (*a*) £8 949 (increase £7 263), (*b*) £55 155 (increase £47 658) ; other generators and motors, (*a*) £229 243 (increase £144 845), (*b*) £708 273 (increase £449 452) ; and electrical machinery unenumerated, (*a*) £178 961 (increase £114 654), (*b*) £491 383 (increase £300 658) ; telegraph and telephone cables, submarine, (*a*) £86 682 (decrease £216 724), (*b*) £286 932 (decrease £137 611) ; other than submarine, (*a*) £131 140 (increase £85 319), (*b*) £480 773 (increase £264 417) ; telegraph and telephone apparatus, (*a*) £153 085 (increase £38 282), (*b*) £445 641 (increase £142 904) ; other electrical wires and cables, rubber insulated, (*a*) £164 576 (increase £34 067), (*b*) £493 663 (increase £150 460) ; with other insulation, (*a*) £218 228 (increase £94 650), (*b*) £600 586 (increase £214 555) ; carbons, (*a*) £9 532 (increase £4 094), (*b*) £40 458 (increase £21 261) ; glow lamps, (*a*) £49 503 (increase £31 329), (*b*) £138 143 (increase £98 403) ; arc lamps and searchlights, (*a*) £400 (decrease £2 551), (*b*) £2 830 (decrease £2 016) ; parts of arc lamps and searchlights (other than carbons), (*a*) £67 (decrease £1 334), (*b*) £2 017 (decrease £306) ; batteries, (*a*) £57 518 (increase £19 743), (*b*) £217 476 (increase £117 541) ; meters and measuring instruments, (*a*) £36 119 (increase £6 121), (*b*) £116 213 (increase £46 485) ; switchboards, (*a*) £14 146 (increase £6 686), (*b*) £46 060 (increase £22 424) ; electrical goods and apparatus unenumerated, (*a*) £234 722 (increase £103 638), (*b*) £703 625 (increase £363 769). Total of electrical machinery, apparatus and material other than uninsulated wire, (*a*) £1 572 871 (increase £470 090), (*b*) £4 829 228 (increase £2 100 154).

Bankruptcies and Liquidations.

In the Winding-up Court last week Mr. Justice Lawrence made an order for the winding up of Portable Electric Motors (1919), Ltd.

A first dividend (9s.) is payable at 4, Ramsden-square, Barrow-in-Furness, to creditors of Wm. Drysdale, electrician, of Barrow-in-Furness.

A meeting to receive an account of the winding up of the North British Electric Welding Company, Ltd. (in voluntary liquidation), will be held at 30, George-square, Glasgow, on May 19.

A first and final dividend of 1s. 3¼d. is payable at the office of the Official Receiver, 11, Dale-street, Liverpool, to creditors of Jas. Skinner, trading as Foster, Skinner & Co., electric fittings dealer, 6, South Castle-street, Liverpool.

The Record Engineering Company, Ltd., is being wound up voluntarily, and the liquidator, Mr. S. B. Saunders, 26, Park-row, Nottingham, has been authorised to transfer the company's undertaking to the Record Engineering Company (1921), Ltd., of Tutbury, Burton-on-Trent.

A meeting of creditors of the Wigan Electro-Metallurgical Works, Ltd., will be held on April 27, at the offices of Messrs. M'Ausland, Airey & Page, 8, Victoria-street, Liverpool, and claims are to be sent to the Liquidator, Mr. John Airey, at that address.

Personal and Appointments.

Mr. F. L. Milne, M.I.E.E., has been appointed as additional electrical engineer and electric inspector to the Punjab Government.

Mr. F. S. Crogan was married to Miss C. K. Novrington at Loughborough on April 16. Hearty congratulations to both contracting parties !

Mr. J. W. Meares, M.Inst.C.E., electrical adviser to the Government of India, has been appointed chief engineer of the Hydro-Electric Survey of India, in succession to Mr. F. E. Bull, retired.

Mr. L. D. Coueslant, of the Engineering Department of Sunderland Technical College, has been appointed professor of engineering at the University of Benares, India.

Tenders Invited and Accepted.

Manchester Electricity Committee require tenders by May 2 for three steam turbine-driven boiler feed pumps for the Barton power station. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

St. Helens Corporation require tenders by May 1 for supply and erection of d.-c. three-wire distributing switchboard. Specifications from the Borough Electrical Engineer.

Dublin Electricity Supply Committee invite tenders by April 27, for a year's supply of arc lamp carbons. Particulars from the City Electrical Engineer.

Kilmarnock Tramways Committee require tenders by May 15 for the supply of stores, including cable, lamps, insulating tapes, overhead material, varnishes, paints, oils, &c. Forms of tender from the Manager.

Tenders for the installation of electric lighting in the church of Sarum St. Edmund, Salisbury. Particulars may be obtained from the Churchwardens, and tenders by May 7 to Mr. E. Usher, Churchwarden, 44, Saltland, Salisbury.

Tenders are invited by May 25 for the supply and delivery to the Postmaster-General's Dept., State of Western Australia, of ironwork (Schedule 704). Tender forms from the High Commissioner for Australia, 406, Australia House, Strand, W.C.2.

The Department of Sanitary Works, Buenos Aires, requires tenders (by June 13) for the supply and erection of electric batteries and lighting plant at Mar del Plata. Local representation is essential. As soon as the specification is received in the Department of Overseas Trade it will be made available to firms interested.

The Australian Commonwealth Postmaster-General's Department invites tenders by May 25 for ironwork, including couplings, piping, bolts, rings, &c. (schedule 704), and by May 31 for porous cells (schedule 1685), and of ammonium chloride (schedule 1683). Specifications can be seen at 35, Old Queen-street, Westminster, S.W.1.

Manchester Education Committee require tenders by May 4 for electric lighting installations in the junior and infants' departments of the Ardwick school, and in the Ardwick Central, Ducie-avenue Central and Cheetham Central schools. Specifications, &c., can be obtained at the Education Offices, Deansgate, Manchester.

The Victorian Government Railway Commissioners invite tenders for the supply and delivery of 50 oil-immersed single-phase track and signal transformers for power signalling (contract No. 33 901). Tenders to the Commissioners, Spencer-street, Melbourne, by June 15. Specifications may be consulted at the Department of Overseas Trade.

Tenders are invited for the supply and installation of the machinery for the electric power station for the low districts of the South Zone of the Argentine Federal Capital. Conditions may be seen in the Technical Director's office, Calle Charcas 1 840, Buenos Aires. Tenders to the secretary of the Direction General of Sanitary Works, Buenos Aires, June 3.

The New Zealand Public Works Department invite tenders for the supply and delivery at Lyttelton of two 50-kVA, two 100-kVA and two 200-kVA condensers, in connection with the Lake Coleridge electric power supply scheme (Section 116). Tenders by noon, June 28, to the Secretary, Public Works Tenders Board, Wellington. Specifications may be seen at the Department of Overseas Trade.

Belfast Corporation invite tenders for the manufacture and erection at the new Harbour power station of extra-high pressure and low pressure switchgear. Specifications from the consulting engineers, Messrs. Preece, Cardew & Rider, 8, Queen Anne's Gate, Westminster, S.W.1., or the city electrical engineer, Mr. T. W. Bloxam. Tenders by April 25.

The New Zealand Public Works Department invite tenders for 10 single-phase oil transformers for the Waikato power scheme for converting three-phase current at 50 cycles, the voltage ratio being 50 000/11 000. Tenders (with deposit of £100) by June 28 to the Secretary of Public Works, Tenders Board, Wellington. Specifications may be seen at 35, Old Queen-street, S.W.1.

The National Board of Sanitary Works, Buenos Aires, invite tenders (by June 3) for the supply and erection of plant for a new generating station, including three 375 h.p. four-cycle Diesel engines (to run on crude petroleum) and three three-phase alternators, each of 250 kW, 2 200 V between phases, 50 cycles and power factor of 0·8. Conditions, &c. (in Spanish) at Department of Overseas Trade, 35, Old Queen-street, S.W.1.

The Commercial Secretary to H.M. Legation at Belgrade (Capt. H. Murray Harvey) reports that he has received an inquiry from a local contractor for plant for the electric lighting of a town in Serbia. Offers are required for two dynamos of 40 kW each, and 50 kilometres of overhead cable, &c., for the supply of current to about 1 200 houses. Name of firm may be obtained from the Department of Overseas Trade.

Tenders are invited in connection with the electrification of the Cape Town–Simonstown and Durban–Pietermaritzburg Railways, for the supply of turbo-alternators, boilers, condensing plant, passenger and freight locomotives, motor coaches and underframes, motor bogies, electrical equipment of coaches, sub-station equipment and transformers. Specifications and forms of tender from the High Commissioner for the Union of South Africa, or the General Manager, Johannesburg. Further technical information can be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1. Tenders to the High Commissioner by May 3.

Tenders are also invited for the overhead equipment of permanent way and overhead transmission lines, switchgear and accessories and track bonds. Specifications and forms of tender from the High

Commissioner, Trafalgar-square, London, W.C., or from the General Manager, Johannesburg, and further technical information may be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, S.W.1. Tenders to the High Commissioner by June 22.

The recommendation of the Bradford Tramways Committee to place a contract for the supply of a hundred steel tramcar tyres with an Anglo-Belgian firm has been referred back by the City Council. It was pointed out that the tenders from English firms were for basic steel, and the steel tyres of the Anglo-Belgian firm were of acid steel. It was, therefore, felt that the matter required further investigation.

Last week Aberdare Urban Council considered three tenders for service cable. One was from a Danish firm at £151, another from a German house at £179, and a third from English manufacturers at £281. It was decide to accept the Danish tender, one member remarking that they should have no qualms of conscience in accepting the lowest tender in face of recent disclosures regarding the ring among British manufacturers.

Last week the Swansea Electricity Committee considered two tenders for the supply of about 600 meters. One firm (a British firm) had made a purchase of German meters and was able to tender at a cheaper rate than the other who specified meters of British manufacture. Some members of the committee favoured the purchase of the German meters, on the ground that under the Reparation Act 50 per cent. of the money would go to the British Government as indemnity. A motion that the offer of the German-made goods be not entertained was lost, it being urged that the opportunity of making an immense saving was thus being thrown away, and the matter was adjourned for further inquiries.

The following tenders are recommended for acceptance by Hammersmith (London) Electricity Committee :—Diamond Blower Company, soot-blower, £210 ; W. & D. Conveyor Company (lowest tender), push-plate coal conveyor, £1 679 (three other tenders, for steel belt on drag-link conveyors, and, like the accepted tender, not including means for extracting coal from storage tanks, were received, the highest being £2 256). Other tenders, providing for means of extracting coal from tanks, were eight in number, and varied from £2 265 to £9 270, the last-mentioned being for an electric telpher system. Of these, the tender of the New Conveyor Company at £2 100, for fixed electric crane (part of a tender at £4 034 which included a drag-link conveyor), is recommended for acceptance. Western Electric Company (lowest) for three-core cable, £4 458, and six-core cable, £256. (Two other tenders, highest for three-core £4 875 and for six-core, £271.) Premier Accumulator Company, 24 new battery cells, £451, removal of 91 existing cells to new position, £180, and supply of 91 additional glass boxes, £153. Hackbridge Cable Company, two auto-transformers, £325 each.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

135 856 Arter. Grinding and other machines having magnetic work-holders. (28 12 16.)
147 564 Siemens & Halske Akt.-Ges. Receiving arrangements for the electric detection of fair-ways of ships. (18/9/18.)
158 592 Western Electric Co. & Deakin. Telephone exchange systems. (28/7/20.)
158 595 Filbar Electric Heater, Ltd. & Kratt. Electric water-heaters. (6/9/19.)
158 604 Automatic Telephone Mfg. Co., Ltd., & Archer. Electric heating apparatus. (4/10/19.)
158 640 B.T.-H. Co. (G. E. Co.) Protective devices for electric apparatus.
158 652 North & Allen. Magneto-electric machines. (7/11/19.)
158 654 Miller, Miller & Sanders. Electric cable connectors particularly for use with car lighting dynamos and the like. (7/11/19.)
158 655 Miller, Miller & Sanders. Electric lamps for motors and other vehicles. (7/11/19.)
158 658 Hawkins, Hawkins & Johnson. Electric lamp signalling systems. (7/11/19.)
158 661 Woodhead. Apparatus for converting tidal energy into mechanical or electrical power. (7/11/19.)
158 673 Scorey & Brella Mfg. Co. Electrical testing apparatus. (7/11/19.)
158 689 Twiss. Electrical insulators. (10/11/19.)
158 701 White. (U.S. Light & Heat Corporation.) Electric battery plate pasting machines. (11/11/19.)
158 707 Picken & Robb. Wireless telegraph receiving systems. (11/11/19.)
158 720 Mullard. Thermionic or oscillation valves. (14/11/19.)

The bulb is provided with a re-entrant portion for supporting an electrode and in which a sealing tube is attached to the said re-entrant portion and extends outwards beyond the general contour of the bulb whereby the electrode can be replaced or whereby a long leakage surface is provided between the said electrode and another electrode.

158 721 Jensen & Tilney. Electric ignition apparatus for internal-combustion engines. (14/11/19)
158 730 B.T.-H. Co. (G. E. Co.) Electric transformers and the like. (18/11/19.)
158 733 Powell, Baden-. Primary electric batteries. (20/11/19.)
158 736 B. T.-H. Co. & Trechman. Protective devices for alternating current electric distribution systems. (20/11/19.)
158 761 B. T.-H. Co. & Young. Magneto-electric machines. (4/12/19.)
158 762 Robinson & Crowther. Electro-magnetic wave reception apparatus. (5/1 2/19.
158 771 Lundberg, Lundberg, Lundberg & Pegg. Electrical switches. (11/12/19.)
158 787 Hamlyn. Electric lamp-holder. (5/1/20.)
158 788 Davies. Means for driving dynamos. (6/1/20.)
158 790 Adams. Trip mechanism for electric ignition devices for internal-combustion engines. (12/1/20.)
158 796 Lucas & Jenkins. Electric cables. (7/2/20.)
158 804 Beattie. Devices for protecting telephone, telegraph and the like instruments against lightning or excessive electric potentials. (16/4/20.)
158 809 Wilson & Callender's Cable & Construction Co. Apparatus for extracting fuses or links on electric circuits. (11/5/20.)
158 812 Baker. Thermally-actuated electric switch. (23/8/20.)
158 821 White. (U.S. Light & Heat Corporation.) Dynamo-electric machines. (11/11/19.) (Divided application on 27,938/19.)

APPLICATIONS FOR PATENTS.

August 31, 1920.

25 065 Radio Communication Company & Scott-Taggart. Radio receiving systems.
25 066 Radio Communication Company & Scott-Taggart. Modulation systems in radio communication, &c.
25 083 Law & Milton. Miners' lamps.
25 115 Metropolitan-Vickers Electrical Company (Westinghouse Electric and Manufacturing Company). Automatic electric substation systems.
25 125 Wall. Means for limiting rise of speed in a.c. generators.

September 1. 1920.

25 172 Burnham. Multi-layer electric coils.
25 174 Ray & Vane. Device for controlling electric signs, signalling, &c.
25 177 Blackburn. Overhead collectors for electric tramways and railways.
25 187 Berry. Electric film re-winders.
25 241 Igranic Elec. Co. (Cutler Hammer Mfg. Co.). Current regulators for incandescent lamps, &c.
25 243 New Union Elec. Co. & Knapton. Electric lamps for kinematograph apparatus.
25 248 Farmer. Contact devices. (10/10/19, U.S.).
25 258 Moll. Electric rivet-heating machine.
25 264 Medway. Stopping or slowing electric motors.
25 286 Lepiney. Incandescent lamps.
25 289 Clarke. Cables.

September 2, 1920.

25 301 Healey & Smith. Dynamos.
25 357 Raney. Automatically reclosing circuit breakers
25 370 Radio Communication Co. & Scott-Taggart. Production of electrical oscillations by thermionic valves.
25 378 Radio Communication Co. & Lea. Production of electrical oscillations by thermionic valves.
25 379 French-Brewster. Telephone receivers.
25 387 Price. Converting a.c. into d.c. and vice versa.
25 388 Etab. Continsouza Soc. Anon. Arc projection apparatus. (19/11/19, France
25 390 Morris-Airey, Shearing & Macrorie. Valve transmitters and receiver

September 3, 1920

25 408 Radio Communication Co. & Scott-Taggart. Radio signalling systems.
25 411 Pilling. Electric clocks, &c.
25 413 Taylor. Improving transmission on a.c. systems.
25 426 Farley. Valves for wireless systems.
25 438 Western Elec. Co. Repeaters for multiplex signalling systems.
25 441 Doubell. Electric photographic printing machine.
25 414 Igranic Elec. Co. (Cutler Hammer Mfg. Co.). Motor controllers.
25 445 Igranic Elec. Co. (Cutler Hammer Mfg. Co.). Rheostats.
25 451 Siemens & Halske, A.G. Controlling relays for wireless telegraphy, &c.
25 453 B.T.-H. Co. (G.E. Co.). Glass-working machines.
25 465 Metropolitan-Vickers Electrical Co. (Westinghouse Elec. & Mfg. Co.). Polarized relay for controlling rotary converters.
25 487 Siemens & Petithory. Number dials for automatic telephone systems.

September 4, 1920.

25 491 Powell. Batteries.
25 504 Roberts. Telephone instruments.
25 534 Baker. Rhestats for arc lamps.
25 537 Sedgwick. Lamp fittings.
25 539 Naamdoze Veotschap Electrotechnische Industrie vorleen w. Smit & Co. Fixing in Euating rings on shafts.
55 542 B.T.-H. Colnno. Co.). Eletric-regulating systems.

September 6.

25 573 Taylor. Providing high frequency alternating currents.
25 576 Fitzgerald. Trolley poles.
25 599 Harwood. Trolley heads.
25 623 Scott (Himmelstjerma). Insulators for supporting electric wires, &c.
25 624 Radio Communication Co. & Scott-Taggart. Electro-magnetic wave-receiving systems.
25 627 Bottom & Goldfarb. Device for indicating interruptions in electric circuit.
25 650 Brooks. Electric transforming systems or devices.
25 679. Phillips abt. Ges. Field magnets. (6/9/19, Germany.)

September 7.

25 708 Electro-Dynamic Construction Co. & Pensabene. Dynamo-electric machines
25 719 Metropolitan-Vickers Electrical Co. & Field. Ventilation of electric machines.
25 720 Fotheringhame. Compass and dip for defining between permanent and sub-permanent magnetism.
25 737 Orling. Magnifying changes in electric currents.
25 760 Burns. Telephone desk sets.
25 792 Akt. Ges. Brown, Boveri et Cie. Starting polyphase motors. (8/9/19, Switzerland)

September 8.

25 825 Stevens. Accumulators.
25 833 Hammonds & Wagg. Electric cooking appliances.
25 872 Atkins. Battery charging switch.
25 887 Moseley. Electric gramophones.
25 888 B. T.-H. Co. (G. E. Co.). Arc welding compositions.
25 889 MacGregor & Wass. Electric cutting machines.
25 890 Western Electric Co. & Nash. Method of jointing cables.
25 918 Pemberton Billing. Weight actuated dynamo driving.

September 9.

25 956 Merton. Telephone call meter carrier.
25 962 Rottenburg. Electric lamps for motor cars, &c.
25 965 Davey. Operating electrodes of electric furnaces.
25 967 Schaeffer. Operating luminous electric discharge lamps, &c. (9/9/19, Germany.)
26 977 Kremenezky. Electrolytic rectifier cell.
25 999 Gouin & Roesel. Alkaline storage batteries. (10/9/19, France.)
25 007 Dutt. Method for generating electricity.
26 008 Dutt. Conversion of latent heat into electricity.

September 10.

26 035 Electric Control, Ltd., & Fisher. Switches, &c.
26 036 Creed & Carpenter. Electro-magnetic apparatus.
26 043 Tucker & Line. Mounting clips for switchgear.
26 044 Tucker & Line. Contacts for switches.
26 050 Gunstone. High tension transformers.
26 057 Dutt. Conversion of latent heat into electricity.
26 075 Von Schlegell. Construction and regulation of electric arcs.
26 104 United Alkali Co. (Barker). Electrolytic cells from production of chlorates, &c.
26 113 Richards. Electric ignition.

September 11.

26 117 Taylor. Electric power transmission.
26 148 Metropolitan-Vickers Electrical Co. & Gowan & Miller. Control of electric motors.
26 154 B. T.-H. Co. & Young. Magneto-electric machines.
26 156 Compagnie Generale Electrique. Starting synchronised motors. (20/9/19, France.)
26 173 La Pichardais. Incandescent lamp socket. (12/9/19, France.)

Companies' Reports, &c.

The recent issue of £500 000 8 per cent. five-year secured and guaranteed notes of the Central Electric Supply Company, Ltd., was oversubscribed.

The directors of the Reading Electric Supply Company, Ltd., have declared a dividend of 4 per cent. on the ordinary shares for the past year.

The directors of the Consolidated Signal Company, Ltd., have declared an interim dividend for the half-year to Feb. 16th on preference shares at the rate of 6 per cent., less tax.

The following companies will be struck off the Register of Joint Stock Companies unless cause to the contrary is shown before June 29: Colston Electrical Works, Globe Associated Cable and Telegraphic Services, Stolz Electrophone Company (1913).

The directors of the Indo-European Telegraph Company, Ltd., have declared a final dividend for 1920 of £1 2s. 6d. per share (making 7 per cent. for the year), and a distribution from equalisation of dividends fund of 15s. per share, both tax free (making 10 per cent. for the year), payable on May 2. In 1919 the distribution was the same.

The net profit of the Bastian Meter Company, Ltd., for 1920 was £455, and, with £589 brought forward, the total was £1 044. The directors recommend payment of the 6 per cent. dividend on the cumulative preference shares, and also a dividend of 6 per cent. on the ordinary shares for the year, carrying forward £328.

The Submarine Cables Trust invite tenders from holders of certificates to be redeemed out of surplus income at a price not exceeding £120 per certificate. Holders desirous of surrendering their certificates should communicate with the Secretary, Mr. Sidney Collett, Electra House, Finsbury Pavement, E.C.2, stating the lowest price they are willing to accept.

The receipts of the Cuba Submarine Telegraph Company, Ltd., for 1920 were £81 542 and the expenses £34 284. After providing £7 063 for income tax and adding difference in exchange (£17 611) and £21 150 brought forward, the total is £78 957. A sum of £15 000 has been placed to general reserve, £17 611 to reserve against loss on investments, and £2 500 to pension fund. The directors recommend a final dividend at 5 per cent. on the ordinary shares, making 5 per cent. for year, and a bonus of 4s. per share (tax free), carrying forward £26 645. The total cost of work on cables during year has been £24 542, which has been charged to reserve fund.

Meetings of the shareholders of W. H. Dorman & Company, Ltd., have authorised an increase of the borrowing powers and an issue of debenture stock. The chairman and managing director (Mr. Walter Haddon) gave an outline of the progress of the company, of the work in hand, &c. He explained that delay had been caused in completing their new building by shortage of labour and of steel and other supplies, but they had progressed slowly to a stage that would enable them in a few months to take possession of a small section. Its completion as a whole was being delayed until late in the autumn because they could not get from the public supply of the Stafford Corporation the necessary electric power, which, in their turn, they were unable to supply by reason of the delays in the extension of their generating plant.

The gross profit of the Urban Electric Supply Company, Ltd. for 1920 was £90 979, compared with £59 825 in 1919, and after deducting expenses the balance is £86 685. Interest, debenture stock redemption and income tax absorb £60 845, leaving, together with £1 323 brought forward, a balance of £27 163. The directors have placed £25 000 to reserve for depreciation and carried forward the balance, £2 163, as they feel that, despite the substantially improved results shown, they are not yet in a position to recommend the resumption of a dividend on the cumulative preference shares, the whole of the cash resources being still required to meet current needs. The aggregate load connected to the thirteen undertakings of the Company is 46,882 kW against 43 299 kW in 1919, and 39 503 kW in 1918. Mr. H. Tudor Crosthwaite has been appointed a director.

It is announced by the Eastern Extension, Australasia and China Telegraph Company, Ltd., that owing to unavoidable delays in obtaining the necessary returns from foreign stations and administrations, it will be impossible to issue the audited accounts and balance sheet for the year ended Dec. 31, 1920, in time to allow of the annual general meeting being held in the present month, but the directors will convene the meeting as soon as the full accounts can be submitted. The directors have, however, decided to pay on the 14th May next a final dividend on the old shares of 2½ per cent. (tax free), making the distribution for the year 1920 ten per cent., tax free, the same rate as was paid for the previous year. The share register will be closed from the 6th to the 13th May inclusive.

The Eastern Telegraph Company, Ltd., announce that, owing to unavoidable delays in obtaining the necessary returns from foreign stations and administrations it will be impossible to issue the audited accounts and balance sheet for the year ended 31st Dec., 1920, in time to allow of the annual general meeting being held in the present month, but the directors will convene the meeting as soon as the full accounts can be submitted. The directors have decided to pay on 14th prox. a final dividend for the year of 2½ per cent., tax free, on the ordinary stock, making the distribution for 1920 ten per cent., tax free, on that stock, the same rate as was paid for the previous year. The usual distribution at the rate of 3½ per cent. per annum (less tax) on the preference stock for the first quarter of 1921 will be paid on the same date. The transfer books of the ordinary stock and shares will be closed from the 28th inst. to 5th May inclusive.

The Company also announce the payment by warrants on the 30th inst. of interest for the half-year ending 30th April on their four per cent. mortgage debenture stock. The transfer books of the stock will be closed from the 25th to 29th April inclusive.

Mr. W. J. New, who presided over the recent meeting of the Melton Mowbray Electric Light Company, Ltd., stated that the connected load had increased from 1 084 to 1 289 kW, and during the past year an additional 300 kW turbo-generating set had been added, together with a Babcock & Wilcox boiler. The gross profit was £5 092, against £3 110 in 1919, and they were paying a dividend of 8 per cent. after placing £1 000 to reserve, and £1 000 to renewal of plant account, a balance of £529 being carried forward. He said that in the past the attitude of the Board of Trade to electrical undertakings had been marked by a spirit of obstruction rather than encouragement. It was a signal instance of the blighting effect of Government interference with industrial enterprise. With labour, coal and all other requisites costing double or treble what they did in normal times it had only been after a severe struggle that some increase in the maximum prices allowable under their provisional orders had been conceded. With an increase of 16 per cent. in output their expenses on coal and wages had gone up 160 per cent., and it was only because of the increase allowed they were able to show a profit a concern of that sort should expect.

The report of the directors of the English Electric Company, Ltd., for the year ended Dec. 31 last states that, after writing down stocks on a conservative basis to correspond with present values, the balance to credit of profit and loss account (including £45 302 brought forward) is £312 238. Deducting debenture interest and trustees' fees (£54 275), interest and discount (£84 608), the year's dividend on the 6 per cent. preference shares (£41 914), the balance is £131 441. The directors propose payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum (less tax), which will absorb £85 205, and to carry forward the balance of £46 236.

Certain dividends receivable from subsidiary companies (including the realised profit on the sale of certain assets) have been, in part, applied in writing off the entire expenses of, and discount on, the recent note issue, as well as reserving for the whole of the premium due on repayment, and in adding a further £25 000 to the capital reserve account. In view of the uncertainties of the present position of trade throughout the world, the directors have considered it prudent to utilise these resources in the manner indicated. In order to replace expenditure incurred in the purchase of the Stafford Works and stocks, and for other purposes, the company issued in November last £1 250 000 8 per cent. six-year secured notes. Ten per cent. of the proceeds of the issue was received prior to Dec. 31, 1920, and included in the accounts for 1920. The balance of £1 100 000 has been received since that date, and will appear in next year's balance-sheet. Further progress in completing the amalgamation of the various undertakings controlled by the company has been made. The properties of the Coventry Ordnance Works and Willans & Robinson have been leased to the company, and arrangements are now in progress for winding up the Phœnix Dynamo Mfg. Company and the United Electric Car Company. The directors are confident that this consolidation will facilitate control, and result in effecting greater economy in administration.

New Companies.

The following list is compiled from information supplied by Messrs. Jordan & Sons, Ltd., company registration agents, Chancery-lane, London, W.C.2:—

BRITISH SANGAMO COMPANY, LTD. (174 133).—Reg. April 9, capital £10 000 in £1 shares, to carry on the business of mechanical, electrical and general engineers. Subscribers: J. Bunn and R. C. Lanphier (both of Illinois, U.S.A.) and S. B. Rogers (Great Eastern Hotel, E.C. 3). Private company.

C. T. BRISCOE & SON, LTD. (173 926)—Reg. March 29, capital £5,000 in £1 shares, to acquire and carry on business of electrical engineers and contractors. Directors: C. T. Briscoe (Garlster, Second-avenue, South Shore, Blackpool), A. E. Briscoe and G. H. Officer. (Private company.)

CAFFIN & COMPANY, LTD. (173 927)—Reg. March 29, capital £25 000 in £1 ordinary shares, to carry on business of railway, electrical, mechanical and general contractors and engineers. Directors: J. R. Ling and H. A. Caffin. Reg. office: 25, Craven-street, Strand, W.C. (Private company.)

R.G. COMPANY, LTD. (173 555.)—Reg. March 7, capital £125 in 6d. shares, to acquire and carry on business of electrical and mechanical engineers. Directors: C. A. Newton, F. Newton, R. Newton, H. Newton and H. B. Ray. Reg. office: 21, Market-place, Derby.

SURREY MOTOR ENGINEERING WORKS, LTD. (173 735).—Reg. March 16. Capital £5 000 in £1 shares, to carry on business of motor, agricultural, electrical and general engineers. Directors: W. A. Wallis and H. S. Whitmore. Reg. office: Station Road East, Oxted, Surrey.

J. TRAVIS, LTD. (174 015).—Reg. April 2, capital £3 000 in £1 shares, to carry on the business of mechanical, electrical and general engineers. Directors: J. Travis and C. Lees. Private company Reg. office: 8, Mile-street, Burslem, Stoke-on-Trent.

H. B. WHITE & COMPANY, LTD. (173 990).—Reg. April 1. Capital £2 500 in £1 shares, to carry on business of mechanical, electrical and motor engineers. Directors: H. B. White and W. Benny. Private company. Reg. office: 16, John Dalton-street, Manchester.

Benn Brothers Journals.

Some Features of the Current Issues.

"The Cabinet Maker": "Retail Furnishers' Advertising"; "Furniture for Children"; and "Design and Tradition."

"Chemical Age": "British Mission to German Chemical Factories: Official Report"; "Technical Records of Explosives Supply: Denitration of Spent Acids"; and "Early Chemistry at Oxford."

"Farm and Home": "Failure of State Farming"; "Potato Problems"; and "Concrete for Farm Buildings."

"The Fruit-Grower": "Packing and Marketing of Carnations"; "Fruit and Vegetable Imports"; and "Ex-Service Men on the Land."

"Gardening Illustrated": "Spraying (illustrated)"; "Fruit Blossom"; and "Chrysanthemums on Walls."

"The Gas World": "Paints and Painting"; "The Gas Mantle Industry as a Key Industry"; "Board of Trade Inquiry as to Merits in Coal Gas."

"Hardware Trade Journal": "Failure of Metals from Internal Stress"; "Appliances Used in Bee-Keeping"; and "The Export Outlook."

"Aeronautics": "The Design of Long Struts Exposed to the Air," by John Case; "Flying Boat Construction," by D. Nicholson; and "The Helicopter," by M. A. S. Riach.

Forty Years Ago.

(The Electrician, April 23, 1881.)

Electric Light at Amsterdam.—The Continent is ahead of us in employing the electric light inside theatres. The proprietors of Carre's Circus illumine their proceedings every evening by means of its powerful rays.

L'Electricien.—We have at last received the first number of this long-promised paper, and now that it has appeared we do not find much that is new in it. We must confess to having thought that electrical science was sufficiently represented in France by our contemporaries *L'Electricité* and *La Lumière Electrique*. We fear that this multiplication of electrical journals, so far from assisting the student, will only embarrass and discourage him.

Society of Telegraph Engineers and Electricians.—We have received a copy of the "Journal," No. 35, Vol. X., for March, and amongst the contents are:—Mr. Heavisides' Paper on "Induction and the Telephone," Mr. Adams's Paper on "Earth Currents," and an original communication from Mr. J. T. Wilmot on a "Manual Translator," and an "Automatic Double Current Translator." Besides these there are abstracts of Papers in foreign publications. The number also contains a revised list of members, which shows a total of 981, composed of honorary members, 4; foreign members, 152; members, 339; associates, 475; students, 11.

Prices of Metals, Chemicals, &c.

Tuesday, April 19.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£71 0 0	10s.	—
Electro Wirebars	,,	£74 0 0	—	—
H.C. wire, basis	per lb.	0s. 11½d.	—	—
Sheet	,,	1s. 0½d.	—	—
Phosphor Bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. 3½d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1d.	—	—
Wire, basis	,,	1s. 1d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£6 5 0	—	
Galvanised steel wire, basis 8 SWG	,,	£26 0 0	—	
Lead Pig—				
English	,,	£22 5 0	—	—
Foreign or Colonial	,,	£20 12 6	—	2s. 6d.
Tin—				
Ingot	,,	£169 5 0	£6 0 0	—
Wire, basis	per lb.	2s. 4d.	0s. ¾d.	—

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £13 10s.

,, (Roll-Brimstone).—Per ton £12 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £32 10s.

Boric Acid (Crystals).—Per ton £69.

Sodium Bichromate.—Per lb. 7½d.

Sodium Chlorate.—Per lb. 5d.

Rubber.—Para fine, 11d.; plantation 1st latex, 11¼d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co., Ltd.

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Arrangements for the Week.

FRIDAY, April 22nd (to-day).

Physical Society.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Papers on "The Effect of Viscosity on the Flow Through an Orifice," by Mr. W. N. Bond; "The Viscosity of Water at Low Rates of Shear," by Dr. A. Griffiths and Constance H. Griffiths; "A Method of Measuring Frequencies," by Mr. G. F. Partridge and Mr. B. S. Smith.

Institution of Mechanical Engineers.

6 p.m. At Storey's-gate, London, S.W. Paper on "Limit Gauging," by Sir Richard T. Glazebrook, K.C.B., F.R.S.

Institution of Electrical Engineers.—Students' Section.

6.30 p.m. At Finsbury Technical College, Leonard-street, London, E.C. Paper on "Searchlights as Used for Coast Defence Work," by Mr. R. C. Hawkins.

Technical Inspection Association.

7.30 p.m. At the Royal Society of Arts, John-street, Adelphi, London, W.C. Lecture on "Physical Properties of Clay," by Mr. A. S. E. Ackermann.

Junior Institution of Engineers.

8 p.m. At Caxton Hall, London, S.W. Lecturette on "Construction and Working of Marine Water-tight Doors," by Mr. H. P. H. Anderson.

Finsbury Technical College Old Students' Association.

8 p.m. At Anderton's Hotel, Fleet-street, London, E.C. Annual Smoking Concert.

Royal Institution.

9 p.m. At Albemarle-street, London, W. Discourse on "Electro-Synthesis in Organic Chemistry," by Sir James Walker, F.R.S.

MONDAY, April 25th.

Electrical Trades Benevolent Institution.

2.30 p.m. At the Cable Makers' Association, Sardinia House, Sardinia-street, London, W.C. Annual General Meeting.

Institution of Electrical Engineers.—Informal Meeting.

7 p.m. At the Chartered Institute of Patent Agents, Staple Inn-buildings, London, W.C. Discussion on "Engineering in Russia," opened by Mr. C. L. Lipman.

Institution of Electrical Engineers.—Liverpool Sub-Section of the North-Western Centre.

7.15 p.m. At St. George's Restaurant, 5, Redcross-street, St. George's-crescent, James-street, Liverpool. Second Annual General Meeting, followed by a Smoking Concert.

Royal Society of Arts.

8 p.m. At John-street, London, W.C. Cantor Lecture on "Recent Applications of Spectroscope and of the Spectrophotometer to Science and Industry," by Dr. S. J. Lewis (Lecture III.).

TUESDAY, April 26th.

Institution of Electrical Engineers.—N. Midland Section.

7 p.m. At the Hotel Metropole, Leeds. Annual General Meeting.

Illuminating Engineering Society.

8 p.m. At the Royal Society of Arts, John-street, London, W.C. Discussion on "Ship-Lighting, in Relation to Comfort, Safety and Efficiency," opened by Mr. W. J. Jones.

WEDNESDAY, April 27th.

University of London.

5 p.m. At University College, Gower-street, London, W.C. Lecture on "Wireless Telegraphy and Telephony by Continuous Waves," by Prof. J. A. Fleming, F.R.S. (Lecture I.).

Institution of Railway and Signal Engineers.

6 p.m. At Midland Grand Hotel, St. Pancras, London, N.W. Paper on "Magnetic Storms, Their Effects upon Railway Signal and Telegraph Apparatus," by Mr. W. J. Thorrowgood.

Institute of Physics.

6 p.m. At the Institution of Civil Engineers, Gt. George-street, London, S.W. Public Inaugural Meeting. Address by Sir J. J. Thomson, O.M., F.R.S.

Institution of Electrical Engineers.—South Midland Centre.

7 p.m. At the University, Edmund-street, Birmingham. Annual General Meeting and Paper on "Magnetos for Ignition Purposes in Internal Combustion Engines," by Mr. E. A. Watson.

Liverpool Engineering Society.

8 p.m. At the Royal Institution, Colquitt-street, Liverpool. Annual General Meeting.

THURSDAY, April 28th.

Institution of Electrical Engineers.

6 p.m. At the Institution of Civil Engineers, Gt. George-street, London, S.W. Discussion on "Tariffs," Papers on "Electricity Supply—Present Conditions and the Hopkinson Principles," by Mr. J. R. Blaikie, and "Multi-Part Tariffs for Domestic Electricity Supply," by Mr. J. W. Beauchamp.

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Notes.

A Second Joint Electricity Authority.

The Electricity Commissioners are to be congratulated upon the promptitude with which they are publishing the results of their enquiries into the various electricity schemes. For the publication of the Mersey decision last week has been quickly followed by a similar document relating to the North Wales and Chester Electricity District. The latter discloses some important differences from the former. Instead of conferring all the powers upon a Joint Electricity Authority, it is proposed in North Wales that the North Wales Power and Traction Company should have authority to supply energy in bulk to the whole district, but should only have some of the powers of a Joint Authority. That is, the North Wales Joint Authority will supervise and act as consultant in the development and co-ordination of supply by the Company and other authorised undertakers in the area, more particularly in regard to the provision of distribution to those places at present without supply. The existing right of local authorities or companies to apply for special orders to establish local distribution undertakings is preserved. On the other hand, the Joint Authority is obliged to submit schemes for electricity supply to undeveloped areas within their district within two years.

Reasons for the Commissioners' Decision.

We are not surprised to see that the technical scheme of the North Wales Power Company has been preferred to the Municipal project. This Company is already supplying power in bulk to a number of undertakers, it has a large reserve of undeveloped water power at its disposal, and its proposals covered the whole area more adequately than did those of the rival scheme. The Commissioners also think it would be impracticable to operate low-fall water-power stations on the Dee as suggested by Chester Corporation, especially as such development would necessitate a stand-by steam plant. This decision renders the erection of a coal-fired station on the Dee estuary unnecessary. The Commissioners insist thatthe agreement between the North Wales Company and the Aluminium Corporation, which owns the Dolgarrog hydro-electric works, must be such as to safeguard the power supply therefrom. The Company must obtain any further statutory powers that may be necessary to this end and it must also satisfy the Commissioners as to its ability to raise the capital required for carrying out the proposals. The result proves the Commissioners to be open minded, to be unpermeated, as has been stated in some quarters, with fixed views on either private or municipal trading and genuinely desirous of doing what is best for electricity supply in each particular district.

Patents, Designs and Trade Marks in 1920.

To the ordinary layman the Annual Report of the Comptroller-General of Patents must be dismal reading, containing as it does nothing but a summary of the activities of the Patent Office during the past year, together with statistics giving the number of applications for patents, designs and trade marks, a record of the receipts and expenditure and such like indigestible stuff. Though the Report might easily be made more attractive (and is, we think, now less attractive than it ever was) it will, as a record of the progress of human skill and invention, be perused with some interest by readers of The Electrician. It appears that there was a substantial increase in the work of the office during 1920, the number of patent applications being a record—36 672—or an increase of 3 819 over the previous year, while of complete specifications there were 21 796, an increase of 2 874. There was also a noticeable addition to the number of complete specifications filed on application, but this was mainly due to "Convention" applications made under the extension of time granted by the Peace Treaties and the Berne agreement of June 30 last. The applications for patents by women numbered 311, compared with 306 in 1919, but as usual we are not told what branch or branches of industry or inventive skill is patronised by the fair sex. Of the 196 requests for licences of right, made under Sec. 2 of the 1919 Patents Act, 176 were granted, four withdrawn and the remainder are pending. Applications for an extension of the term of 27 patents were made, and of these, four were granted, one was refused, one was allowed to stand over and three are pending.

Life of Patents and Fees.

It is curious to see that of the patents sealed in 1905 only 30 or 0·2 per cent. were kept in force by the payment of renewal fees; the number of the 1906 patents in force was 227 or 1·4 per cent., and of those of 1907 the number was 1 175 or 7·5 per cent., while of those granted in 1913 only 4 916 or 29·9 per cent. were kept in force until the end of the eighth year. This clearly proves that a very high percentage of patents are allowed to lapse before half their normal period has expired, and shows what a large number of inventions are allowed to lapse owing to the high fees demanded. We notice that the total receipts of the Patent Office for the past year were £487 542, and after meeting all expenses there was a surplus of £80 507. Though we desire to see ordinary Government departments self-supporting we think that nothing more should be demanded of the Patent Office and any balance on the year's operations should be applied in the reduction of the fees payable by patentees. This surplus is really a tax upon poor patentees, and is a clog upon progress and industrial development.

The Efficiency of Telephone Instruments.

So much attention is paid by the commercial and technical communities at the present time to what may be called the human factor in telephone operation that the important allied question of how far the electrical efficiency of the apparatus used can be improved is often lost sight of. More attention, however, might well be paid to this point, as it is obvious from Papers such as that read recently by Sir William Noble before the Institution of Electrical Engineers that finality in speech transmission has by no means yet been reached. In this matter the French authorities seem to have taken the lead, if an account of some instruments and apparatus used in testing subscribers' telephone equipment which was recently given in the "Annales des Postes, Telegraphes and Téléphones" by MM. G. Valensi and Palhols, is anything to go by. In these tests the standard testing circuit consists of a solid back transmitter, 300 O line, supervisory relay, Western repeater and 30 miles of standard cable. These secondary standards were checked every six months against primary standards, which, in their turn, had been checked in 1919 and in 1920 against the British Post Office standards. Further to standardise the measurements, the American and British standard one mile cable was used. This with a frequency of 800 has a resistance of 88 O, a capacity of 0·054 microfarads, an attenuation constant of 0·106, while the value of Z was 571 O 43 deg. The routine tests were carried out by inserting amounts of standard cable in circuit until equivalence was reached between the speech received over the standard circuit and over the transmitter being tested. We are not surprised to learn that the efficiency obtained is very variable, principally because the distance of the speaker's mouth from the mouthpiece and the pitch of the voice both vary, though it is found that the variation is not so great with the table telephone as with the hand telephone. The tests, indeed, rather point to the fact that some education of telephone users is necessary, and that the much-maligned table instrument has advantages with which it is not usually credited over the more convenient hand combination instrument.

Hydro-Electric Progress in Spain.

We are not surprised to find that like other countries which are dependent upon imported fuel Spain has made considerable progress with the development of her water power in recent years. For while in 1914 only 281 000 h.p. was generated by this means last year the figure had increased to about 620 000 h.p. Following fashion there is, of course, a Commission to deal with hydro-electric problems, and this body, since its appointment in 1918, has reported that the cost of a national, as opposed to a privately owned, scheme would be 130 000 000 pesetas, and has drawn up the main headings of a Bill which is to be presented to the Cortes. Recently, matters have been carried a step further by deputations from the Instituto de Ingenieros Civiles and the first National Congress of Engineers waiting upon King Alfonso to submit a project for a national system of electrical generation and supply. This would include transmission lines, over 4 000 miles in length for supplying energy to various parts of the country. These lines would run along the railways, which would be eventually converted to electric traction and would also serve the industrial areas and the principal towns. In addition to hydro-electric works steam-driven stations would be erected at mines whence inferior quality fuel is obtained. Under a later scheme, which is estimated to cost £8 000 000 the maximum transmission distance from any station to any consumer would be only 50 miles, while the charge would not exceed 5 centimos per unit. If either of these schemes mature there should be a great demand for electric equipment in Spain, but as in any event steady progress is being made in the erection of private plants the market is one well worthy of cultivation by British engineers and exporters.

Trade Unions and Co-partnership.

We regret the recent decision of Mr. Justice Eve in the actions brought by a member of the Amalgamated Society of Carpenters and by a member of the General Union of Operative Carpenters for injunctions to restrain their unions from excluding them from membership because they had participated in the co-partnership scheme of Messrs. Lever Brothers. The men received the union rate of wages for their trade, and they had committed no breach of the rules of the Unions. Nevertheless the latter decided that the co-partnership scheme was inconsistent with their well-being, apparently because the additional benefits accruing under it amounted to such an increase of remuneration that those receiving it would not be so ready to obey an order to strike as the ordinary members of the unions. An interesting psychological point this, and one upon which much argument might profitably be inaugurated! After reviewing the whole of the facts, the Judge came to the conclusion that he was bound by Sec. 4 (1) of the Trade Union Act of 1871, and that, therefore, he had no jurisdiction to entertain actions to enforce agreements between members of a trade union as far as these related to the conditions of employment. Though this is doubtless a legally sound judgment, it is not unlikely to discourage firms from introducing co-partnership schemes, a more important result in our opinion, than depriving workers of union membership. Neither will it tend to the growth of that industrial harmony and goodwill which are so essential at the present time

The Taxation of Electric Vehicles.

A drawback about most regulations relating to taxation and licensing is that they can be read in more than one way. If one of these ways means paying a less sum than the others the taxpayer naturally seizes on it as being the true meaning. Alternatively the tax collector prefers the rendering which gives him the most revenue. A case of this kind has arisen under the Finance Act of 1920 with regard to the taxation of electrical vehicles. It will be remembered that para. 6 of the second Schedule of this Act provides that all electrically propelled vehicles shall pay a flat rate of £6. On the other hand, para. 5 of the same schedule lays down a scale of taxation for commercial vehicles. The question has therefore arisen under which heading a commercial electrical vehicle should be taxed.

A very pretty problem! Correspondence which has passed between the Hon. Secretary of the Electric Vehicle Committee of Great Britain and the Ministry of Transport has resulted in it being ruled that so long as the electric vehicle is not used solely for commercial purposes it may be taxed under para. 6. Accordingly owners of commercial electric vehicles are advised when applying for a licence to state that they intend to use the vehicle for other than solely trade purposes. This concession in favour of electric vehicles, as we pointed out at the time, is one which will we hope lead to their more general use, as to escape by even so little from the full burden of taxation is an advantage which cannot be overlooked in these days.

Tramway Track Renewal.

Practically all tramway undertakings are now in difficulties about track repairs and renewals. During the war, particularly from 1916 to 1919, no renewal work was undertaken owing to the lack of both men and material. In consequence of this prolonged neglect extra track renewals have now to be effected at a much earlier date than would otherwise have been the case and at a cost which is roughly about three times the pre-war figure. Naturally the reserve and depreciation funds are inadequate to bear such a strain, and many local authorities have therefore been compelled to borrow money for the purpose. For instance, the London County Council has had recourse to a loan, and Belfast Corporation also wishes to raise over £1 000 000 for this purpose. We are not greatly enamoured of this method of overcoming the difficulty, for it must leave any undertaking that employs it in a still more precarious financial position than it is at present, as the interest and sinking fund on the additional capital will represent a fairly substantial sum which must be provided in addition to the ordinary current expenses. It is to be hoped, therefore, that the policy will be avoided where that course is at all possible.

The Repayment of Tramway Loans.

Without wishing to rub it in it must also be remarked that the policy pursued by municipal undertakings in the past and the latitude allowed by the Board of Trade for the repayment of loans are responsible for a good deal of the present trouble. A period of 30 years was usually permitted for repaying money raised for buildings, permanent way and road widenings. As the life of tramway track varies from about 12 to 16 years, according to the traffic, with an average life of 13 or 14 years, it is clear that these loan periods were much too long, while in some cases proper allocations to the depreciation and reserve funds were conveniently avoided whenever that seemed good for political or other reasons. We are glad, therefore, to see that the Ministry of Transport clearly recognises this, for in a recent communication to the Urban Council of Stretford they state that adequate provision should be made for repaying the capital borrowed within a definite time. This is a sound principle, whose adoption we have frequently urged in The Electrician, and we only refer to it now in order to emphasise its integrity, and to urge all tramway undertakings to create a sufficient depreciation fund to meet all ordinary repair and renewal requirements. We admit it is not easy to do this at present owing to the heavy running expenses, while increased fares have not always brought the expected relief. The situation must, however, be faced if the tramways are to be restored to a good financial position.

Maximum Charges for Electricity.

Owing to increased generation and distribution costs, many electricity supply authorities have found the maximum prices for electrical energy allowed in their provisional orders insufficient for securing financial happiness. Consequently several applications for permission to increase these maxima have been made under the Statutory Undertakings (Temporary Increase of Charges) Act. A few local authorities, however, have had recourse to Private Bill procedure, and have included clauses authorising such increases in their omnibus Bills. One of these Bills—that of St. Helens Corporation—came before the Local Legislation Committee of the House of Commons recently, when we are pleased to notice that the clause was struck out, though authority was given to make such a charge as the Ministry of Transport might allow from time to time. This decision seems to be in accordance with the general principles of the existing legislation governing the price of electricity, and it will also make for uniformity of practice in future.

Too Many Cooks.

It should also be the province of one, and only one, Government department to say when the maximum charge is to be increased or decreased. For instance, in the case of the St. Helens Bill, we had the unedifying spectacle of the representatives of the Ministry of Transport and of the Ministry of Health taking opposite sides—the former opposing and the latter supporting the proposed clause. Now, we are quite as anxious as the Ministry of Health to have good and economical municipal administration, but as the St. Helens electricity department has hitherto not been very successful we cannot see why they should intervene. If we may judge by their activities generally their inspectors must know less about electricity supply administration than the Electricity Commissioners. One of the principal reasons given for the increase was that considerable extensions of plant were necessary, and that there would be heavy payments for interest and sinking fund on unproductive capital for two or three years. But a remedy for this state of affairs could be provided by the suspension of the operation of the sinking fund for a short period, for any system of finance which would tend to check an increased demand for energy would be most unwise.

Propaganda and Truth.

Most propaganda would fail of its object were it not leavened with a little exaggeration. True propaganda must tell a good story which bears probability on its face, and if, on closer examination, the claims made are found to be true so much the better. But truth is not essential. In the special housing number of The Electrician our lively contributor "Electrocynic" made play with the arguments of a certain doctor who sought to show that the gas fire was the only hygienic method of heating, because it was the only method of heating by radiant heat. This misguided medical gentleman probably convinced a number of people who knew no better, but he must have startled not a little the majority of those who have some working knowledge of heating science. We are the more inclined to the idea that he had some success by reading in a recent issue of "The New Statesman" an article by "Lens" on "A Domestic Experiment." This article embodies the same quaint conception about electric fires, gas stoves and radiant heat as those upon which "Electrocynic" animadverted. Indeed, while the hand is undoubtedly that of "Lens," the voice is the voice of the British Commercial Gas Association, as was the voice of "Our Medical Correspondent." It may be therefore of general interest to point out that while Special Report No. 3 of the Fuel Research Board shows that the radiant efficiency of the domestic coal fire is 20 per cent., and of the gas fire 50 per cent., recent experiments in the laboratories of the Metropolitan-Vickers Company show that the radiant energy of the electric fire is over 60 per cent. If then radiancy is the criterion of the hygienic heating, Prof. LEONARD HILL and his followers must revise their opinions, and the B.C.G.A. must find some other basis for its activities. We might add that the article is the more insidious in that "Lens" would lead the casual reader to suppose he would employ electric heating if it were not so expensive, though those of us who know more about the matter are aware that electric heating, were it ever so cheap, would still be anathema to the gas interests. Fortunately "Lens" has not taken sufficient care to hide the cloven hoof for at the end of his article he says: "The case for cheap, good and universal gas heating cannot be beaten." This gives the whole show away.

A Municipal Mutual Supply Scheme.

IN these days when municipal activities of all kinds are looked upon askance, we can hardly congratulate the Metropolitan Boroughs Standing Joint Committee on their latest venture; though we do not doubt it has been put forward with the best intentions. Owing to the high price of materials and stores generally the Committee are enlisting the support of the London Borough Councils towards obtaining parliamentary sanction for the establishment of mutual supply depots, and for carrying on various trades. The excuse for this grandiose proposal is that associations of manufacturers and importers make excessive profits by combining to maintain high charges. This is all very well, but, if true, the best way to combat it is not for a municipality to start business on its own account as iron and brass founders, metal workers, boilermakers, and manufacturers of plant, machinery, tool implements, on capital raised on the security of the rates. Of course, the scheme is advanced as a means of relieving the rates from the burden imposed by the present trading methods, but if past history is any guide, relief of the rates is the last thing it would achieve. We sincerely hope that now this brain wave has been generated, its oscillations will be allowed to die away into space. Nevertheless, there is something to be said for the idea of the various Committees of one local authority co-operating in buying. Most of them are extensive purchasers of engineering stores and supplies, and by buying in large quantities and distributing them as required, economy might be effected. Such a proposal would have our support.

The International Students' Union.

THE interchange of thought between men of science in different parts of the world has long been recognised as a necessity to substantial advances in knowledge. In the case of students embarking on their career, it is particularly desirable. Old minds work in more or less fixed grooves. Youth, however, is open to receive impressions, and early intercourse with those in a similar position in other countries is not merely an educational benefit but a guarantee of mutual understanding and tolerance contributing to the peace of the world. We are, therefore, interested to notice that the attempt to form an international students' union prior to the war has been resumed. France, Belgium and Czecho-Slovakia have taken a prominent part in the movement, and an important conference has just been held at Prague—the seat of one of the oldest universities in Europe. It is hoped through this confederation to assist students in various ways, for example, by the exchange of students and professors in different countries, the organisation of visits and international sports and the exchange of books and magazines. Most of the chief countries of Europe appear to have given their support, and all nations included in the League of Nations are eligible. We hope that this country will play a leading part in the movement, which is eminently a desirable one.

Training of Foreign Engineering Students.

FINLAND is one of those countries which must develop its water power in order to provide the necessary energy for power and traction purposes. To assist in this laudable end arrangements have therefore been made by the Government authorities to send ten engineering students from the Helsingfors Technical High School to Germany for a year so that the latest practice may be studied. A sum of 100 000 marks is to be provided in the Finnish Budget for defraying the initial expenses, and among the works to which the students will be attached are those of Messrs. Siemens & Halske, and Voight & Haeffner. This is, we think, a much more important matter than would superficially appear. For these young Finnish engineers will certainly return to their native country with a strong bias in favour of German machinery and German methods, and this bias is of the sort that may well influence orders later on. There is, however, another reason why this policy should be noted. During our own theoretical period of reconstruction we were given to understand that a certain number of Chinese and Indian students would be admitted to British workshops. But good though the idea was, it now seems to have been forgotten. It should, however, certainly be resuscitated and, in view of the importance of developing British trade, the Government should be pressed to inaugurate some suitable scheme for the admission of foreign students of our universities and technical colleges. There are more ways of getting contracts than going round with an order book, and this is one of them.

West Lancashire Joint Electricity Authority.

THE formation in the Mersey and West Lancashire Electricity District of the first Joint Electricity Authority, which was briefly referred to in our last issue, may be said to inaugurate the second and most important stage in the re-organisation of the electricity supply of the country. For though the preliminary work of defining the various districts requires careful examination of existing sources of supply and good knowledge of local industrial conditions, it is when the Joint Authority has been formed and attempts are being made to co-ordinate the work of the authorised electricity undertakers in the district that the real difficulties will arise. And difficulties there are undoubtedly, though that is no reason why so much energy and ingenuity should have been expended in magnifying them and in the, to some people, congenial task of putting obstacles in the way of those whose business it is to carry out the policy of the Electricity Supply Act of 1919.

OPPOSITION TO JOINT AUTHORITIES.

This opposition is naturally making the most of the civic pride and the natural jealousy which exists among certain local authorities, particularly as to which of them shall have the honour of leading the reform movement in each district. Attempts are also being made to set the supply companies and the municipal undertakers in opposition to one another, while others raise the bogey of large increases in rates, which are, in their opinion, likely to follow the heavy capital expenditure required for new capital stations and transmission lines. As we have already shown these risks are much exaggerated, so much so that theoretically a Joint Electricity Authority, if properly organised and endowed with adequate powers, should be able to administer its undertaking at least as economically as the best and most up-to-date of the existing company or municipal undertakings. In practice it will, we think, be able to do much better, with the result that many of the smaller supply authorities will soon be in a position to show a considerable economy in working as a direct result of their obtaining a cheap supply from the new Authority.

Time Required for Development.

Of course, it will be a few years before the economical and other advantages to be derived from a cheap supply of electricity have their full effect. For one thing, present methods of generation and supply are so complicated that it will take time to introduce standard practice. Moreover, every true and lasting reform in any sphere of activity is a thing of slow growth in its early stages and the Electricity Commissioners clearly recognise this in their decision on the schemes submitted for the Mersey and West Lancashire District. At the local inquiry divergent views from many municipalities were expressed, and a strong plea was put forward on behalf of some of the local authorities for "compartment" development. Though the Commissioners think that a Joint Authority should be formed for the whole of the district, now modified as the result of the inquiry, a temporary concession is made to the advocates of parochialism by the creation of a separate committee for the Wirral peninsula, subject to eventual *liaison* with the Joint Authority. In addition, the fullest use is to be made of the generating plant of the Mersey Power Company, which has a modern and well-equipped undertaking, and its area of supply will probably be extended. This clearly shows that it is intended to make the most of existing resources and proves the prudence and wisdom of the Commissioners, who recognise, as clearly as anyone, that some years must elapse before any Joint Authority can adequately meet the needs of the whole of its area. But in the meantime it must not be forgotten that the most distant parts of the district are given power to deal with their own immediate requirements. Both the Wirral Committee and the Mersey Power Company are to have one representative each on the Joint Authority, which is ultimately destined to absorb both.

A New Capital Station.

As we have already stated, the Joint Electricity Authority is empowered to erect a new capital generating station on a suitable site near Liverpool, as well as a transmission system connecting this station with Liverpool, Bootle, Prescot and St. Helens. The demand for electrical energy in these districts is very considerable, and, as extensions of plant are urgently required at all the existing stations, it is probable that money will actually be saved by concentrating expenditure on the capital station and transmission lines, rather than on the extension of several isolated stations.

Outlines of the Draft Order.

Only the bare outlines of the Draft Order are given in the notice issued by the Commissioners, but sufficient is said to show that the new Joint Electricity Authority will have to be self-supporting, for any deficiency on the revenue account which may arise from the supply of electricity is to be met by a readjustment of the charges or otherwise and is also to be met only by those undertakings which are connected with the Joint Authority's transmission system. No objection can be made to this provision, for it is only equitable that those undertakings likely to benefit from the expenditure incurred by the Joint Authority should bear the risk of any loss that may arise. We are the more convinced of this in that we do not see how there can be any risk of serious loss. On the contrary, there should be a considerable benefit to all concerned, but the provision is, doubtless, a concession to those who have raised the cry that the new Authorities will involve a charge upon the rates, and as a sop is not unsatisfactory.

Miscellaneous Powers and Duties.

It is proposed to confer the necessary financial powers upon the Joint Authority, but obviously this cannot be done until the Electricity Supply Bill becomes law. Consequently we hope that the Government will be able to give sufficient time to the consideration of this measure during the current session. The Bill has received a somewhat hostile reception in certain quarters, notwithstanding the voluntary character of its powers, but unless it, or a modified measure, is passed, the Act of 1919 will remain a dead letter and the good work of the Electricity Commissioners will be wasted. We cannot think that anybody really interested in electricity supply desires this.

Areas Without Supply.

We notice that both the Joint Authority and the Wirral Committee will be required to submit, within a period of two years from the date of their formation, proposals for giving a supply of electricity in areas so far unauthorised, where there is a reasonable prospect of such supply being remunerative. This is a very proper obligation to impose and it is somewhat similar to the condition laid down in the old provisional orders. It should assist in the extension of electricity supply into the smaller urban and rural areas and should thus prove of great assistance in developing agricultural and rural industries. Whether supply is to be given in these areas by the Joint Authority itself, or only a bulk supply is to be provided, leaving the local authorities to act as distributors, is not clear, but for the moment this point is not very material.

Temporary Expedients.

Though the Commissioners have decided upon the principle of the formation of a Joint Electricity Authority, it will be some time before such an Authority can come into being, and in the meantime two small provisional committees are to be formed in order to deal with questions relating to the development of electricity in the main district and in the Wirral respectively. The various parties are to be consulted about the terms of the Draft Order and then the Commissioners will hold a further local inquiry into its provisions in accordance with the terms of Sec. 5 (4) of the Electricity (Supply) Act.

Complicated Procedure.

When the Commissioners have finally decided upon the form of the Order it must then be submitted to the Ministry of Transport, who may confirm it either with or without modification. When the Order is confirmed by the Ministry it must then be laid before each House of Parliament, and it does not come into operation until it has been approved, either with or without modification, by a resolution passed by each House. It will thus be seen that a long and somewhat involved procedure must be gone through before an Order constituting a Joint Electricity Authority can come into force, and that the Ministry of Transport and each House of Parliament may either reject it or introduce modifications. The worst of it is that such procedure gives a chance to those forces of reaction to which we have referred to do their best to check progress.

An Electric Battery Vehicle Meter.

By GEO. J. DUCKETT.

With reference to the interest about the electric battery vehicle and its applications, I have noticed lately considerable debate is taking place regarding the suitability of the ampere-hour meter used on these vehicles for registering the amount of current taken in charging and discharging the vehicle battery.

The One Suitable Type of Meter.

I have come to the conclusion that there is only one type of meter that will stand up at all to the requirements of the electric road vehicle. That is the mercury motor meter designed to withstand the maximum rate of charge, in which the main current is carried by a shunt, and only a small percentage is allowed to pass through the mercury bath. It will be readily understood how important it is to see that the meter is of ample capacity to carry the load, which is of a very varying character. For instance, in the Edison A 8 type nickel alkaline battery, with a capacity 300 Ah, and a normal charge and discharge rate of 60 A, it is not sufficient to assume that the normal rates of charge and discharge will be the average rates, as these cells are capable of withstanding a very high boosting current in a given time. A 300 A 8 cell can, in fact, be boosted at :—

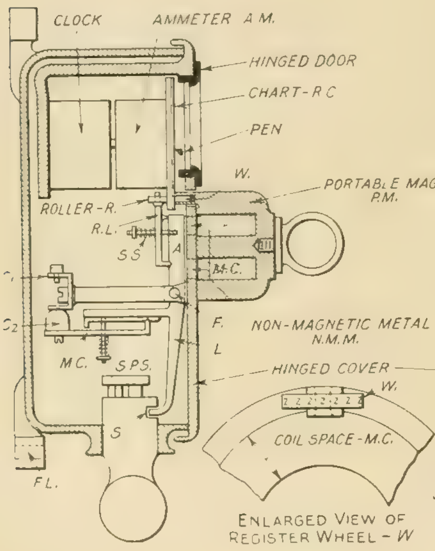

Fig. 1. Fig. 2.

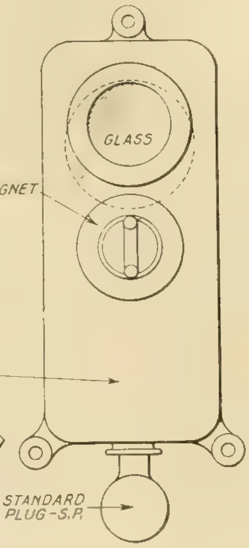

Fig. 3.

Twice the normal rate for 1 hour.
Three times normal rate for ½ hour.
Four times normal rate for ¼ hour.
Five times normal rate for 1/12 hour.

An A 8 cell may therefore receive 60×5=300 A for five minutes, a sufficiently long period to upset a meter rated at the normal battery charging rate of 60 A.

Meters for Platform Trucks.

Manufacturers very often insert a clause when guaranteeing their batteries' suitability for use on warehouse or platform trucks, that the user must fix recording meters on the vehicles. Now, although I have stated that the mercury motor meter will stand up to the vicissitudes of the road vehicle, yet I think I can say without fear of contradiction that there is not a meter (English or American) on the market of suitable construction for fitting on platform trucks.

In view of the foregoing remarks it must follow that I have some alternative method in mind of recording the current put into the battery of these vehicles. This takes the form of a recording ammeter interlocked in such a manner as to be as near fool-proof as possible.

The instrument for realising this result is best explained by reference to Fig. 1, which shows a sectional view of the inside of the tell-tale meter. Fig. 3 is a front view showing the location of the charging plug and operating magnet; Fig. 4 shows the actual working result obtained with the apparatus; and Fig. 5 illustrates the simple nature of the wiring of the indicator.

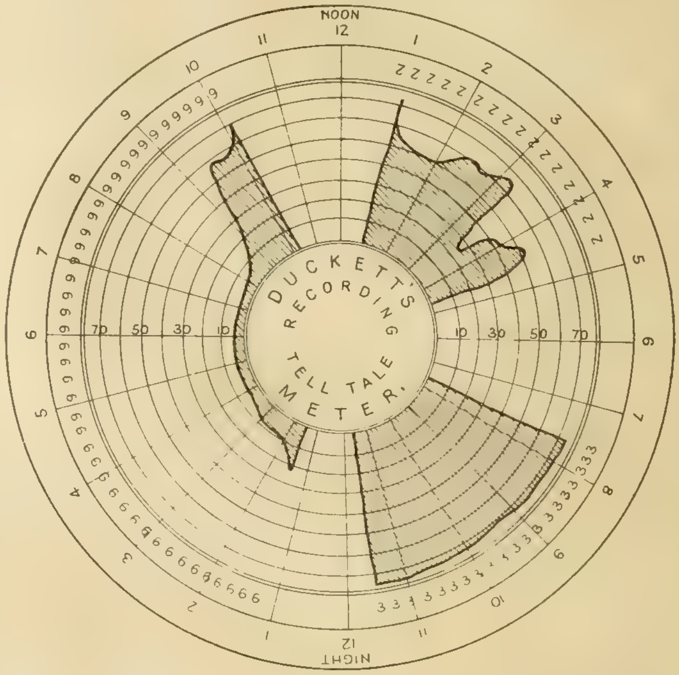

Fig. 4.

The Device Described.

If the driver wishes to charge the battery of his truck he plugs the main standard plug *SP* into the socket of the recorder, and in order to complete the electrical circuit, a small electrical magnet *PM*, which is attached to the main flexible cable, is placed in the position shown in Figs. 1 and 3.

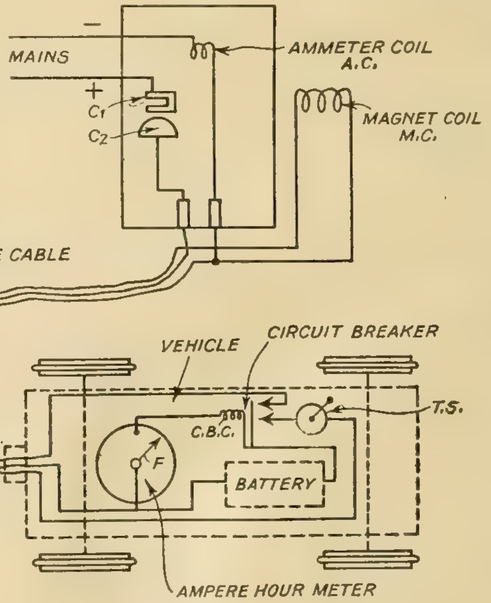

Fig. 5

The magnetic lines of force of the magnet *PM* pass through the lid of the recorder to the armature *A*, which, of course, in turn is attracted to the lid, resulting in closing the main contacts C_1 and C_2. At the same time, the arm *L* is moved forward into slot *S* and cuts in the plug *SP*, thus preventing it from being withdrawn from the socket when the battery is under charge. Attached to the armature *A* there is an arm *RL* carrying a roller *R*. This roller is in turn pressed against the inner side of the disc carrying the chart by virtue of the compression of the spring *SS*. The disc, which has a slight lateral movement, as well as a rotary one, presses the face of the recorder chart against the wheel *W* (which has figures embossed on its edge), and as there is a piece of carbon paper between the disc and the chart, the pressure exerted by the edge of the wheel *W* reproduces the figure on the chart. As the pressure of the embossed wheel on the face of the chart depends directly upon the flow of the current to the battery, or, in other words, on the completion of the circuit through the contacts C_1 and C_2, the figure imprinted upon the chart indicates the exact time at which the current was switched on.

As the contacts C_1 and C_2 have been closed, the battery of the vehicle should now receive a charge, the amount of which will be registered by the movement of the recorder pen. This is clearly seen in Fig. 1, the result of such record being given in Fig. 4.

MAKING OR BREAKING CIRCUIT.

It sometimes happens in the ordinary system of charging that the charging plug is pushed in or withdrawn from the socket with the current on; and although the voltage is not very high, it is possible thus seriously to damage the contacts. In the arrangement I am describing, it is impossible to either make or break the circuit with the current on.

For instance, if the contacts C_1 and C_2 are closed before the plug *SP* has been pushed into the socket, the arm *L* has been moved forward so that it is impossible to push the plug into the socket. Likewise the plug cannot be withdrawn, as the arm *L* locks the plug in position during the time the battery is under charge.

WIRING THE VEHICLE.

Fig. 5 shows the method of wiring the vehicle and the recorder. The main current flows first of all to the upper contact C_1 and C_2, and thence to the truck battery, after which it passes through the circuit breaker *CB* through the recording ammeter coil to the negative main.

The ampere-hour meter is usually fitted with two contacts for tripping the circuit breaker when the vehicle battery has received a full charge, but in this case the portable magnet coil *MC* is also de-energised, and the current is cut off, owing to the armature *A* (Fig. 1) falling into the off position. Thus all current is cut off from the battery and the recording apparatus.

This arrangement affords an absolute check upon the attendant, and the driver's time is not encroached upon at all, whilst on referring to the indicator chart he is able to see at a glance the exact condition of his battery, and consequently the driver is enabled to concentrate his mind on his legitimate work. Moreover, he is freed from an irritating and distracting sense of responsibility, as the operation is entirely automatic and eliminates all dangerous looking electrical apparatus, of which the average man is more or less afraid.

The Theory of the Three-Phase Variable Speed Shunt Commutator Motor.

By J. L. D. RIDSDALE, M.Sc.

(*Continued from page* 481.)

EFFECT OF BRUSH DISPLACEMENT.

Up to the present, it has been assumed that the brushes are in the neutral position, *i.e.*, so placed that the axes of the stator and rotor coils for each phase are coincident. It will be of interest to consider briefly the effect of displacing the brushes. It will be quite sufficient for the present purpose, and will considerably simplify the investigation if the stator impedance is neglected. Further it will be assumed that the compensating E.M.F. E_c impressed on the rotor brushes is zero. In Fig. 15 is drawn a vector diagram for the motor when the brushes are displaced through an angle θ, the displacement being in the same direction as that in which the field revolves. As has already been shown, the effect of such a displacement is to cause the E.M.F.s generated and induced in the rotor to lag by θ degrees behind the E.M.F.s which would be generated and induced in the rotor, if there were no brush displacement. Thus the rotor induced E.M.F. and rotation E.M.F. are represented by *OC* and *OD* in the diagram inclined at an angle θ to the vectors *OH* and *OB*. The E.M.F. impressed on the rotor brushes is represented by *OJ* in the diagram, and can be resolved into two components, $OJ' = R_tE \cos\theta$, and $OQ' = R_tE \sin\theta$; it will be seen that the component $R_tE \sin\theta$ functions as a compensating E.M.F.

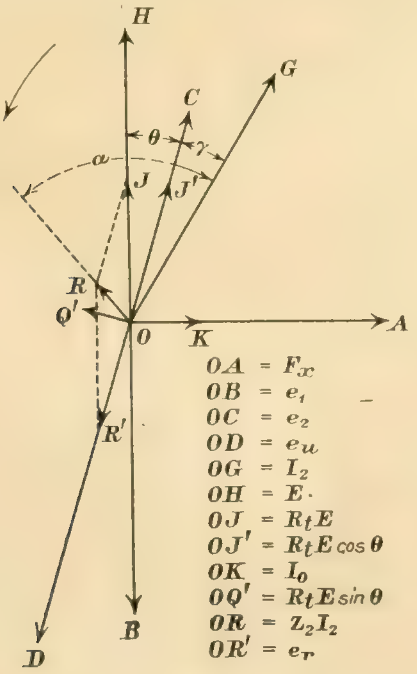

FIG. 15.

The following vector equations are obtained from the diagram :—

$$E = Z_0I_0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

$$R_tE + e_r = Z_2I_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

Remembering that $e_r = e_2S$

$$I_2 = \frac{R_tE + e_2S}{Z_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

But $e_2 = R_mE\ e^{-j\theta}$,

hence $I_2 = e_2\,\dfrac{Re^{j\theta} + S}{Z_2}$.

Inserting $e^{j\theta} = \cos\theta + j\sin\theta$ and $Z_2 = r_2 + jx_2$, rationalising and separating real and imaginary parts,

$$I_2 = \frac{e_2}{r_2(1 + \tan^2\alpha)}\left[\left(R\,\frac{\cos\overline{\theta - \alpha}}{\cos\alpha} + S\right) - j\left(R\,\frac{\sin\overline{\alpha - \theta}}{\cos\alpha} + S\tan\alpha\right)\right] \quad . \quad . \quad . \quad (21)$$

Torque Speed and Rotor Current.

Since the flux, $F_{y'}$, rotation in which generates the E.M.F., e_u, is in phase with the rotor induced E.M.F., e_2, equation (21) gives the rotor current as the resultant of two component currents, the one in phase with, and the other in quadrature with the flux $F_{y'}$. Remembering that the algebraical value of e_2 is R_mE, the torque per phase in kg. metres is

$$T_q=\frac{R_m{}^2E^2}{61{\cdot}6u_1r_2(1+\tan^2\alpha)}\left[R\frac{\cos\overline{\theta-\alpha}}{\cos\alpha}+S\right]. \quad . \quad (22)$$

Thus the starting torque is

$$\frac{R_m{}^2E^2}{61{\cdot}6u_1r_2(1+\tan^2\alpha)\cos\alpha}[R\cos\overline{\theta-\alpha}+\cos\alpha]. \quad . \quad . \quad (23)$$

Thus if R has a value less than $\cos\alpha$, the starting torque never vanishes, and assumes a positive value for all values of θ. If $R=\cos\alpha$, the starting torque vanishes when $\theta=180+\alpha$. If R is numerically greater than $\cos\alpha$, the starting torque vanishes when

$$\theta=\alpha\pm\cos^{-1}\left[-\frac{\cos\alpha}{R}\right]. \quad . \quad . \quad . \quad . \quad . \quad (24)$$

When θ has any value lying between the two limiting values given by equation (24), the starting torque will be negative; for any other value of θ the starting torque is positive.

Equation (22) gives the no-load slip

$$S_0=-R\sec\alpha\cos\overline{\theta-\alpha} \quad . \quad . \quad . \quad . \quad (25)$$

and the no-load speed is thus

$$u_0=u_1(1+R\sec\alpha\cos\overline{\theta-\alpha}). \quad . \quad . \quad (26)$$

It is thus clear that in theory within certain limits depending on the value adopted for R, the no-load speed can be varied by varying the value of θ, *i.e.*, by displacement of the brushes.

Returning to equation (21), converting to real form and substituting $I_s=\frac{R_mE}{2\sqrt{r_2{}^2+x_2{}^2}}$ gives

$$\frac{I_2}{I_s}=2\sqrt{(R^2+2RS\cos\theta+S^2)}. \quad . \quad . \quad . \quad . \quad (27)$$

For a given value of θ, I_2/I_s is a minimum when $S=-R\cos\theta$, Inserting this value of S in equation (27) gives $2R\sin\theta$ as the minimum value of $\frac{I_2}{I_s}$.

Thus if the rotor current is to be kept within reasonable limits, either one or both of the factors, R and θ, must be small.

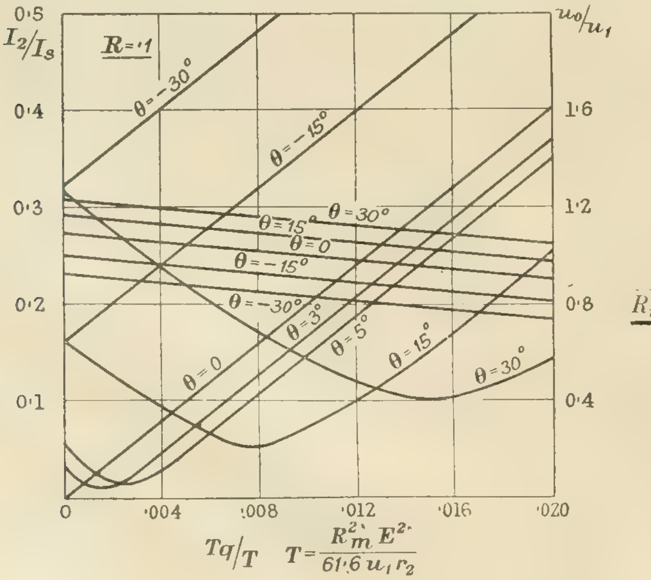

Fig. 16.

It will be seen on reference to equation (26), however, that if R is small, or if the angle θ is small, only a very limited variation in the speed can be obtained.

In Fig. 16 are drawn for various values of θ curves showing the rotor current and speed plotted as a function of the torque. The value of R is taken as 0·1. As before, it is assumed that $\tan\alpha=3$, and that $\frac{x_2/R_m{}^2}{x_0}=0{\cdot}02$. It will be seen that the curves are of the same general character as those of Fig. 8.

Current and Power Factor.

Expressions for the total current taken by the motor and for the power factor are easily obtained.

The stator current is given by

$$I_1=I_0+R_mI_2e^{j\theta}.$$

Substituting for I_0 from equation 18 and for I_2 from equation (20),

$$I_1=\frac{E}{Z_0}+R_m\left(\frac{R_tE+e_2S}{Z_2}\right)e^{j\theta}$$
$$=\frac{E}{Z_0}+R_m{}^2E\left(\frac{Re^{j\theta}+S}{Z_2}\right).$$

On substituting for $e^{j\theta}$, Z_2 and Z_0, this reduces to

$$I_1=\frac{R_m{}^2E}{r_2(1+\tan^2\alpha)}\left[\left(R\frac{\cos\overline{\theta-\alpha}}{\cos\alpha}+S\right)-j\left(R\frac{\sin\overline{\alpha-\theta}}{\cos\alpha}+S\tan\alpha\right.\right.$$
$$\left.\left.+\frac{r_2}{R_m{}^2x_0}\cdot\overline{1+\tan^2\alpha}\right)\right].$$

The current supplied through the rotor brushes is

$$R_tI_2=R_t\,.\,\frac{R_tE+e_2S}{Z_2}$$
$$=R_m{}^2E\,.\,R\,.\,\frac{R+Se^{-j\theta}}{Z_2}.$$

Substituting for $e^{-j\theta}$ and Z_2

$$R_tI_2=\frac{R_m{}^2E}{r_2(1+\tan^2\alpha)}\,.\,R\,.\left[\left(R+S\frac{\cos\overline{\theta+\alpha}}{\cos\alpha}\right)-j\left(R\tan\alpha\right.\right.$$
$$\left.\left.+S\frac{\sin\overline{\theta+\alpha}}{\cos\alpha}\right)\right].$$

Thus the total current taken by the motor is

$$I=I_0+R_mI_2e^{j\theta}+R_tI_2,$$

$$\text{or}\quad I=\frac{R_m{}^2E}{r_2(1+\tan^2\alpha)}\left[\left\{R\left(R+\frac{\cos\overline{\theta-\alpha}}{\cos\alpha}\right)+S\left(1+R\frac{\cos\overline{\theta-\alpha}}{\cos\alpha}\right)\right\}\right.$$
$$-j\left\{\frac{r_2}{R_m{}^2x_0}(1+\tan^2\alpha)+R\left(R\tan\alpha+\frac{\sin\overline{\alpha-\theta}}{\cos\alpha}\right)\right.$$
$$\left.\left.+S\left(R\frac{\sin\overline{\theta+\alpha}}{\cos\alpha}+\tan\alpha\right)\right\}\right],$$

and the phase angle between the supply E.M.F. E and the current I is given by

$$\tan\lambda=$$
$$\frac{\frac{r_2}{R_m{}^2x_0}(1+\tan^2\alpha)+R\left(R\tan\alpha+\frac{\sin\overline{\alpha-\theta}}{\cos\alpha}\right)+S\left(R\frac{\sin\overline{\theta+\alpha}}{\cos\alpha}+\tan\alpha\right)}{R\left(R+\frac{\cos\overline{\theta-\alpha}}{\cos\alpha}\right)+S\left(1+R\frac{\cos\overline{\theta+\alpha}}{\cos\alpha}\right)} \quad . \quad . \quad . \quad (28)$$

Variation of Power Factor with Torque.

In Fig. 17 are drawn curves showing how the power factor varies with the torque for different values of the brush displacement, the value of R in all cases being taken as 0·1. It will be observed that the curves of Fig. 17 closely resemble those of Fig. 13. For negative values of θ when the machine operates as a motor the power factor is always low. For positive values of θ, except when θ approaches zero or 180 deg. the power factor reaches unity for a value of the torque which, for a constant value of R, depends on the brush displacement.

It is possible, however, by properly adjusting the brush displacement to maintain the power factor at unity for all values of the torque.

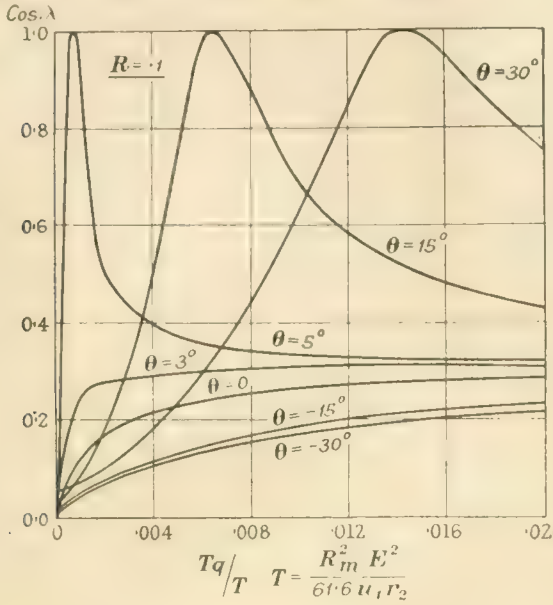

Fig. 17.

From equation (28) it is seen that the slip at unity power factor is given by

$$s = \frac{R\left(R\tan\alpha + \frac{\sin(\alpha-\theta)}{\cos\alpha}\right) + r_2/R_m^2 r_0\,(1+\tan^2\alpha)}{R\frac{\sin(\theta-\alpha)}{\cos\alpha} - \tan\alpha} \quad . \quad (29)$$

Inserting this value of the slip in equations (22) and (27), the torque per phase in kg. metres at unity power factor is

$$T_s = \frac{R_m^2 E}{61{\cdot}6\,u_1 r_2} \cdot \frac{R\sin\theta(1-R\cos\theta) - r_2/R_m^2 r_0}{R\sin\theta - \tan\alpha(1+R\cos\theta)} \quad . \quad . \quad . \quad (30)$$

and the rotor current at unity power factor is

$$\frac{I_2}{I_s} = \frac{2\sqrt{R\sin^2\theta(1+2R\cos\theta+R^2) + r_2^2/R_m^4 r_0^2(1+\tan^2\alpha) - 2R\sin\theta\,\frac{r_2}{R_m^2 r_0}(R\sin\theta\tan\alpha - 1 + R\cos\theta)}}{\cos\alpha[R\sin\theta - \tan\alpha(1+R\cos\theta)]} \quad . \quad . \quad . \quad (31)$$

By means of equations (29), (30) and (31) the curves in Fig. 18 have been drawn, which show how the speed, rotor current and brush displacement vary when the latter is so adjusted as to maintain unity power factor for all values of the torque. The curves have been drawn for values of R equal to 0·5, 0·1 and −0·5. The negative value of R corresponds to a tapping below the star point (Fig. 5), in which case the brush displacement must be in the opposite direction to that shown in Fig. 15, in order that the power factor may reach unity. It will be seen that the curves in Fig. 18 resemble those in Fig. 14.

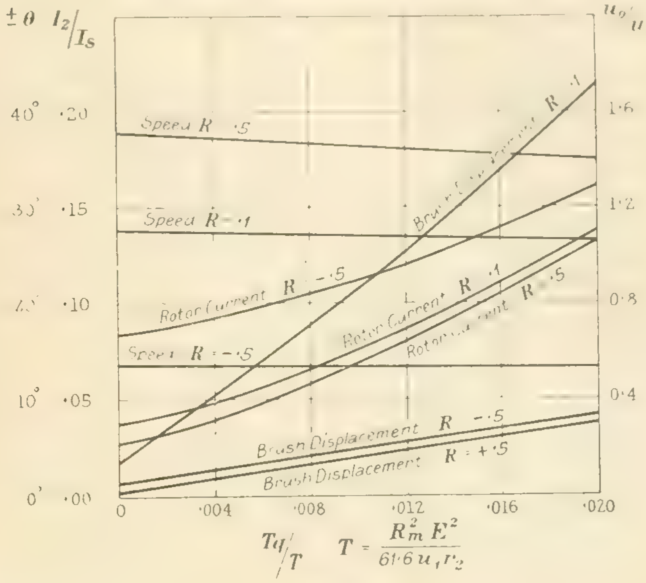

Fig. 18.

(To be concluded.)

X-Rays and their Industrial Applications.*

In introducing his lectures, Major Kaye dwelt upon the analogy between X-rays and light rays. It was only when Laue substituted in 1912 the diffraction grating, which Nature provides in crystals, for the ruled grating that we were able to analyse X-ray beams like light beams, and since we possessed nothing intermediate between these two types of gratings, there remained an unexplored gap of four octaves between the ultra-violet—which Schumann, Lyman and Millikan (characteristic lines of carbon) had so much extended [from λ = 3 600 down to λ = 200 A.U. (1 Angstrom unit = 10^{-8} cm.)]—and the X-rays (12 to 0·17 A.U.) and γ-rays (1·4 to 0·01 A.U.). Röntgen rays and electrons were intimately interrelated, the one being the manifestation of the other. When the speed of an electron was suddenly altered, an electromagnetic wave was produced; a great alteration gave a hard wave of high frequency, a small alteration a soft wave; much slower electrons produced light. Conversely, rays striking a substance transferred their energy to the moving electrons; when the whole of the energy was transferred, the wave frequency reached its upper limit. X-rays probably played a part in atmospheric electricity and thunderstorms. The potential gradient, 150 V per m. near the surface, decreased to 2 V per m. at 9 km. altitude; thus the conductivity of the air increased rapidly in the higher atmosphere, and that fact pointed to an external source of atmospheric electricity, to be found in high-speed electrons ejected by the sun and permeating the air through the intermediation of their more penetrating alias, the X-rays; those electrons replenished the downward currents of the dissipated negative charge of the earth.

Types of X-Ray Bulbs.

The X-ray bulb might be called an X-ray lamp, in which potential applied corresponded to lamp temperature. Essentially still like Röntgen's bulb of December, 1895, it had developed into complicated devices, as Major Kaye's rich collection of recent bulbs showed. We distinguished two types of bulbs, the gas tube, not highly evacuated, and the hot-kathode Coolidge tube, evacuated to the utmost possibility. In the gas tube the residual gas, containing a few ions to start with, supplied electrons through shock ionisation; the current increased steadily with the volts applied. In the hot-kathode tube the number of electrons depended upon the temperature of the kathode filament, and we could alter volts and amperes independently; the saturation current utilised was less affected by changes in the wave-form of the exciting potential than it was in the gas tube; the latter, however, utilised very high potentials more effectively, and might, at low gas pressures, yield twice the X-ray output of the Coolidge tube, for the same volts and milliamperes. As regards control and reliability, the Coolidge tube was certainly superior, though much depended upon experience. In the gas tube the ions were driven to the electrodes. The positive ions hitting the kathode released electrons which, by colliding with the molecules of the residual gas, generated more ions and electrons; the electrons striking the target generated X-rays, and the cycle continued as long as potential was supplied. The positive ions were also responsible for the puzzling fluctuation in the pressure of the gas which tended to disappear, especially at high potentials. The gas was actually driven into the glass walls and entrapped there, particularly in the presence of volatilised metal; the walls thus became positively charged. The pitting of the kathode, the puncturing of the bulb and the spasmodic displacement of the focal spot, very undesirable for good definition of radiographs, were inconsistent effects. In the "boiling tube" of Müller (Fig. 1), one of German gas bulbs developed during the war for deep therapy, the gas pressure was low. To prevent gas emission from the anti-kathode of platinum this hollow electrode was kept at constant temperature by boiling water; the water was charged into a spherical bulb added to the apparatus, and an inverted glass flask with long neck was placed in the kathode and in this bulb, lest the water boil away. The tube was operated at 200 000 V. When the discharge would no longer pass, because the vacuum was too high, a spark passed from the glass to the regulator outside the bulb, a small jet was ignited and a puff of gas was introduced into the tube by an osmosis tube heated by the flame. The rays produced were said to be more homogeneous than the Coolidge-tube rays.

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* Abstract of three Cantor Lectures, delivered before the Royal Society of Arts on March 7, 14, 21, by Major G. W. C. Kaye, O.B.E., M.A., D.Sc.

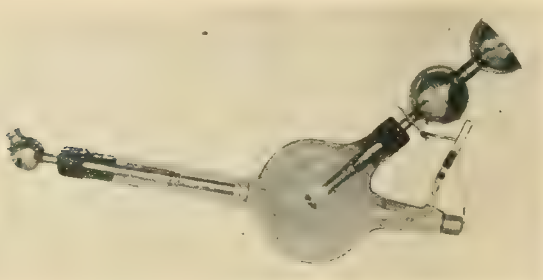

Fig. 1.—Müller Boiling Tube.

The Coolidge Tube.

In the Coolidge tube, introduced in 1913, the vacuum was very high, the tube and metal being preheated to facilitate exhaustion, and the electrons were furnished by a hot spiral of tungsten, mounted within a focussing bowl or tube of molybdenum; shock ignition was negligible. The space between the electrodes was filled with carriers of one sign, and at high current density an appreciable obstruction arose owing to the electrostatic repulsion between the electrons crossing over and those following. This "space-charge" set an upper limit to the current at high filament temperature; to lessen the space-charge the potential was raised, or a trace of gas introduced. In the small radiator-type the heavy, massive target was kept cool by being fitted with fins; this type acted as its own rectifier and could be worked directly from the transformer. Small radiator tubes were made with lead-glass walls, ¼ in. thick, and a window of dark glass for the emergency rays. The General Electric Company turned out 100 tubes per day, taking up to 20 kW, the bulbs being blown in moulds; for all-round qualities British tubes could not yet compete with the Coolidge tube.

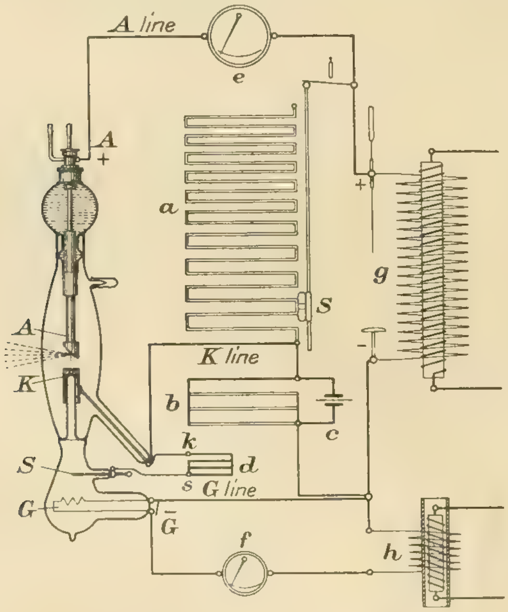

Fig. 2.—J. E. Lilienfeld Tube.

The Lilienfeld bulb (Fig. 2), also of 1913, had likewise undergone extensive modification since, and might be said to act as a combination of a hot kathode tube and a gas tube, claiming the advantages of both. A special hot kathode *G* in an annexe to the main tube (Fig. 2) was separately excited by a moderate potential *h*; the electrons emitted passed through the hollow kathode proper *K*, which was kept cold, and were subjected to a very high potential before striking the anti-kathode *A*; the employment of the cold kathode admitted of using high momentary current densities. Special resistances *b* and *d* were inserted between *G* and *K* and between the wire *S* and *K*, the object being to ensure that *K* was only active in the movement of the maximum potential of the induction coil *g*; the main resistance was *a*, and the ray hardness was regulated by means of a slide.

The Need for a Unit.

The need of a unit of "candle-power for X-rays" was becoming pressing with the development of massive doses of high penetrating power in metallography and in deep therapy. When we worked a Coolidge bulb with tungsten target at constant potential (40 000 V) and current (0·45 mA) and analysed the output by the Bragg spectrometer (with the aid of a crystal and an ionisation chamber), we obtained a spectral curve like the lower curve of Fig. 3, the ordinate at any point representing the amount of the X-radiation of tungsten of that wave-length. The area of the curve was a measure of the total output of radiations of all wave-lengths. The rays were of a great variety and certainly not homogeneous; but the point of minimum wave-length λ_0 (near 0·3) could be fixed with great precision. As long as we kept the volts *V* constant, that point remained stationary; if we increased the volts, it shifted to the left (*see* Fig. 4). By Planck's relation $Ve=h\nu=hc/\lambda_0$, where *e* was the electronic charge, *h* Planck's constant, ν the frequency, and *c* the velocity of light. The maximum ordinate (near $\lambda=0{\cdot}35$ in the diagram) was less precise, but the product $\lambda_{\max}.\,V$ was also constant probably. To arrive at an X-ray candle we had to alter the various factors, one at a time. If we first raised the current (the lower and upper curves of Fig. 3) from 0·45 to 1·15 mA, the output area increased. If we varied the potential, keeping the current constant, we obtained a series of curves (Fig. 5), the areas of which increased with the square of the volts, at any rate up to 70 kV; the λ_0 shifted to the left as mentioned as well as the $\lambda_{\max}$. The curves were all different. As the volts rose above 60 kV, the wavelets of the characteristic X-ray lines of tungsten developed and finally dominated the spectrum. Including these characteristic radiations the increase in area grew with the cube of the volts; if we under-run the bulb and deducted the characteristic radiation, the square rule held. With other target metals, *Ni*, *Mo*, *W*, *Pt*, we obtained curves, all starting with the same λ_0, but the ordinates increasing irregularly. Excluding the characteristic radiations the total output seemed proportional to the atomic number of the elements, being given by $kNiV^2$, where the constant *k* changed with the square of potential and the type of bulb. Measurements of the *k* proved that the efficiency of X-ray bulbs was still deplorably small, about 1 per mille.

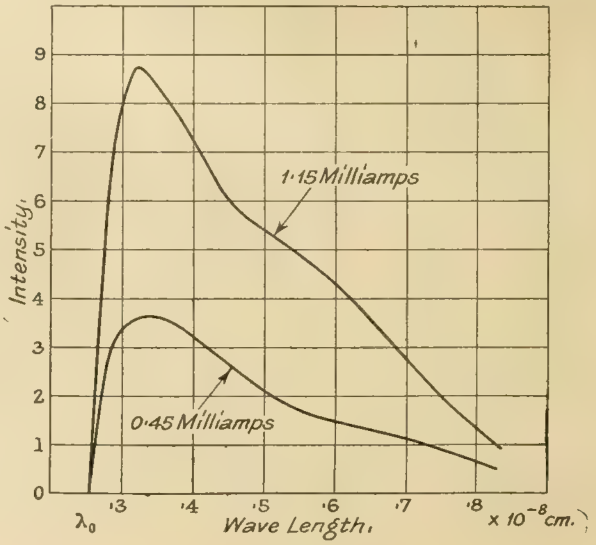

Fig. 3.

The Generation of Current.

Passing in the second lecture to the generation of currents of 200 000 V and more, Major **Kaye** discussed the advantages of induction coils and transformers. Both required some sort of valve or mechanical rectifier to cut out or to invert half of the potential wave. In the case of the coil and rotary interrupter the mechanical rectifier was a commutator mounted on the interrupter spindle ; in the case of the transformer the commutator was mounted on the shaft of a synchronous motor (with alternating-current supply), or on the shaft of a rotary converter. The valves used were of the kenotron type, *i.e.*, hot kathode tubes. The Coolidge radiator tubes were self-rectifying. Transformers were more expensive in initial cost and maintenance, but gave also twice the efficiency of a coil ; control was more easy (as they were free from the vagaries of interrupters), and measurements were more precise. The interrupter was the most untrustworthy part of the coil outfit and wasted much energy, especially with heavy currents. As regards the potential waveforms much confusion existed owing to the arbitrary methods of measurements in use, which were empirical to the last degree. Comparison of coils and transformers were frequently based on conditions not strictly comparable. To ascertain whether a gas bulb and a coil gave the same quantity and quality of X-rays as a Coolidge bulb and a transformer, we should at least have the same equivalent spark-gap and mean current. For that we needed a spectrometer, to measure the spectral distribution of the output, and simultaneous oscillograms of volts and amperes ; the latter two should be closely in phase. A kathode ray oscillograph had advantages over the electrometer and the moving coil galvanometer which might give over-shot readings with very rapid changes.

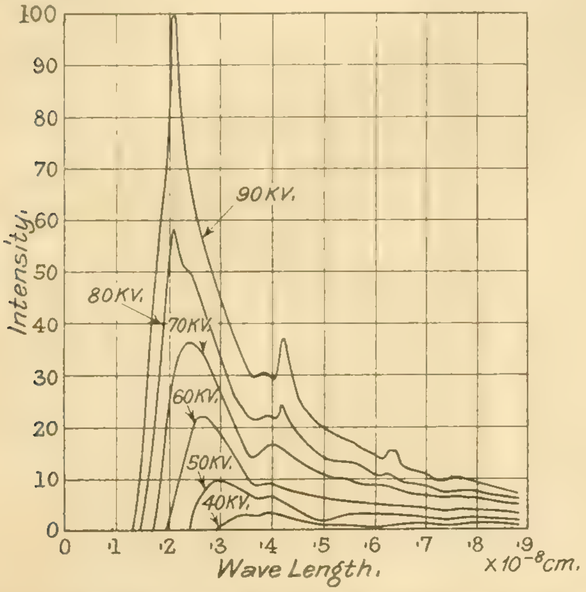

Fig. 4.—X-ray Spectrum of Tungsten at Various volts, same Milliamperes. No Filter. NaCl Crystal.

In order to obtain electrons at highest speeds we might use high potentials from sources (*a*) of constant potential or peak values form ; (*b*) sinusoidal transformer discharges ; and (*c*) pulsating coil discharges. When we worked the Coolidge tube with (*a*), (*b*), (*c*) at the same current, the study of the spectrometer and oscillograph proved that the order of efficiency was that given, when (*b*) was selectively rectified and (*c*) provided with a mercury interrupter ; the more constant the potential, the fewer the relatively-slow electrons, but that superiority became less marked as the potential rose. The case of the gas tube was quite different. The oscillograph showed a succession of peaked waves, whether the potential was constant or variable. In case (*a*) the tube made the constant potential intermittent ; in (*b*) the middle portion of the transformer loop produced peaks waxing and waning in height with the potential ; in (*c*) one or more current peaks corresponded to the potential peak. The spectral curves did not differ much, as was to be expected, and their maxima agreed as to wave-length ; the shape of the spectral curve depended upon the type of tube and not on the excitant.

Though these were secondary factors, we should generally raise the potential of the Coolidge tube as high as possible and keep it there, or increase the frequency of the transformer very considerably ; at higher current intensity, however, the X-ray output was much less than proportional to the current for ordinary interrupter speeds, because the current wave lagged behind the potential wave owing to the arcing at the interrupter. In the gas tube the intermittent discharge might be useful in dissipating the residual ionisation, and the interval between the discharges of a coil-driven bulb helped in checking the rise of the target temperature. But intervals of the mercury breaks amounting to 90 per cent. of the time between successive impulses were needlessly long ; in the case of single-phase transformers the figure might be 60 per cent. We might raise the efficiency of cases (*b*) and (*c*) by raising the frequency, though that would lead to more heating. In (*c*) we should also increase the primary volts and the condenser capacity so as to produce a series of flat-topped peaks without tails, thus approaching the constant potential condition. The coil being essentially a shock apparatus, however, this method of excitation superposed harmonics of high frequencies (several thousands per second) on the waves which, reflected in the secondary circuit, were reluctant to pass through the bulb ; the tendency to sparking across the tube was hence increased. To obviate this we had to lower the gas pressure or to immerse the tube in oil, if we could not suppress the high frequency waves before they reached the tube. The latter was done in the German symmetrical coil. In this novelty two separate coils were mounted vertically side by side with their secondaries as well as their primaries in series ; the annular air space between the coils facilitated cooling. In the two connecting leads between the secondaries were inserted a gas bulb and a rectifying spark gap ; on each side of the latter gap and in series with it was a high water resistance. The self-induction of the secondary circuit being low, but the resistance high, the high-frequency waves were damped out. A some-

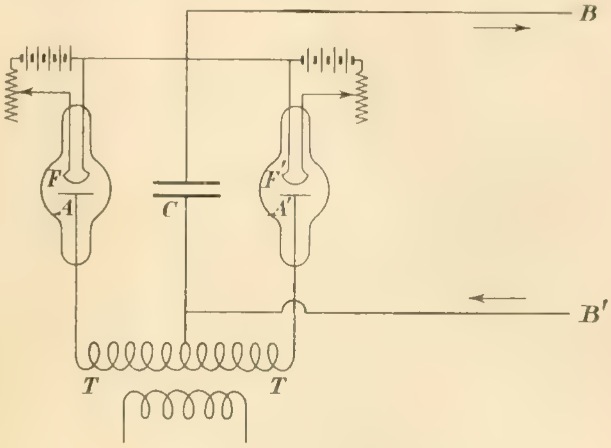

Fig. 5.—Kenotron Rectifiers.

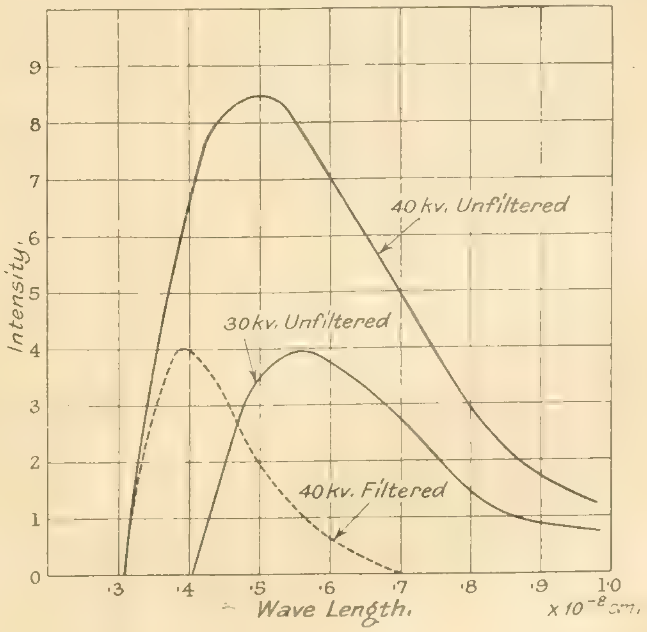

Fig. 6.

what similar apparatus had been designed by Mr. Mortimer Codd in this country.

Advantages of Constant Potential.

The constant potential had the further advantage of admitting of precise measurements which were very desirable in therapeutics, and though that advantage was, as mentioned, less marked at higher voltage, it became distinct again when the characteristic radiations began to appear. In America static (influence) machines of the Wimshurst types had recently given good results. The Medical Supply Association exhibited a large Wimshurst machine with eight pairs of glass plates, driven by an electric motor and excited by a smaller machine with ebonite disc, all in a sealed case of wood and glass. Another source of high potential was the transformer coupled with kenotron valves rectifying up to 200 000 V; in Fig. 5 both half-waves of the transformer are rectified. Three-phase systems required six such valves, and they were so combined with condenser and inductances that Hull had transformed and rectified 150 V alternating current at 2 000 cycles to 92 000 V with a fluctuation of only 1 per cent., and currents of 50 000 V with a fluctuation of 0·1 per cent.

To ensure homogeneity of the rays we had still largely to rely on the characteristic rays of the *K*, *L*, *M* types, and on filtering these through a screen either of the same metal as the antikathode or of an element of slightly smaller atomic number. It was inadvisable, however, to push the potential too high, lest a general short-wave radiation should make its appearance which could not be filtered. The critical potential for the *K* radiation of tungsten (atomic number 74) was 70 000 V, and the optimum was about 100 000 V. A filter of tungsten or tantalum (atomic number 73), 0·15 mm. thick, would remove most of the general radiation but would not stop *K* α and β components of *K*; an equally thick filter of the ytterbium (atomic number 70) would leave only the α component with an intensity 30 times that of the remaining general radiation. For molybdenum (atomic number 42) the optimum was 30 000 V, and zirconium (number 40) gave the best filter. Tungsten would be a good filter for platinum (number 78). This filtering unfortunately reduced the available intensity very much, as Figs. 6 and 7 showed by the diminution of the curve areas. In Fig. 7 tungsten rays, at 40 kV, are filtered through 3 mm. of aluminium. In the National Physical Laboratory different homogeneous rays were produced by a battery of tubes provided with antikathodes of different metals.

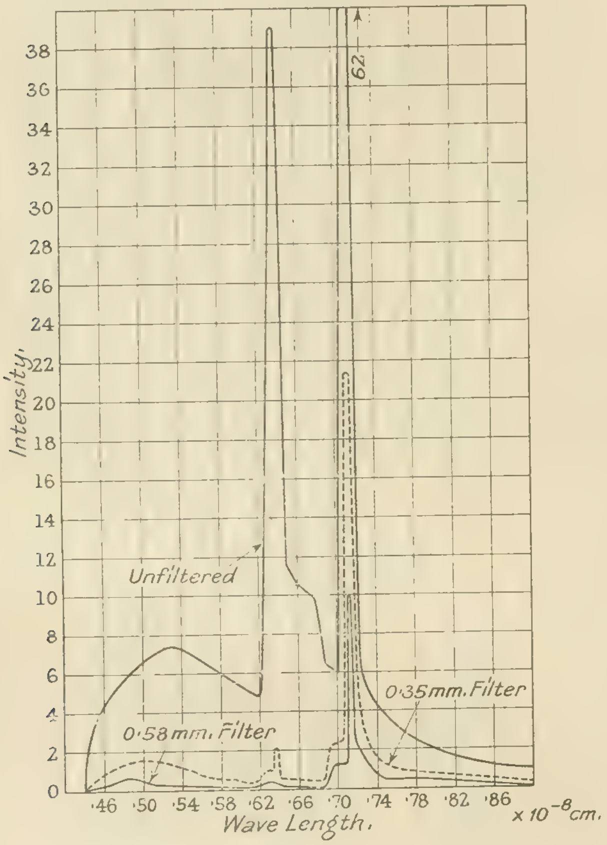

Fig. 7.

Applications of X-Rays.

Turning to applications of X-rays, Major Kaye referred first to the importance of the study of crystal study, which Laue originated in Munich in 1912 and which the two Braggs and others had developed with remarkable success. That powdered crystallised materials could be examined in the same way, when slightly compressed into thin rods, had been observed by Laue's collaborators Friedrich and Knipping already. When the pencil of X-rays fell on such a rod, normally to the axis, and a photograph was taken of the pencil penetrating through the material on a photographic film concentric to the rod and to the point struck at a distance of several inches, the spot appeared surrounded by rings characteristic of the atoms in the material. In this way Debye and Scherrer (Göttingen), and later Hull, Duane, Howe and others at Schenectady, had shown that probably all substances were crystalline and that the various physical properties, elasticity, hardness, melting point, &c., were all manifestations of the atomic forces revealing themselves in the crystalline form. Major Kaye exhibited a very simple apparatus of Hull for these studies (of the type just described), with the aid of which salts like NaF, NaCl, KF, &c., could be distinguished in natural and artificial mixtures. On the photographic strips shown, the rings mentioned appeared as bands, indicating, of course, the spacings and not spectral lines in the ordinary sense. They had further studied the effect of heat treatment, rolling, and ageing in metals like tin, cadmium, molybdenum. The value of these tests was that they did not in the least destroy the specimen which frequently did not require any purification, nor preparation, and which might be examined in the furnace.

Some Industrial Uses.

In the third lecture, Major Kaye reviewed, with the aid of a large number of slides, progress in the industrial applications of X-rays, dwelling also on the service they had rendered to medical science and to science in general. He drew attention to the moral effect on the workers, who knew that concealed defects and bad workmanship might be discovered at any stage, and to the success recently obtained in distinguishing "old masters," old bronzes, furniture, &c., from modern imitations; such distinctions were possible because the old materials, canvas, wood pigments, primings in the case of paintings, differed from the modern materials, or had changed with age. The scattered radiation was a difficulty, especially of metallurgical radiography. Every surface struck by the rays emitted secondary radiations in all directions to the detriment of definition. To avoid this scattering the object should be brought close to the photographic plate or screen, if possible, while kept away from the tube. The plates should be enveloped with sheet lead (with an inner lining of aluminium), a hole being left big enough for the reception of the direct image. Irregularities in the contour should be cemented with paraffin wax to the bottom of a cardboard or aluminium tray, and mercury or lead shot be poured round it. The Bucky grid inserted between plate and object also did good service; it was a rectangular grid of metal with spherical faces, radially divided into cells, so that only the direct rays could pass; the grid itself was kept in slight motion to prevent its being registered on the plate. The practicable limits of penetration depths were the following: lead 4 mm. to 5 mm., tin 12 mm., carbon steel 7·5 cm., aluminium and its alloys 10 cm. to 15 cm., wood 30 mm. to 40 mm. To extend these ranges we should require either much higher potentials with improved cooling arrangements or shorter exposures and better plates and screens. The emulsion plates were backed with heavy metals or combined with intensifying screens of calcium tungstate. The closest contact between screen and emulsion was in the "Impex" plate secured by embedding the fluorescing salt in a super-imposed gelatine film which was dissolved off before the plate was developed; the exposure would thereby be reduced to 1/30. The "duplitised" films, celluloid films with emulsion coatings on both sides, of which sometimes several were piled up in sandwich fashion, also gave sensitive detectors. The ionisation method of detecting X-rays offered great promise, as it could be made more sensitive than any photographic method available.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Office on receipt of published price, plus postage.]

"Year Book of the American Institute of Electrical Engineers, 1921." (New York: American Institute of Electrical Engineers.) Pp. 437.

"Radiotelegraphisches Praktikum." By Dr. Ing. H. Rein and Dr. K. Wirtz. (Berlin: Julius Springer.) Pp. xviii + 558. M.120.

Variable Speed Motors in Heavy Industries.

Lecturing before the I.E.E. Western Centre at Swansea to an audience largely consisting of engineers and technical officials from the local collieries and steel works, Dr. S. Parker Smith (Assistant Professor of Electrical Engineering at the Imperial College of Science and Technology, London) said he proposed to deal as briefly as he could with some facts relating to the application of variable-speed motors to the heavy industries from the point of view of the electrical designer.

It so happened that the field systems of all practical forms of motor consisted of alternate N. and S. poles. Hence, to obtain a unidirectional torque the current in any given armature conductor must reverse every time it passed from one pole to the next. The method by which this reversal of current was brought about depended upon the type of motor employed. In the synchronous motor, alternating current was fed into the armature windings while the alternate N. and S. poles were produced by exciting the field coils with direct current derived from a separate source. In order that reversals of current should correspond with reversals of flux, such motors could run at synchronous speed only. As the central station engineer aimed at keeping the supply frequency as near as possible constant, the speed of such a motor could not be varied because :—

Speed frequency* = Supply frequency = Constant.

Accordingly, the synchronous motor must be dismissed as unavailable for the purpose of the present enquiry.

Speed Variation on Induction Motors.

In the induction motor, the condition for maintaining unidirectional torque was :—

Speed frequency = Supply frequency − Slip frequency.
= Constant − Slip frequency.

So here it was possible to reduce the speed by suitably increasing the slip. But, in the operation of the plain induction motor, there was the further relationship that, no matter what the speed, the consumption of electric power was determined by the torque, or :—

Power input ∝ Torque.

Hence, whenever the motor was called on to exert full-load torque, it would take full-load power, even though it be crawling round at only one-tenth full-speed, and consequently only giving an output of one-tenth the rated horse-power.

Commutator Motors.

An entirely different state of affairs existed in a motor the armature of which was provided with a commutator. Thanks to the commutator and brushes, reversal in the direction of the current in any conductor as it passed from one pole to the next was brought about in a way which was quite independent of the speed. At first sight, this seemed ideal, for the action—in so far as production of torque was concerned—was entirely independent of the speed. In actual practice, however, it was necessary to avoid destructive sparking at the brushes, and this could only be done when the voltage per bar and other important factors of design were held subject to severe restrictions.

In direct-current shunt motors the speed was substantially independent of the speed, and with series excitation the speed fell off rapidly as the torque increased. By suitable compounding, any desired result intermediate between these two extremes could be easily obtained. On the one hand, it is often useful to add a certain number of shunt turns to a series motor to prevent racing at light loads ; on the other hand, it was often useful to add a few series turns to a shunt motor to increase the starting torque, or to cause the speed to fall when the motor is severely overloaded.

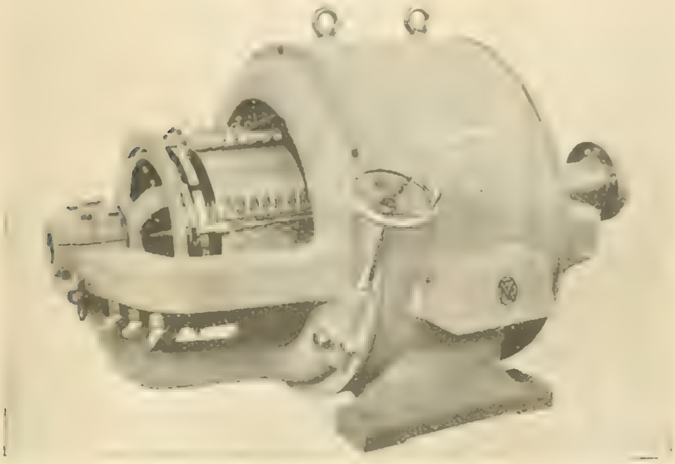

Fig. 1. Three Phase Commutator Motor for Driving Fan 50/90 h.p., 600/1,000 r.p.m., 50 cycles.

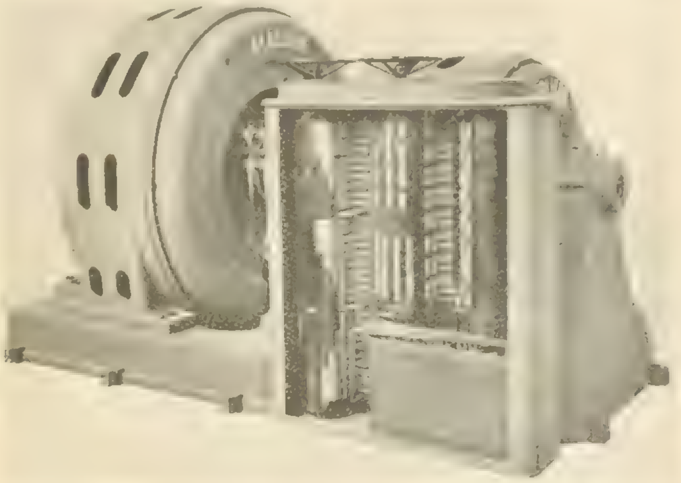

Fig. 2. Motor Set with Open-pole Change-over Switch and Starting Device.

The various methods available for controlling the speed of a direct-current motor appeared immediately from the equation :

$$\text{Speed} = \frac{\text{Supply Volts} - \text{Ohmic drop}}{\text{Field}}$$

Evidently the speed could be adjusted by varying (1) the field, (2) the resistance in the armature circuit, or (3) the voltage acrosss the terminals.

Speed Control of Shunt Motors.

In considering the speed control of shunt motors run off constant pressure supply mains by adjusting the field strength the ohmic drop term could be practically ignored ; for though its presence tended to make the motor slow down on load, this effect was roughly compensated for by the weakening effect of armature reaction on the field. In modern interpole machines the limits of speed variation obtainable by adjusting the field strength were very wide, as much as 1 : 5 or even 1 : 6 being possible. The lower limit was fixed by the

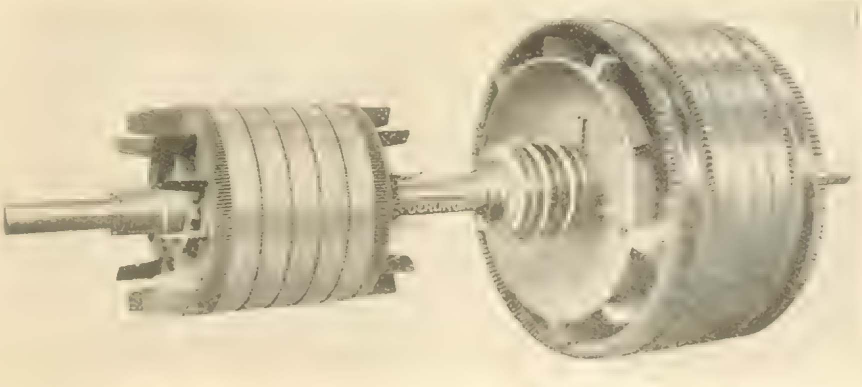

Fig. 3. Rotors of Main and Auxiliary Motors on same Shaft.

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* Speed frequency = number of pairs of poles × revolutions per second.

maximum flux it was possible to produce in the motor, and by the cooling, especially the cooling of the field windings at low speed. The higher limit was set by instability, commutation troubles and excessive mechanical stresses. It was an economical method, because the power expended in field excitation never exceeded a small fraction of full load.

With resistance control, the input was constant for a given torque, whatever the speed, so the greater the reduction of speed the lower the efficiency of the motor became. Also, if the torque varied, the speed varied accordingly, attaining full speed at no-load almost regardless of the amount of resistance inserted. The method was, moreover, too uneconomical for continuous running. Its application was consequently confined to limiting the current when starting up.

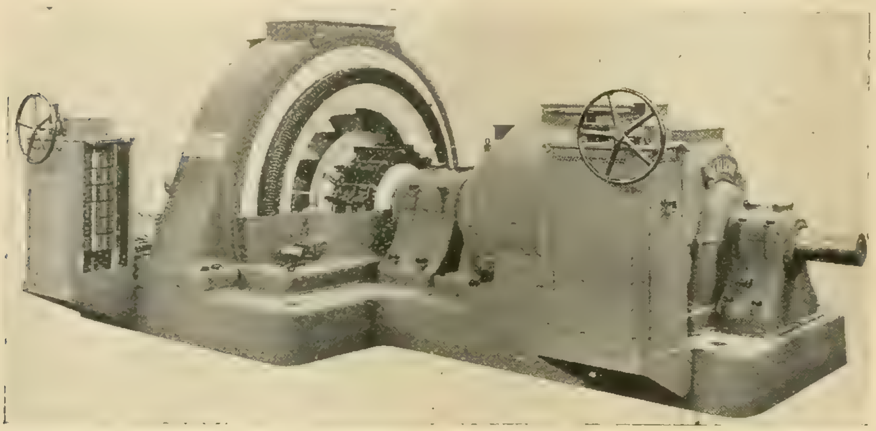


Fig. 4.—Rolling Mill Motor Pole Change-over arrangement for same Technical Data as Fig. 1. View showing Main Motor with Top Cover Removed and Change-over Switch Visible.

Speed variation by voltage control was the best of the three, as regards economy; but its application involved the use of one or more extra machines. By using two like motors in place of one large one, the well-known series parallel control might be adopted; but then there were only two really efficient running positions, viz., when the motors were either in series or in parallel. To obtain higher speeds, the practice of weakening the fields was sometimes resorted to; but remembering that:

$$\text{Torque} \propto \text{armature current} \cdot \text{field},$$

it must be realised that where increased speed involved increased torque—as was often the case—the method of weakening the field involved actually reducing one of the torque-producing factors, thereby necessitating a very rapid rise in the armature current.

The Ward Leonard System.

Another method of varying the speed by varying the voltage was the Ward Leonard system. It applied the principle of varying voltage on a broader and more elastic basis than the series-parallel control; but it involved the use of at least two extra machines, viz., a variable-voltage generator and a motor to drive it. By adding a flywheel to the motor generator set the Ilgner system was obtained in which the kinetic energy of the flywheel could be drawn on for the purpose of levelling out the peaks of a fluctuating load such as occurred in the operation of winders and rolling mills. While admitting that Ilgner sets had served a useful purpose in the past, Dr. Smith preferred to regard them as cumbrous and expensive expedients for bridging over a period of transition. The ideal to which we were rapidly approaching was to have generating units and networks so large in comparison with any single load that load equalisation became superfluous. It was also obviously desirable to avoid the conversion of high-tension alternating current to low-tension direct current.

This, however, involved the use of alternating-current motors, and here we entered the field of compromise. By varying the number of poles or by employing the cascade connection the induction motor could be made to run at a limited number of economical speeds, usually 2, 3, 4, 5 or 6. The number of poles could be varied by changing the connections to the windings, as is done in the case of the Oerlikon motors in the photographs reproduced herewith (selected from the slides shown by the lecturer); or by altering the number of phases, as was done by Creedy (*see* The Electrician, Vol. LXXVIII., p. 544). The cascade connection was obtained either by using two motors, as in the Oerlikon photographs, or as in the Hunt cascade motor.

Though these devices were perfectly satisfactory for many drives, there were several cases where they were insufficient. Occasionally the plain induction motor with resistance control could replace the flywheel converter set without serious loss of efficiency, for example, winders in which the starting period was small compared with the running period. Other cases, however, demanded more complicated solutions, when conversion was to be avoided, and this led the lecturer to consider alternating-current commutator motors.

Alternating-current Commutator Motors.

So long as small or medium outputs only are needed, both single-phase and 3-phase commutator motors could be built to give similar characteristics to direct-current motors, though the speed range was more limited and the cost was higher. Dr. Smith mentioned that we were indebted to the President of the Institution for showing us how to make the single-phase shunt motor work; but, except for the work of a few enthusiasts like Mr. Creedy, comparatively little had been done in this country to develop this type of machine. Where a series characteristic was satisfactory and single-phase supply was available, the series motor with a variable-ratio transformer proved to be an admirable solution; nor did it seem objectionable to demand single-phase for motors when it was supplied in considerable bulk to arc furnaces. For large powers some form of variable-speed set became essential, owing to the severe limitations imposed on the design of alternating-current commutator motors. There were many such sets; in most of them the main motor was an induction motor and the auxiliary motor a three-phase commutator motor.

Here, however, we had entered into the wide field of development, and it was not yet possible to say whether the rather inefficient and costly converter sets would be ultimately ousted. In this country manufacturers still had decided leanings towards continuous current and were often prepared to sacrifice too much in order to confine their energies to standard production. Nevertheless, progress could not be retarded; every day alternating current was ousting continuous current, and if British manufacturers did not encourage development along difficult paths and insist on more highly trained technical staffs, then the lead of the industry would pass to the Continent, as appeared to be the case in electric traction. There was, however, no need to allow this—the country which had played so important a part in the discovery of electric machines would surely be able to undertake their development—whatever trials and failures were entailed.

B.T.H. Rotary Converters.

If the 3-phase motor were as convenient and efficient a machine as the direct-current motor electrical engineers would have been spared a great deal of anxiety and a great deal of expenditure. As it is, however, to obtain the greatest advantages from 3-phase transmission and the greatest advantages from the use of direct-current motors intermediate converting machinery is necessary. This machinery introduces into the scheme of things some important problems of finance and some very interesting technical questions. In this connection there is one school that pins its faith to motor converters and another school which considers that the greater advantages and less disadvantages accrue by the use of rotary converters.

In the latter school we may perhaps justly place the British Thomson-Houston Company, or, at least, we may say that they have designed and manufactured a large number of machines of this kind in an attempt to obtain that high factor of efficiency and reliability in converting plant which is so essential if power is to be economically supplied.

Essential Features.

Figs. 1 and 2 show two typical rotary converters made by this firm and indicate sufficiently well their general design and appearance. It may be said that the rotary converter in essentials is similar to a direct-current generator with the armature winding connected to slip rings as well as to the commutator. The direct-current brushes are placed so as to obtain the maximum voltage

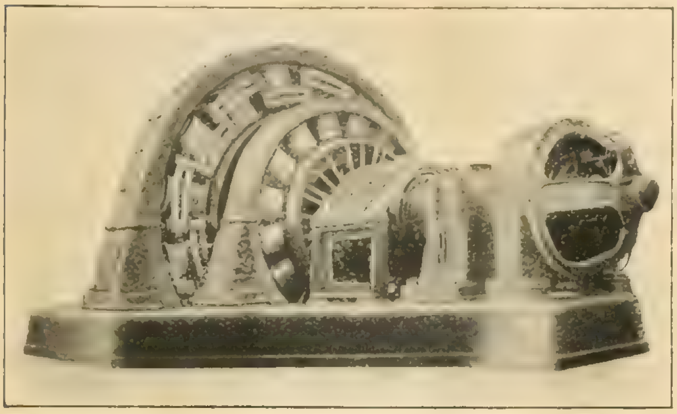


FIG. 1.—4 500 KW, 375 REVS. PER MIN., 50 CYCLE BOOSTER CONTROLLED ROTARY CONVERTER WITH DIRECT COUPLED EXCITER.

generated by the armature, and when the two tappings of the armature to the slip rings coincide with the positions of the positive and negative brushes there is a maximum pressure across the tappings, this pressure being equal to the direct-current voltage. As the armature rotates the pressure passes through a cycle of changes which, in general, follow a sine law. As the alternating-current maximum voltage is equal to the direct-current voltage the virtual value of the alternating-current voltage is equal to 0·707 of the direct-current voltage in the case of the single-phase and 2-phase machines, 0·612 in the case of the 3-phase delta machine, and 0·353 in the case of the 6-phase diametrical machine. The direct-current voltage of the rotary is therefore approximately fixed by the alternating-current voltage with which the slip rings are supplied, though certain variations in this relation are obtainable by methods mentioned below. It is important to note that as the direct-current voltage usually required is comparatively low and the alternating-current distribution voltage comparatively high, a transformer must be used in connection with the converter set. While this addition is, to some extent, a disadvantage as regards cost, it has the considerable advantage that only comparative low pressures exist in the revolving machinery.

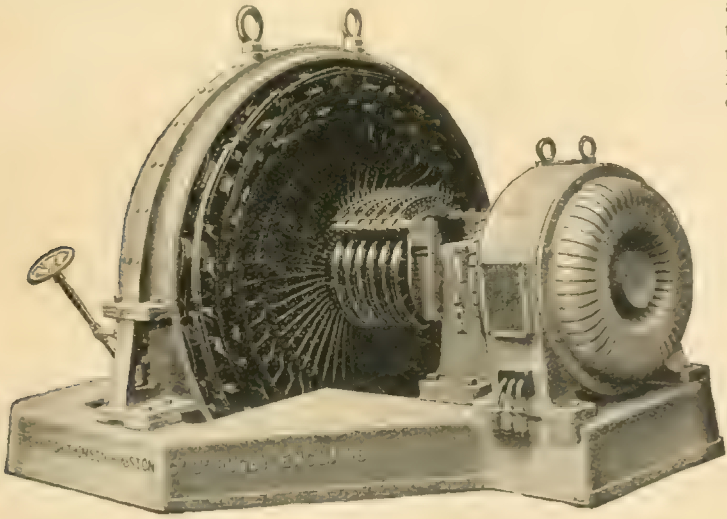


FIG. 2.—2 000 KW 50 CYCLE REACTANCE CONTROLLED SELF-SYNCHRONISING ROTARY CONVERTER WITH ALTERNATING-CURRENT STARTING MOTOR RUNNING AT 375 REVS. PER MIN.

This low voltage also obviates the use of charging devices which are often necessary when converting machinery has to be started from high-voltage circuits. The current passing is also small, being the difference between the alternating current and direct current, and even this difference can be materially decreased by increasing the number of phases up to six. For this reason a 6-phase winding is usually employed, as this gives a machine which is not only cooler, but is capable of withstanding a higher overload and giving an increase in efficiency from 0·25 to 0·5 per cent

HEATING AND POWER FACTOR.

Fig. 3 gives curves showing the heating factor of 1, 2, 3 and 6-phase converters when operating at power factors between unity and 90 per cent. and illustrates the point which we have just made. It will be noted the heating increases with decreasing power factor. This is due to the cancellation of the alternating-current and direct-current circuits not being so complete as when the power factor is unity. Heating factor is a term employed to describe the ratio of C^2R losses occurring when the machine is operating as a rotary to the C^2R losses which would occur in the machine when operating as a direct-current generator, the direct-current output being the same in each case.

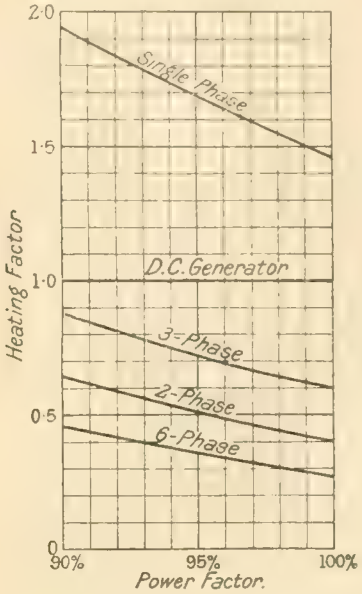


FIG. 3.—CURVES GIVING THE HEATING FACTOR OF 1, 2, 3, AND 6-PHASE CONVERTERS.

The conditions under which a rotary converter operates necessitate considerable attention being paid to commutation. For while in the ordinary type of direct current generator the armature current produces a magneto motive force at right angles to the main field structure, distorting the flux distribution under the main pole and producing a flux in the commutating zone of opposite direction to that required for good commutation and thus even with commutating poles fixing the limit to the overload capacity of the machine in the rotary converter the armature reaction due to the alternating current over 180 deg. balances the armature reaction produced by the direct current. The commutating conditions thus approach closely to those which would exist were the ordinary direct current generator fitted with completely compensated windings and are therefore superior to the conditions in both an ordinary generator and a motor converter. Further, it is possible for a rotary converter to produce a field under the commutating pole which will compensate for the reactance of the coil under commutation more closely than in any other type of converting apparatus which is not equipped with compensating windings.

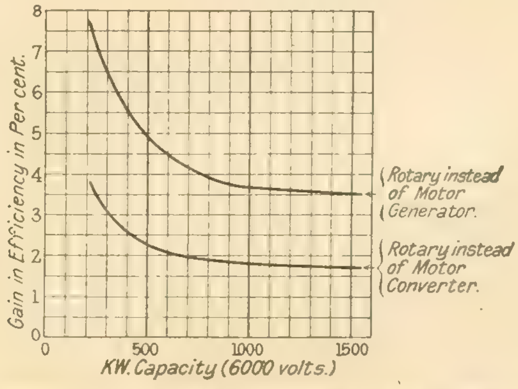


FIG. 4.—CURVES SHOWING THE APPROXIMATE GAIN IN OVERALL EFFICIENCY BY INSTALLING A ROTARY CONVERTER.

This cancellation of the alternating-current and direct-current armature currents and armature reaction and the use of the same magnetic circuit for both the direct-current and alternating current sets gives, it is claimed, the rotary converter equipment a higher efficiency than other types of converting apparatus. This point is illustrated in Fig. 4.

Relation of A.C. and D.C. Voltage.

When as is usual rotaries are employed for converting alternating to direct current an approximately constant voltage on the direct current side is obtained with constant alternating current voltage at the slip rings. If the alternating current at the slip rings be kept constant a particular excitation of the field will give unity power factor at the slip rings, a reduction in the field current producing a lagging current and an increase producing a leading current. In the latter case the effective magnetising value of the current is exactly equal and opposite to the extra ampere turns which have been produced in the main field coils, so that the resultant effective ampere turns are always constant for a given applied voltage at the slip rings. If a reactance is placed between the source of constant voltage alternating current and the slip rings of the rotary voltage variation can be obtained by weakening or strengthening the field of the machine. As, however, the rotary runs most efficiently at unity power factor the normal direct current voltage should be that which is obtained with that power factor between three-quarters and full load, unless it is desired to use the rotary to compensate for lagging current in the system, an ability which is of considerable importance as is evident by a reference to Fig. 5.

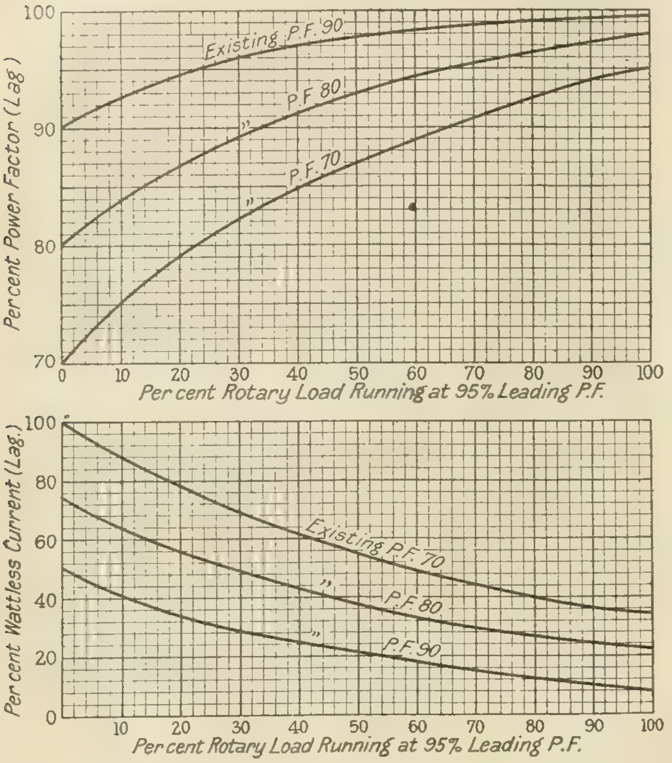


Fig. 5.—Curves showing Improvement in Power Factor which will be effected by installing, as extensions, Rotary Converters operating at 95 per cent. leading power factor.

Starting Rotaries.

There are also some interesting points about starting rotary converters and we may refer particularly to the method of using a self-synchronising induction motor for this purpose. In this case the induction motor which is mounted on the same shaft has the main rotary as its stator windings connected in series with the converter armature at starting. The induction motor starts the converter and brings it up to synchronising speed. At this point the motor acts as a synchronising reactance and allows the converter to synchronise automatically with the supply through the stator windings of the motor. As soon as the converter is in synchronism the induction motor stator windings can be short-circuited and the converter is then ready for paralleling on the direct current busbars. Fig. 6 shows an oscillogram taken during the starting of a 1 000 kW rotary converter by this means. Curve 2 is the direct current taken from the line and curve 1 is the voltage across the induction motor stator windings. The time taken to self-synchronise and short-circuit the induction motor windings was 45 seconds.

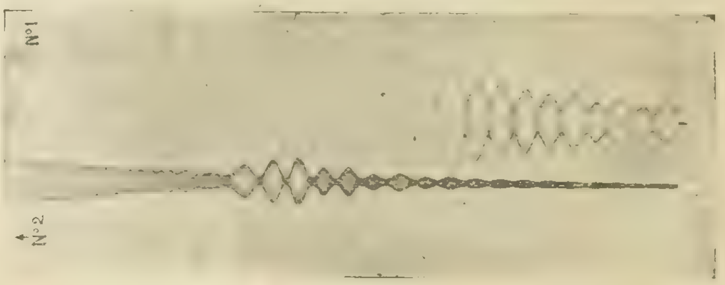


Fig. 6.—Oscillogram showing Starting and Self-Synchronising of a B.T.H. 1000 kW Rotary Converter.

The Reason Why:

Each Process Must Be Inspected.

By W. J. HISCOX.

The inspection department is now looked upon as an integral part of the factory organisation, but in the majority of factories it is apparent that the inspector's activities are not altogether appreciated by the operator. The method of inspection after each and every process is not regarded with a kindly eye, and it is considered as another "management dodge" for scoring at the expense of the "worker."

In a factory where a piece work or bonus system operates, friction between the inspector and the operator is sometimes acute, and the latter considers it a personal affront when his work is not accepted. It is, of course, a serious matter to him when a large batch of work is returned, for this materially reduces his earnings, seeing that the time spent in rectifying them could be more profitably employed.

Inspection and the Piece-work System.

It was the adoption of the piece-work system which made inspection so necessary. Paid by the hour, irrespective of the amount of work done, the operator had no incentive to scamp his job, and consequently it was done thoroughly. With the advent of piece-work, however, the operator had the opportunity of increasing his earnings, and it was not altogether surprising that, in the endeavour to produce more in order to earn more, the quality of his work deteriorated. The grievance of the operator is that, in endeavouring to comply with the exhortation to produce more, he is penalised by the inspector. He does not always appreciate that "quality" as well as "quantity" is included in the exhortation. Yet that affects him quite as much as it does the management. Buyers will not look at shoddy work when good stuff is available, and the firm must study its reputation to ensure obtaining sufficient orders to keep the factory going.

The Dislike of Criticism.

Apart from the effect upon his earnings, the average man dislikes criticism, and this is doubly the case when it is backed by a refusal to accept his produce. The operator is responsible for a certain process, and having had years of experience he naturally considers he is fully qualified to do the job. The possibility of an accident, involving the scrapping of a piece, he does not object to, for that may happen to anyone, but when his work is returned for the rectification of minor defects—the inspector's report being endorsed "roughly finished" or some similar comment—his ire is aroused. "That fellow ought to try and do the job himself," is a comment which is often passed, this implying that the inspector, in the same circumstances, would not do better, as is perhaps the truth.

It is not for the purpose of finding fault, however, that the inspector exists. A standard of workmanship has been adopted, and it is the duty of the inspector to see that no work leaves the factory which does not conform to that standard. Fault finding only follows when that standard is not reached, and if the inspector is to keep his job he must do his duty. No man considers that a bus conductor is exceeding his duty because he insists upon charging his fares. He is employed to do that, and he must do his duty. The inspector has also a duty to perform, and it must not be taken as a personal affront because he does it.

With all respect to the operator, it must be admitted that when earnings are contingent upon the amount of work produced, there is always a tendency to sacrifice quality to speed. Pride of workmanship takes second place, and this, to a certain extent, is unavoidable. The man who places quality above everything is penalised in every directon, for his earnings suffer considerably, whilst he gets the reputation of being a slow worker, and as such is not looked upon with favour by the management.

The Requirements of a Commercial Age.

But it must be remembered that we are living in a commercial age, and art to a certain extent must give place to utility. The factory is producing a commodity to sell, and for the factory to carry on the article must be sold at a price which will yield a fair margin of profit. But it must be observed that the selling price must be low enough to attract sales, and this means the adoption of a standard of quality conforming to the price charged. This standard must not be exceeded, or an economic loss on production follows; neither must it be reduced, otherwise the customer is not receiving value for money, and a falling-off of sales is the result.

The inspector calculates to a nicety the ultimate effect of any slight discrepancy, and if, in his opinion, it will adversely affect the utility of the article, then he insists upon a rectification. If, on the other hand, the inaccuracy is but a technical deviation from the standard, having no real effect upon the utility of the article, then he may consent to let it go.

He does not, however, suffer this discrepancy to pass without comment, for experience has taught him that the operator is quick to profit by any show of leniency on the part of the inspector, and it is in this connection that little breezes are frequent. The inspector knows the old offender—the operator who sails as near to the wind as possible—just scraping home, but never extending himself to produce a really accurate job. And it is the work of this individual that is often pulled up.

Adherence to Standard.

The operator agrees that the utility of the article is not affected, and the contention is accepted by the inspector. Still, a certain standard is fixed, and it must be adhered to. It is all very well, once in a way, to allow work to pass through which is slightly below standard, but this must be looked upon as an act of grace, and not treated as a matter of course. The passing of a batch of work under these conditions should be appreciated by the operator, who should show his appreciation in determining to do the right thing by the next batch. But, unfortunately, he is apt to take advantage of clemency, and the next batch is, if anything, a little worse. An adverse report follows, and the operator protests that the inspector is prejudiced, and friction consequently follows.

The insistence of the management on having the first two or three pieces of each batch inspected, before the bulk is proceeded with, is not taken too kindly by the operator, and yet it is to his advantage. He protests that it is quite unnecessary, and that the carrying out involves loss of time. It is probably true that the loss of a few minutes may be occasioned, but surely this is better than having the whole batch of work rejected upon completion. The inspector of the first few pieces will reveal any discrepancy, whether this be due to the operator or to his tools or jigs, and this can be remedied without a deal of trouble. Once the first few pieces have passed the inspector, the operator knows that, so long as he does the work in accordance with what now may be termed the examples, there is no fear of ultimate rejection. The few minutes spent upon the preliminary inspection, therefore, are put to practical use, and are certainly not wasted.

"Tut-Tut" and the English Language.

To the Editor of "THE ELECTRICIAN."

Sir: I am a professional caster of stones, and therefore may not complain when a few pebbles are hurled at me in retaliation. Indeed, I welcome them, and so far from feeling aggrieved, as "Tut-Tut" apparently hopes and expects, I am immensely pleased to be the victim of his courteous bombardment. Certainly it was a brave action, considering how deficient he appears to be in all the qualities necessary for any kind of literary undertaking. I admire "Tut-Tut," and will deal with him as charitably as I possibly can.

A Vicious Conception.

Before defending myself against "Tut-Tut's" specific allegations, I should like to dissociate myself from what I take to be his general contention. In effect, he says that only the faultless may criticise. This opinion is widely held, but nevertheless represents an utterly vicious conception of the critic's function. The right of criticism is a God-given privilege, possessed equally by the expert and the *ignoramus*. The idea that perfect executive ability must precede any attempt at criticism is sheer snobbery. Even if I could write no better than "Tut-Tut" (which Heaven and the Institute of Journalists forbid!) I should still feel at liberty to pick holes in the writings of the most eminent authors.

My knowledge of English is probably a great deal more comprehensive than "Tut-Tut" could be expected to realise; although, of course, I neither make, nor have made, any claim to infallibility. He certainly has unearthed two errors, which I hasten to acknowledge. In one place I used the word "perspicuous," instead of "perspicacious," owing to a momentary confusion of the two adjectival offshoots of a common root. However, I think even "Tut-Tut" will admit that, in spite of this mistake, I had "at least a vague acquaintance" with the meaning of the word. Elsewhere a slip of the pen, the typewriter or the compositor has caused the word "or" to be printed instead of "and," with the result that the sentence is disfigured by the numerical disagreement of subject and predicate.

The Pot and the Kettle.

Your budding grammarian objects to my title, which he considers ambiguous. Ambiguity is frequently an advantage in captions; but I think that the meaning of "Electrical Advertising" is quite clear when read—as it is meant to be read—in conjunction with the sub-heading. I am not in love with the phrase, but I could not think of any equally brief and expressive alternative. However, if I ever write another article on the same subject, I will see what can be done to meet "Tut-Tut's" objection. Perhaps by that time our word-makers will have invented a generic term for all kinds of electrical apparatus, in which case I shall be able to oblige without difficulty. To be logical, "Tut-Tut" should object equally to the phrase "Electrical Engineer," which, curiously enough, does not signify an engineer fitted with dry cell ignition.

As to civility, the less "Tut-Tut" says about this particular virtue, the better for his own peace of mind. He might suddenly realise that he was very successfully acting in the rôle of the famous pot which accused its friendly co-worker of having a black exterior surface. I am frequently caustic, but I *try* to avoid impertinence, and to savour my satire with the sauces of humour and good (but not impeccable) style. "Tut-Tut" is frankly and deliberately impertinent, and has apparently made no attempt to cultivate the saving graces.

He is boyishly triumphant over the "snare" into which he supposes me to have fallen. There is no snare—seen or unseen—in my sub-title, as he might have realised if his literary education had included an adequate training in the art of punctuation. On closer inspection "Tut-Tut" will find a full-stop after the word "copy." This full-stop marks the completion of the phrase. Since this kind of "snare" seems to afford him some amusement, he may like to exercise his agile wit upon such choice examples as "Paradise Lost," by John Milton; "The Murders in the Rue Morgue," by E. A. Poe; and "Buried Alive," by Arnold Bennett.

"Which" or "That"?

I can quite appreciate that the grammatical niceties involved in the correct use of "which" and "that" are beyond the comprehension of "Tut-Tut." They are not, however, beyond mine. A long essay would be necessary for his proper enlightenment; and I can only say here that I am prepared to defend my use of the word "which" before any jury of literary experts, and also to adduce examples of parallel usage from the writings of Samuel Johnson and the erudite editor of Chambers' Dictionary.

No; I do not think that "sales influence" and "sales value" are in keeping with the classical tradition, but they are convenient and permissible expressions. The only rule about the use of the word "only" is that its position shall not cause any ambiguity. I used the word quite unambiguously, as "Tut-Tut" admits, and therefore quite correctly.

A Disagreeable Subject.

He seems to be a little mixed in the matter of parts of speech. A part of speech is a class of words. A noun is a part of speech, and the subject of the sentence I had in mind was a noun, and therefore, like every other word in the language, a part of speech. The subject of a sentence is always a noun, a pronoun or an equivalent clause, but I am not close enough to my school days to say whether a clause or phrase may properly be described as a part of speech. I should think it might. Evidently the sentence "Whom the gods love die young" is considered to be a tough nut for the juvenile grammarian. If "Tut-Tut" will put the word "Those" in front he will have no further difficulty in identifying the subject.

Persons who disagree (violently) with one another are likely to be disagreeable to other people at the same time, and this is also true of parts of speech. Clumsy I may be, but I do not as a rule "confuse things as such with the relations between things," and I should hate to have composed such a deplorably clumsy sentence as the one just quoted.

The Misused Absolute.

"First in Originality" is not only indefensible, but is also a very silly expression. I have probably a fuller acquaintance with the idiomatic uses of the words than "Tut-Tut" has, and am well aware that they may be legitimately used otherwise than in their strict literal senses. The phrase is bad because it employs *idiomatically* two words of similar *literal* significance.

Not being, I hope, a literary purist, I do not know whether such a person would say "The matter is given consideration," but I *do* know that the construction of the phrase is perfectly correct. That which can be received can also be given, and if it is in order to say that a certain matter has "*received* my consideration," it is also correct to say that I have "*given* the matter my consideration."

"Tut-Tut" is at liberty, of course, to suggest anything which occurs to his curiously constituted mind, but I can assure him that when I wrote "It is, for obvious reasons, impossible to give actual examples of badly-written advertisements," I meant exactly and literally what I said. As to "Tut-Tut's" other example of the misused absolute, no question of grammatical construction is involved. The truth of the statement, "Neither can the non-technical copy-writer produce satisfactory copy on technical or semi-technical subjects" is, to my mind, quite indisputable, and I refuse to qualify it in any way.

"Tut-Tut's" Altruism.

In conclusion, I should like to tell "Tut-Tut" that I appreciate and admire his altruistic motives in criticising me. It is, as he says, difficult to avoid falling into error, and I am quite conscious of my liability in this direction. It is, however, easy to avoid personal comparisons, in spite of which he has very unwisely invited if not instituted a comparison between us. I am obviously prejudiced in the matter, but it seems to me that, whatever my sins of criticism may be, they are white as snow when viewed against the crimson background of "Tut-Tut's" enormities. My article was written in sarcastic vein, but the criticisms were impersonal and, I venture to think, a great deal more helpful than the kind in which "Tut-Tut" incompetently revels.

I am afraid that his article is not likely to modify my literary style. The momentary anguish caused by his introductory *doggerel* has made me immune to anything he can say in *prose*. If he *is* a budding poet he had better nip himself in the bud. If my pen is "softened in its expression of criticism . . ." and "applied to the writing of helpful constructive suggestions . . . . instead of merely to the spouting forth of the suggestion that they (the copy-writers) are all no good," it will not be due to "Tut-Tut." Imagine my "softened" pen "*spouting* forth." But, Sir, what has all this to do with electrical advertising ?—I am, &c., "Electrocynic."

Reviews.

Telegraphy, By T. E. Herbert. (London : Sir Isaac Pitman & Sons, Ltd.) 4th Edition, revised and enlarged. Pp. xx.+1019. 18s. net.

"Herbert" has now become one of the classics of telegraph literature, and the appearance of the fourth edition is evidence that the book fills a need especially when one remembers that the second edition was reprinted four times.

As a very complete exposition of the practice of the British Post Office, it leaves nothing to be desired, and it thus constitutes a valuable guide to the aspiring student, and a handy book of reference to the engineer or manufacturer. In some respects it may be considered too complete, and one is inclined to feel that chapters on the measurement of current, E.M.F. and resistance might be left to specialist handbooks, and the space so set free devoted to the engineering side of telegraphy.

No British telegraph engineer has yet had the courage to take up and do for irregular impulses formed of flat-topped waves what numerous writers have done for the sinusoidal current at telephonic frequencies. It is true that Malcolm has treated the submarine cable case with extreme thoroughness, and Devaux-Charbonnel has done something for the aerial line, but what is wanted is for someone with a facile pen to take Vaschy's work up, and make it easy for the plain man to read. Franklin's writings on "Electric Waves" direct the student to the land of Canaan.

The book under consideration points to the necessity for clarity of ideas in this direction, for, in the preface, it is stated that the transmission speed on aerial lines is determined by the received current. It is of course true that the greater the leakance on an aerial line, the lower is its transmission capabilities and so, at first sight, the statement above cited is true. But, the real explanation is surely *this*, that the greater the leakage, the less the applied voltage at the receiver terminals, and consequently the greater the time to start the receiver in motion, and the lower the acceleration of the moving mass, whatever it may be. All this stands out very clearly in Devaux-Charbonnels' work.

In the book before us the treatment of apparatus and systems is very complete, and the sections on power arrangements, test boxes and frames, protective devices and methods are clearly described.

The new sections at the end of the book cover the amplifying valve, weak current telegraphy, circuit efficiency, and factors of safety of overhead telegraphs, the vibroplex or auto-dot sender, while the Gulstad relay and its derivatives are well treated.

Underground and aerial construction are, as they always have been, very well treated indeed.

So long as a book is an Official Text-book for Technological examinations it must, it is supposed, cover certain specified ground. One would like to see this book divided into two sections, and more space devoted to the mechanics of construction, and the question of transmission thoroughly taken up. H. H. Harrison.

Cours Pratique d'Électricité Industrielle. By H. Chevalier. (Paris: Librairie Polytechnique Ch. Beranger.) Pp. 403. 24 fr. + 50 per cent.

The present volume is the first of three forming a course in electrotechnics intended primarily for the use of technical school students, and for the practical engineer. This first volume deals with the properties of direct currents, their generation and utilisation ; the second volume will be devoted to the consideration of single and polyphase currents, and the third volume to the principal applications of direct and alternating currents.

In the book under notice, the first three chapters are devoted to the properties of the electric current, and the fourth and fifth to primary and secondary cells. Then follow chapters on magnetism, electromagnetism and induced currents, a short chapter on commercial condensers, and chapters on the direct-current dynamo and motor. The three final chapters deal respectively with supply meters, transmission and distribution, and with units.

The subject matter is illustrated by no less than 436 diagrams, and throughout particular attention has been given to the needs of the average type of technical school student. Line diagrams are used almost exclusively, and, with but few exceptions, these diagrams have been carefully drawn, and are very satisfactory in every respect. One or two draughtsman's errors have, however, escaped the notice of the author. Fig. 318 shows the series and shunt coils of a two-pole compound dynamo wound in opposite directions so that they act differentially, whereas we think the diagram is intended to represent the normal connections for a level or over compounded dynamo. In Fig. 323, showing the connections of a six-pole compound dynamo, five poles are wound normally, and one differentially. The permeability curve (Fig. 119), showing μ plotted against H, would indicate that for values of H above about 50 the product μH—*i.e.*, the value of B, decreases with increasing values of H.

In common with far too many elementary textbooks, the action of compound dynamos is only imperfectly explained.

There is a great tendency to explain the load characteristic of a compound dynamo as a combination of the characteristic of a shunt dynamo and that of a series. This explanation omits—and it is a very important omission—to consider the difference in the action of the shunt winding in, say, a level compounded dynamo from that in a shunt dynamo. In the first case the shunt current is constant, whereas in the other the shunt current falls as the load increases. So that the load characteristic of a level compounded dynamo is obtained from that of a separately excited dynamo at constant excitation, with the addition of the effect of a few series turns. The method cited in the present book as the practical method of determining the number of series turns to be employed involves the assembly and test of the machine with a temporary separately excited coil to take the place of the series winding. In actual practice the number of turns can be predetermined with sufficient accuracy.

In general, however, the subject matter is dealt with in a manner which, from the point of view of the type of reader for whom it is intended, is in every way satisfactory. The book can be recommended as well suited to the needs of those who, although they require a good sound knowledge of the principles governing the action of direct-current apparatus, do not need to have an advanced, highly theoretical knowledge of the subject. A. E. Clayton.

Armature Winding. By C. Sylvester. (London : S. Rentell & Company, Ltd.). Pp. xiii. ; 171. Price 7s. 6d. net.

" The object of this book is to provide both a practical and technical assistant to those who are engaged on the winding side of the electrical engineering industry." Though rather a strange way of prefacing a book intended for the use of armature winders, the author has fulfilled his object wherever he has kept shop-practice before him. Matters such as winding shop equipment, winding tools, forming, insulating and winding coils, banding, finishing, testing are well treated. But when the author leaves practice and turns to theory, we are reminded of what the author tells us that the shop engineer said to the foreman about Smith : " Give that job to Jones, because Smith will only *bodge* it up." For example, the " student, armature winder and engineer-in-charge " is taught that " an alternating current is one which periodically changes its direction of flow ; that is, it is alternately in one direction and the other, or in other words, it is alternately positive and negative. The time taken for the current to complete a cycle is very short, probably 1/15th of a second, or less." For the theory of armature windings, &c., we think that the reader will do better elsewhere; but the author is on much safer ground when he says : " Armature winding may be truly said to be an art," and writes from this standpoint.

Stanley Parker Smith.

Shorter Notices.

Science and Theology. By F. W. Westaway. (London : Blackie and Son.) Pp. xiv.+ 346. 15s. net.

Seeing that some 300 books have been consulted by Mr. F. W. Westaway in the compilation of this volume, it would be somewhat presumptious for the ordinary person to pass judgment thereon. It may be described as a summary of all there is to know up-to-date not only of science and theology, but of other subjects such as philosophy, chemistry, the history of the earth, the evolution of animal and man, and so forth.

A further proof, were such needed, that the author is a learned man lies in the fact that he can say he does not know and he says it pretty frequently, and this inspires confidence. Under such circumstances it is manifestly more in order to accept his hypotheses and admit his premises.

Whether it be suitable reading for the man in the street who, having put through his business, civil and domestic functions, would snatch an hour here and there to acquaint himself with the new aspect in which these all-time questions of undying interest are now presented must be left for that gentleman to decide ; but for the student and scholar who are better equipped to grapple with the subjects all is well.

One detail the ordinary reader may well be grateful for, and that is the sparsity of footnotes which are so teasing. The method of putting the names of authorities and their works at the end of each chapter is excellent.

Mr. Westaway emphasises one point which should be helpful to all those who are awakening from the long slumber of acquiescence in the supposed established order of things, namely, that nothing is established. Growth, and therefore change is a natural process, and may be accepted without surprise or fright.

That this principle applies to religion, no less than to science or a child, he makes clear in the last chapter with so much gentleness and consideration, that the feelings of the most orthodox of Christians could not be hurt thereby. He touches on that vital part of man without which he cannot be said to exist at all—his higher, inner life. One is therefore led to hope that he (the author) will fulfil the promise given in his preface " to expand it into another volume."

Winning the Public. By S. M. Kennedy. (London : Hill Publishing Company.) Pp. 168. 15s.

The author of this book is the Vice-President in charge of the Public Relations and Business Development of the Southern California Edison Company, one of the foremost of the electric public utility services in the United States, and as such is an authority on the methods whereby such a service can be conducted on the most efficient lines. The author presents his subject from the points of view of the consumer, the employee, and the investor, and the principles set down are generally applicable to all forms of public services.

Much stress is laid on the necessity for regarding the consumer primarily as an individual and of recognising that a consideration of the personal element is absolutely necessary to the success of any public service. While admitting that the importance of the human element is great, we are of the opinion that it is in the " driving home " of these points that the weakness of the book lies.

Chapters on the " Display Room " and " Advertising " outline numerous methods of publicity and deal with the various media of advertising calculated to produce the best results. The chapter on " Service " is undoubtedly worthy of special mention, and in itself contains sufficient sound sense and advice to make the book worth reading by all who have any connection with a business organisation.

Correspondence.

X-RAY DANGERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : In expressing agreement with the remarks in your issue of April 8 on the dangers of X-rays of short wavelength and the associated dangers of high-tension electrical apparatus, I should like to point out that an extensive research in radiology—chiefly from the point of view of the application of X-rays to the examination of materials—involving considerably higher voltages and much more penetrative radiation than is common in general medical practice, has been in progress for some three or four years in the Radiological Laboratory of the Research Department, Royal Arsenal, Woolwich. The question of protection has always received the fullest possible attention, with the result that, although a large number of scientists have been exclusively engaged on this work for that space of time, there has been no evidence whatever of any deleterious effects either of the X-rays or high-tension products.—I am, &c.,

V. E. Pullin,
Director of Radiological Research.

Woolwich, April 21, 1921.

THE ELEMENTS OF ELECTROTECHNICS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir : It is generally understood by those who read them, that Reviews are the personal opinions of those who write them. This particularly applies to signed reviews.

In the case of textbooks dealing with the elements of a subject the reviewer is chiefly concerned with the author's objective and in discovering whether, in his opinion, it has been achieved.

In the case under discussion I quoted the author's intention from his cover-sheet, and then endeavoured to indicate that, in my opinion, though the work contained an amazingly large and varied amount of information, it could hardly be said to "explain in simple language the fundamental principles of the electrical industry."

That is still my opinion, and as it is only natural that the author does not endorse it, we must agree to differ. Educacationists who read Mr. Young's letter together with the quotation which he gives from his preface—especially the first paragraph—will be able to form their own opinions quite readily. As Mr. Young truly remarks: "So much depends on the point of view."

I regret that my notes and memory played me false and caused me to write of aluminium outputs, when, in fact, Mr. Young had merely written about the discovery, occurrence and extraction of aluminium, showing how the cost per ton had decreased with development. Again, those same notes caused me to write that an expression for eddy current losses gave place to one for the damping forces of an eddy current brake. Mr. Young points out that the eddy current brake expression took precedence. I hope that this will considerably ease the path of "those about to embark on an electrical career," and of those "who, perchance, may not have the advantage of a technical education."—I am, &c.,

London, April 19. J. Paley Yorke.

The North Wales and Chester Electricity District.

As a result of the recent inquiry at Llandudno into the two schemes submitted respectively by Chester Corporation and by the North Wales Power & Traction Company, Ltd., the Electricity Commissioners have arrived at the following conclusions:—

(1) The area provisionally determined receives general assent except in respect of certain districts on the eastern side of the area, and the Commissioners have decided to confirm the boundaries of the district, subject to the inclusion of the Municipal Borough of Congleton, the Urban Districts of Alsager and Sandbach, and the Rural District of Congleton, and to the exclusion of the Urban Districts of Northwich, Middleswich and Winsford, and the Rural District of Northwich.

Chester Scheme Rejected.

The scheme promoted by Chester Corporation contained proposals for (*a*) the development of a series of low-fall water-power stations (without storage) on the River Dee between Llangollen and Erbistock; (*b*) the establishment of a new steam-generating station on the Dee estuary; (*c*) the temporary utilisation of supply from H.M. Factory, Queensferry; (*d*) the establishment of a small water-power station in the Vale of Clwyd; and (*e*) ultimate co-operation with the Company for a large supply from their hydro-electric system.

From the evidence submitted to them, the Commissioners have come to the conclusion that the engineering proposals in this scheme cannot be approved, inasmuch as (*a*) it would be impracticable at the present time to develop low-fall water-power stations on the Dee; and, in any event, such development would have necessitated a stand-by steam plant for ensuring reliability of the supply; (*b*) the erection of a coal-fired station on the Dee estuary is unnecessary, and the cost of generation at such a station would compare unfavourably with that of a supply from the North Wales hydro-electric system; (*c*) no definite proposals were included for the full development of the water-power resources of the western part of the district. Moreover, the scheme, which provides for the establishment of a Joint Electricity Authority consisting of representatives of local authorities and bodies prepared to accept financial responsibility, failed to secure adequate public support. The Commissioners consider that a supply from H.M. Factory, Queensferry, should be utilised temporarily. The information given with regard to the development in the Vale of Clwyd was insufficient to warrant a favourable opinion, although the Commissioners recognise that this small water power may hereafter be utilised.

Power Company's Proposals Approved.

(3) The scheme promoted by the Company provides for the utilisation of the water-power resources of the western area by the improvement of Cwm Dyli, the further development of Dolgarrog, and a new and extensive development at Maentwrog. The Commissioners are satisfied that the engineering developments at Cwm Dyli and Dolgarrog are sound. Comparisons with independent and earlier reports have also established the soundness of the proposed first development at Maentwrog, while an examination of the scheme for the second development has satisfied the Commissioners of its feasibility.

Subject to the Commissioners being satisfied that the agreement between the Company and the Aluminium Corporation, Ltd., who own the Dolgarrog Works, will be such as to safeguard the power supply therefrom, the Commissioners have decided to accept the engineering proposals of the Company's scheme. The adoption of this scheme will, in their opinion, ensure an ample supply of electricity to meet the requirements of North Wales with a sufficient surplus for distribution at commercial rates to districts outside North Wales. Such an additional outlet will enable the full economic development of the available water power to be undertaken.

Conditions Imposed on Company.

The acceptance of the company's scheme by the Commissioners will be subject to (i) the Company obtaining any further statutory powers which may be necessary; (ii) the Company satisfying the Commissioners as to their ability to raise the capital required; and (iii) a consideration of the amount payable by the Company in respect of back dividends. The Commissioners are satisfied that the provisions of Sections 43 and 45 of the North Wales Electric Power Act 1904 for the revision of maximum prices and of the relation between price and dividend sufficiently safeguard the public.

4. A Joint Electricity Authority is necessary for the district for local supervision in the public interests over the development and co-ordination of the supply of electricity. Having regard, however, to the local circumstances, the best interests of the district would be served by the delegation or transfer by the Joint Electricity Authority to the Company of its powers of supply with certain exceptions.

Joint Authority to be Formed.

The Electricity Commissioners have accordingly decided to prepare a draft Order providing for the establishment of a Joint Electricity Authority for the district. (i) In settling the representation on the Joint Authority, the Commissioners will give due consideration to the proposals embodied in the scheme submitted by Chester Corporation and to the representations made by various Local Authorities, but they will have regard to the necessity for constituting a body which will not be too large to be efficient.

(ii) The Order will provide for the delegation or transfer to the Company, by Deed to be approved by the Commissioners, of such of the powers of the Joint Electricity Authority as the Commissioners may determine.

The intention of the Commissioners is that while the supply of energy in bulk throughout the whole district shall be in the hands of the Company, such powers shall be reserved to the Joint Electricity Authority as will enable it to facilitate the development and co-ordination of supply by the Company and other authorised undertakers in the Area, and in particular to control the development of distribution in all present unoccupied areas (subject to the existing right of local authorities or companies to apply for special orders to establish local distribution undertakings); to supervise generally the exercise by the Company of such of the powers of the Joint Authority as may be delegated to the Company; and to advise the Commissioners on matters affecting supply.

(iii) The Order will embody the outlines of the technical scheme to be undertaken by the Company, but will provide that modifications thereof may be made with the approval of the Commissioners.

(iv) The Order will require the Joint Electricity Authority to submit within a period of two years from the date of its formation proposals for securing a supply in unoccupied areas where there is a reasonable prospect of such supply being remunerative.

(v) The Order will not impose upon the Joint Electricity Authority any financial responsibility other than its own administrative expenses, which will be met by contributions from each of the interests represented on the Authority.

Transitory Provisions.

Pending the establishment of the Joint Electricity Authority, the Commissioners will ask the parties concerned to form a small provisional committee, with whom the Commissioners can consult from time to time in regard to any development of supply in the district. The observations of the parties represented at the recent Inquiry will be invited on the clauses of the Draft Order before the Commissioners hold the further Inquiry required by Sec. 5 (4) of the Electricity (Supply) Act, 1919.

Patents in 1920.

The 38th Report of the Comptroller General of Patents, Designs and Trade Marks states that only one application was made in 1921 under the Trading with the Enemy Amendments Acts for a licence, which was granted. The number of applications deposited under the arrangements relating to foreign patents was 194, against 725 in 1919. These arrangements have now been discontinued, owing to the expiry of the emergency legislation.

Number of Patents and Designs.

The number of applications for patents was 36 672, against 32 853, the number of provisional specifications 23 255 (against 23 852) and of complete specifications 21 796 (against 18 922), the number sealed being 14 191, against 12 301. The number of applications for designs was 13 669, of which 13 071 were registered, and for trade marks 14 064, only 7 122 being registered.

The receipts from patents fees were £420 472, from designs fees £8 691, and from trade marks fees £39 295, being increases of £56 091, £1 214 and £18 501 over the respective amounts for 1919. By the Patents Rule 1920, certain new fees were imposed, including fees of £15 and £16 for the 15th and 16th year of a patent, and existing fees were increased in a few cases. The designs and trade marks fees were increased, generally speakers by 100 per cent. from April 1. The total receipts were £487 542, an increase of £83 067. On the expenditure side, salaries amounted to £274 654 against £202 535 in 1919, due to the general increase in the Civil Service war bonus. The surplus of receipts over expenditure was £86 507.

FREE LIBRARY.

The number of readers who made use of the Library was 120 512, compared with 98,618 in 1919. The number of volumes added was 6 576, of which 3 920 were scientific text books or periodicals, 2 954 being obtained by purchase and 966 by gift or exchange. The number of works in the Library at the end of the year was 59 394, and the approximate number of volumes (exclusive of duplicates) 183 675. The new "relative" shelf classification of the Library is now complete for A—HE LM—NH and NK—Z. The intervening classes cover the subjects of Mechanics, Heat and Heat Engines, and Railways (part done). The library is now open till 9 p.m.

SALE BRANCH AND PATENT FEES.

During the year 260 368 patent specifications, 7 870 abridgment volumes, 58 128 Illustrated Official Journals, and 36 621 Trade Mark Journals were sold, compared with 247 387, 7 281, 52 288, and 34 946 respectively in 1919.

The amount received from renewal fees and patents again increased, the figures being £286 498 10s., against £247 408 in 1919, the increase being largely due to belated payments under the Treaties of Peace with Germany and Austria. There was a further substantial increase in the work of the Office, caused to a considerable extent by the filing of a large number of applications from abroad under the provisions of the Treaties. The applications communicated from abroad numbered 1 265, against 1 320 in 1919; and under the provisions of the International Convention 6 797 applications were made, against 2 661. The number of applications post-dated in consequence of disconformity between the complete and provisional specifications was 291, and the applications for patents of addition 959, compared with 220 and 531 respectively. The number of cases in which complete specifications were filed in respect of cognate provisional specifications was 498, against 503.

LICENCES OF RIGHT, RESTORATION AND REVOCATION.

Under Sec. 2 of the Act of 1919, which came into operation on April 1, 196 requests for indorsement of patents were received. Four applications were withdrawn, and indorsements were effected in 176 cases. The remaining requests are still pending. Only two applications were made for the restoration of patents lapsed in consequence of non-payment of renewal fees; one patent was restored and the second application was withdrawn.

Under the provisions of Sec. 26, which empowers the Comptroller to revoke a patent upon application made within two years from the date of the patent by any person who would have been entitled to oppose its grant, there were 17 applications covering 16 patents. Three applications were withdrawn, 2 not entertained, and 5 are still pending. In 5 cases an order requiring amendment of the specification was made, and in the remaining case (in respect of which 2 applications were lodged), the patent was revoked by consent.

EXTENSIONS OF TERM OF PATENT.

Under Sec. 18 of the Acts, 10 applications by originating summons for extension of term were lodged covering 27 patents. In four instances (covering 6 patents) extensions were granted, viz., of four years (2 patents), 5 years, 4 years (2 patents), and 3½ years. One application was refused, and in 2 cases (covering 11 patents), the Court directed that the applications should stand over generally. The remaining three applications (in respect of 9 patents) are pending. Of the 11 patents in force which have been prolonged beyond the normal period that of Creed & Coulson (No. 22 653 of 1902) has been prolonged to 1921, and that of Fleming and Another (No. 18 788 of 1904, with patent of addition 14 986 of 1908) has been extended to 1921.

DESIGNS.

The number of applications to register designs received during the year was 13 669, including 252 sets, compared with 14 094 (335 sets) in 1919. The number of Designs applications is still very much below the numbers received before the war, and it is noteworthy that there has been no recovery in these applications similar to that in the case of patents and trade marks applications.

The number of designs of which the copyright was extended for a second period of five years was 1 860, and the number of which the copyright was extended for a third period of five years was 532.

TRADE MARKS.

The number of applications made for the registration of trade marks (including 168 applications made to the Cutlers' Company of Sheffield) was 14 064, compared with 12 479 in 1919.

Of the trade marks registered in 1906, registration was renewed for a second period of 14 years in 3 624 cases, of those registered in 1892 for a third period of 14 years in 1 443 cases, and of those registered in 1878 for a fourth period of 14 years in 901 cases. During the year 7 696 trade marks were advertised and 7 122 registered.

REGISTER OF PATENT AGENTS.

The names of 68 patent agents were added to the register during the year, mostly as the result of applications under Rule 6 of the Register of Patent Agents Rules, 1920. The total number on the Register on the 31st December was 309.

Electrical Trades' Benevolent Institution.

The annual report of the Committee of Management, submitted at the annual meeting on Monday, states that the number of members and subscribers is 306. The past year's income from contributions was £1 723. 15s. 3d., and the total income was £2 337. 2s., compared with £3 445 in 1919. The latter year benefited by two special appeals. A balance of £2 006. 2s. 5d. has been carried to capital account after payment of grants and expenses. The local advisory committees in Cardiff, Manchester and Newcastle-on-Tyne are doing splendid work towards furthering the interests of the Institution, and it is hoped that in the present year Committees will be formed in Birmingham, Leeds and Liverpool. The number of collectors shows a gratifying increase, but there is still an insufficient number of collectors, and the Committee again appeals to the heads of firms to encourage the members of their staffs to become members of the Institution, and also to encourage one member to undertake the collection of subscriptions. The appeal of the President of the annual festival (Mr. E. Manville) in December last resulted in a collection of £1 136, 18s.

Mr. J. Y. FLETCHER, who presided at the meeting, proposed the adoption of the report and accounts. He said that, on the expenditure side of the accounts, secretarial and office expenses were less than in the previous year (£146, compared with £171). It was not to be expected that this item would be reduced, in spite of the fact that the Secretary was now acting in an honorary capacity. The office expenses in some of the previous years had practically equalled the amount paid by way of remuneration to him. Subscriptions and donations resulting from the annual festival differed but little from the previous year. The other subscriptions were £306, compared with £638, and other donations £350, compared with £1 041. The previous year was the gainer by the receipt of a legacy of £100, no corresponding item appearing in the 1920 accounts. He drew attention to the absence of support of this character received by the Institution, compared with that of kindred institutions. In the case of one kindred institution, the amount of legacies in one year exceeded the total invested funds of the E.T.B.I. Grants had been made in every case which had come before the Institution, where assistance in the direction of obtaining employment could not be found. Six grants were made, compared with four in the previous year. The total value of investments now stood at £14 355, compared with £12 539 in the previous year. The annual festival for this year would be presided over by Mr. Ll. B. Atkinson, and would be held at the Trocadero Restaurant on Wednesday, Oct. 26.

Mr. W. R. RAWLINGS seconded the resolution for the adoption of the report and accounts, and it was carried unanimously.

Mr. RAWLINGS moved and Mr. R. W. HUGHMAN seconded a resolution that the retiring members of the Committee, Mr. H. H. Berry, Mr. H. Bevis, Mr. E. J. Clark, Mr. F. W. Fifield, Mr. W. E. Hobbs, Mr. G. C. Law, Capt. R. J. Wallis-Jones, O.B.E., Mr. S. D. White and Lord Vaux of Harrowden, be re-elected, and it was carried. Mr. J. H. Farthing and Mr. A. H. Allen were also elected as Members of the Committee.

The CHAIRMAN stated that Mr. Hawes had himself proposed that he should act as secretary in future in an entirely honorary capacity. He moved a vote of thanks to him for having remained so long in that position at a trivial fee, which, after taking into account expenses which he had borne, really brought him no remuneration. The motion, having been seconded by Mr. RAWLINGS, was carried unanimously.

Alterations in the rules were adopted in order to give the Committee power to appoint local Advisory Committees and providing that temporary relief, not exceeding £5, may be granted by Secretaries of Local Advisory Committees, subject to authorisation of two or more members.

A vote of thanks to the Chairman concluded the proceedings.

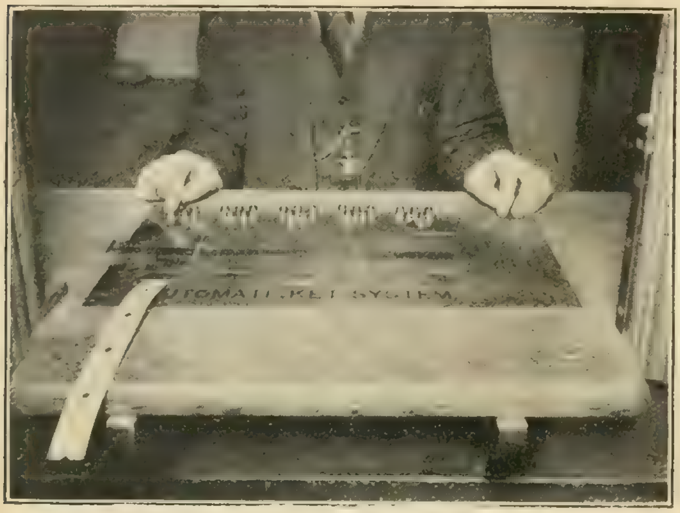
Electric Traction on Railways.

An interesting Paper on TRANSPORT, by Mr. A. Watson, of the L. & N. W. and the L. & Y. Railways, was read last week before the Manchester Statistical Society. In the course of the Paper Mr. Watson suggested that the most useful development in the nearer future would be the ELECTRIFICATION OF RAILWAYS. Conditions in Great Britain were not favourable to an extensive use of the airship and aeroplane in internal transport organisation, while the nature of the country also prevented canals from becoming of prime importance. Unless reasonable dividends were realised railway enterprise must come to a standstill. Without such dividends it would be impossible to contemplate a large expenditure of capital on the electrification of lines, which from the public point of view, was very desirable. The first point to consider in a survey of national transport service was economy by co-ordination. In the use of road transport there would inevitably be wasteful competition between road and rail unless the two were co-ordinated. Looking to the future, it was plainly impossible, said Mr. Watson, to expect the spending of money on new arterial roads or the reconstruction of canals until the country had recovered its financial position, and he believed that the country must rely upon railways more than ever. Their capacity, already unequalled, could be enormously increased by the use of electric traction. London, for instance, should be within three hours of Manchester. The country was on the threshold of great electrical development, and the electrification of railways would give a great stimulus to a national system of electrical power production. It was interesting to note, also, that the demand for transport power was greatest when the demand for industrial power was smallest.

"Automaticket" Machine.

A new automatic ticket machine is now in experimental operation at Leicester Square Station on the Underground Railway of London. A small temporary booking office, which is open on week-days at the present time from 4 p.m. until midnight, has been erected and tickets are issued for even money fares to stations on the Underground Railways at rates from to 2d. to 6d.

The machine, which is shown in the accompanying illustration has five sets of buttons and delivers tickets singly, or in twos, threes fours or fives. It is found specially useful during the evening theatre rush, in dealing with parties. Passengers pay their money in the ordinary way for the issue of a ticket, and it is computed that by the use of this machine a booking clerk can deal with passengers at the rate of about 40 per min. Each of the five magazines in this new machine is charged with a single strip of about 2 000 tickets. To issue a ticket, or tickets, the booking clerk presses a button—according to the fare and number of tickets required. The pressing of the button actuates the mechanism of the machine, and the ticket or tickets are delivered to the passengers through a small slot in front of the machine.



View of the "Automaticket" Machine.

Benn Brothers Staff Dinner.

The staff of Benn Brothers, Ltd., was entertained by the directors at dinner at the Holborn Restaurant, London, on Friday, April 22. Sir John Benn, Bart., Chairman of the Company, occupied the chair, being accompanied by Lady Benn, and just under two hundred members of the staff were present. The guests included Mr. J. W. Beauchamp, Mr. W. R. Cooper and Mr. L. P. Sidney.

After the loyal toast had been honoured, Mr. H. P. Shapland, in proposing "The Staff," said that it included 250 people in the direct employ of Benn Brothers, Ltd., and if it might be held to cover contributors, newsagents all over the world and those engaged in printing and engraving, about two thousand people were engaged week by week in producing and distributing the firm's journals.

Mr. J. W. Cusden, in responding, spoke of the cordial relationships existing between the directors and staff.

Captain F. H. Masters, O.B.E., proposed "The Directors," and suggested that a suitable motto for the firm would be "Tradition and Progress." The toast was pledged with musical honours.

In the course of his reply, Mr. Ernest Benn referred to his intended visit to America. He was going to the United States because in his view the trade and technical Press was destined to play a very much larger part in the affairs of the world in the future than it had done in the past, and also because he was convinced that the future happiness of the nations largely depended upon cordial relations between the United States and the United Kingdom. If anything was known in America about the production of trade papers which had not been heard of at 6 and 8, Bouverie-street, he would hope to find out all about it. In his view the success of Benn Brothers, Ltd., was due to one or two simple causes. First of all to hard work, and secondly, because commercial men all over the Kingdom recognised that their enterprise in Bouverie-street was rendering help to the business world. Every member of the staff was conscious of being of use to the community ; as a firm they were rendering real service in promoting business for British firms in markets at home and abroad. Mr. Benn also announced the result of the ballot for the committee of Benn Brothers Social Circle, the institution of which he welcomed as one of the most important happenings of the year because of its value in increasing the spirit of goodwill and the cordial relationship which already existed among their members.

The M.C.s were Miss Day and Mr. J. A. Knivett. A musical programme was carried out during the evening under the direction of Mr. H. H. Wardle.

I.E.E. North-Western Centre.

The concluding meeting of a most successful session of the North-Western Centre of the Institution of Electrical Engineers took the form of a smoking-concert at the Albion Hotel, Manchester, on April 19. In spite of the call of a fine spring evening, there was a good attendance and an excellent musical programme, principally executed by members, another sign of the versatility of the electrical industry. During the earlier portion of the evening an enterprising organ-grinder outside arranged a rival entertainment, a form of interruption—inevitably followed by a bribe to seek fresh fields—which appeared to be a legitimate and regular part of his means of livelihood. It was felt that the commercial instinct displayed was worthy of a more eminent profession.

Few gatherings of engineers fail to evoke a sense of astonishment at the varied talents of their members, exemplified in this case, for example, by excellent pianoforte accompaniments by Mr. S. L. Pearce. So spirits grew higher, laughter louder and smoke denser until it was necessary, at an earlier hour than usual, to ascertain whether the problem of conservation of fuel supplies had resulted in further mutilation of the time-table.

And there are strong rumours that the next session will be more informal—or less formal—than ever.

A British-American Alliance.

With a view to further cementing a happy relationship established some time ago with organisations in America and Canada propagating similar objects to their own, namely, the improvement of relations between employers and employed, the Executive Committee of the Industrial League and Council recently decided to send a delegation to America for the purpose of conveying fraternal greetings, but primarily to study economic conditions and ascertain the possible channels through the medium of which a revival of trade can be stimulated. The idea has received the cordial approbation of large organisations of employers and employed on the other side of the Atlantic and messages (including one from the Civil Federation) received by Mr. John Ames, General Secretary of the Industrial League, prove that employers and employed in America are closely watching developments in our coal struggle.

The National Civic Federation of America, of which Mr. Samuel Gompers, president of the American Federation of Labour, is a vice-president, embraces within its ranks all the big employers and representatives of labour in the United States. Mr. E. J. P. Benn, C.B.E., honorary treasurer, and Mr. Frank Elliott, a member of the Executive Committee, are the delegates from the League. They sailed on the 23rd inst., and while in the States they intend to devote particular attention to the problem of the readjustment of wages in view of the falling prices and the steps which are being taken to re-establish overseas trade. An interesting tour has been mapped out which will include all the big industrial centres between New York and Kansas and Chicago and Quebec. The Industrial League entertains high hopes that as a result of the visit and the establishment of more intimate relations with American manufacturers and employer as great step forward will be accomplished towards the revival of trade.

Electric Traction in Italy.

An extensive scheme has been approved by the Italian Government for the introduction of electric traction on some of the State railways, and certain privately-owned lines. About 4 000 miles are to be converted, at a capital cost of about 800 000 000 lire, the work to be completed in 10 years. The Ministry of Transport will supervise the work, which is to be executed partly by the State Railway Administration and partly by private firms. It has been decided to adopt the three-phase 16-cycle system, which is used on the majority of the existing lines, the only important exception being the Milano-Varese-Porto Ceresio lines, where the third-rail direct-current system of 500 V is used.

The success of electric traction has been so great that on those lines which are now so operated the traffic receipts have been trebled. A special type of electric locomotive is being devised, and a standard type of overhead equipment has been adopted. All orders for plant and equipment will be placed with Italian firms wherever possible. The consulting engineers of the State railways say that the current required for their new lines can be provided by the power plants already in existence or in course of construction. It will be necessary to erect a few large hydro-electric stations, and their construction will be undertaken by the State in certain localities in order to fill in gaps in the existing system and to provide a suitable reserve. Tenders will shortly be invited from private firms for other lines, in order that the maximum amount of progress may be made, as it is intended that over 300 miles shall be completed each year. The lines to be electrified have been divided into four groups, which are to be proceeded with in the order of importance.

Parliamentary Intelligence.

COUNTY OF LONDON BILL.

On Monday a Select Committee of the House of Lords, over which the Marquis of Bristol presided, commenced the consideration of the Bill of the County of London Electricity Supply Company, for additional powers in regard to their Romford Provisional Order and the Barking site.

The Hon. Evan Charteris, for the promoters, explained that the object of the Bill was to clear up the legal position as regarded the Barking site, to simplify procedure for raising money and to amend the clause which was inserted in their Act during the war which had the effect of limiting their power to raise capital. In Clause 4 they were seeking extended powors for erecting a generating station. All they asked was Parliamentary sanction to build a generating station if and when the Electricity Commissioners, in their discretion, gave them power to do so. The company had a capital of £3 000 000, and it was in order to raise money on the most advantageous terms that it was desirable that it should be treated as a separate undertaking. The London County Council, the Conference of Local Authorities owning electricity works and Ilford Urban District Council had lodged petitions, which showed no grounds on which they could have a right to be heard before them. The Barking station was not within the jurisdiction of the London County Council. The company contended that that was a matter between them and the Electricity Commissioners. Whatever might be the objection put forward by the Ministry of Transport, who in effect were the Electricity Commissioners, he thought that that was a matter between the Committee and the promoters, and had nothing whatever to do with the London County Council, the Ilford Council or the Conference of Local Authorities.

Mr. Clode, for the London County Council, submitted that that authority had every right to be represented, considering that in the future they would have all the rights of purchase of electricity undertakings within their area. It was a thing unknown to put into exsitence a station which had no purchase rights.

The Committee decided that both the London County Council and the Conference of Local Authorties had the right to be represented before the Committee.

Sir Harry Renwick, chairman of the County of London Electricity Supply Company, said the authorised share capital was £3 000 000, and of that £1 500 000 had been issued in ordinary and preference shares and £1 000 000 in debentures. Last year, after paying 8 per cent. on the ordinary and 6 per cent. on the preference share capital, there was a surplus of £131 000 carried forward. He regarded that position as very satisfactory. Briefly, they were asking for power to do something which the Commissioners might want to carry out. They were in absolute need of 100 000 kW and everything beyond that was in the hands of the Commissioners. It was impossible to raise the money under their Act of 1918, and some additional powers were necessary.

In cross-examination, Sir Harry said the proposal was to supply requirements four years hence. Unless they started the new station at once they would be unable to supply the demands of the area. The extension of the station beyond 100 000 kW would be in the hands of the Commissioners.

After the completion of the Company's case, Mr. Craig Henderson addressed the Committee on behalf of the London County Council, who opposed the Company's Bill.

The Committee adjourned.

LIVERPOOL CORPORATION BILL.

Last week a Select Committee of the House of Lords, presided over by the Duke of Bedford, considered the Liverpool Corporation General Powers Bill, which contained some electrical clauses. There was opposition by the Electrical Engineers and the Electrical Contractors' Association, for whom Mr. Page, K.C., pointed out that there was an action pending between the Association and the Corporation on the ground that the Corporation were exceeding their statutory powers in supplying electrical fittings, &c., and they did not want that action to be prejudiced by anything that occurred before the Committee. They wanted to secure that the Corporation were not getting an extension of their powers in any way, and if that were made clear that would satisfy the Association.

Mr. Jeeves, K.C. (for the Corporation), said the only new power they were seeking was to enable them to make bye-laws and regulations in regard to electrical undertakings, and they would have to be submitted to the Commissioners.

Mr. Tweedy-Smith, solicitor to the Electrical Construction Association, said they objected to the Corporation making bye-laws for Liverpool, as they would then become their own inspectors, and there would be a special bye-law for Liverpool alone. The Board of Trade had made bye-laws applicable everywhere and he thought that should be sufficient for Liverpool. Witness agreed that the power would be subject to the sanction of the Electricity Commissioners, but he thought it would be a disadvantage for the Corporation to have a set of bye-laws not applicable to other parts of the country, and might bring them into conflict with the fire insurance companies.

The Committee decided to allow the clause, and the other portions of the Bill were then considered.

SCOTTISH WATER POWER SCHEMES.

The Grampian Electricity Company has withdrawn its Bill, owing to the serious nature of the opposition, and it has also withdrawn its opposition to the Bill of the Lochaber Water Power Company, which seeks authority to use the Pattack Waters in Laggan. The Lochaber Water Power Company's Bill has been under consideration this week by a Select Committee of the House of Commons, presided over by Sir Harry Samuel.

Mr. H. P. McMillan, K.C., for the promoters, stated that of the 18 petitions lodged against the Bill 14 had been withdrawn, and the opposition remaining was that of fishery and other interests on the lower reaches of the river Spey.

A report of the proceedings will appear in our next issue.

Legal Intelligence.

Default in Supplying Electricity.

At the North London Police Court on Tuesday the Hackney Borough Council were summoned by Charles Dore for making default in supplying electric power to his premises.

Mr. Tilley (for complainant) said that under their Provisional Order the Council were obliged to supply electrical energy within the borough to any premises within 50 yards of a distributing main, and were under a penalty of 40s. a day if they failed to do so. Mr. Dore entered into an agreement for a supply of electricity, paid certain fees and had his house wired by a small master man, who did the work himself, as he employed no labour. The Council's employees, however, refused to connect the house, on the ground that the wiring had not been done by trade union labour. It was contended that this amounted to default on the part of the Council, who ought to be in a position to control their own workmen and employees.

The Deputy Town Clerk (Mr. Challoner) did not defend the action of the trade union, which was causing the Electricity Committee considerable anxiety, but he submitted that the Council were protected by a paragraph in the Order which stated that no penalty should be inflicted if the default was caused by "inevitable accident or *force majeure*." In that case the only alternative for the Council was to discharge the workmen, which would lead to the withdrawal of all the union men employed by the undertaking, and the consequent stopping of many works employing thousands of men.

The Magistrate reserved his decision.

Non-Ferrous Metals Research.

At the meeting of the British Non-Ferrous Metals Research Association on Monday, Mr. Thos. Bolton, who presided, expressed surprise at the inadequate support the association was receiving, both from those engaged in the industry and from the users of its products. Now that work was well under weigh he hoped there would be a rapid increase in membership. It was natural that manufacturers should jealously guard such special knowledge as they might have acquired, often at considerable expense, but in his view the function of the association was to investigate and instruct on the fundamental facts and principles underlying their processes, leaving the application largely to members themselves. In that way there was plenty of scope left for individual practical efficiency and the manufacturer who attached importance to trade secrets was far more likely to obtain such as would be of value by joining the association, and absorbing all he could from it, than by remaining outside and relying upon his own investigations.

Work Done.

The bureau of information was doing valuable work, including the issue of a quarterly "bulletin" to members. The first research carried out was on brass and copper castings, which was taken over from the Brass and Copper Tubes Association in April, 1920, and completed in September resulting in the issue of a report containing much useful practical information. The research on atmospheric corrosion, initiated by the Royal Institution of British Architects and Institute of Metals, had also been transferred to the association, and was being carried out by a strong joint committee. A research worker had been appointed, and Prof. H. C. H. Carpenter had arranged for the work to be done at the Imperial College of Science and Technology, where the worker would be under his supervision. Technical committees have been appointed to consider and suggest matters needing investigation, and on their recommendations two further researches have already been put in hand: (1) On the effect of foreign substances up to 1 per cent. in copper; (2) on so-called "nickel-silvers." The former was being conducted at the National Physical Laboratory, under Dr. W. Rosenhain, and the latter by Dr. C. F. Thompson at Sheffield University. Collaboration with the Scientific Instrument Research Association in carrying further an investigation which they had made into abrasives and polishing powders was also under consideration. The work in hand for the current year would cost £2 000, which, with about £2 000 required for administration, would absorb the subscriptions in sight, and the Government grant, but it was hoped that an increase in membership would provide funds for other important investigations.

Electricity Supply.

Arrangements are being made for the public electric lighting of Pontardulais by next winter.

Lowestoft Corporation has been authorised to borrow over £13 000 for new feeders, services, meters, &c.

It is proposed to expend £5 810 on new cables and services in Southwark during the current financial year.

Sanction to a loan of £4 500 for electric supply mains and services has been obtained by Bridlington Corporation.

Stirling Council has invited Mr. J. A. Robertson, of Salford, to prepare a report on the proposed extension of the electric supply undertaking.

Coventry Corporation has authorised the laying of a new high-tension cable at a cost of £3 500, and the extension of supply mains to Upper Stoke.

Salford Corporation has applied for authority to borrow £3 000 for the electric lighting of the streets of the Lower Kersal and Weaste housing estates.

A public inquiry was recently held at Aylesbury into the application of the Corporation for sanction to borrow £3 500 for electric pumping plant at the sewage works.

Wigan Electricity Committee is laying supply mains to the Beech Hill housing estate, and they will be of sufficient capacity to meet any demands for energy en route.

Though Teignmouth Urban Council would welcome the introduction of electricity supply, it cannot see its way to take over the provisional order for the town which is held by Messrs. J. & W. Purves.

The date for the inquiry into the organisation of electricity supply in the West Riding (Aire and Calder) Electricity District, which was postponed owing to the coal crisis, has now been fixed for May 18 at Leeds Town Hall.

Alterations and improvements are to be made at the Fulham (London) Borough Council electricity station, including the replacement and extension of the economisers, the installation of a new centrifugal pump, &c., at an estimated cost of £21 000.

The London County Council is recommended to pass a resolution welcoming the introduction of the Electricity Supply Bill and urging upon the Government in the public interest to take every step in its power to ensure this measure becoming law during the present session of Parliament.

E. A. Bridge, Hy. Dearden, Horace Finch, Thos. White and Edward Prior (electrical engineer, of Church-road, Burgess Hill) have applied to the Electricity Commissioners for a Special Order to authorise them to generate and distribute electrical energy in Haywards Heath and Cuckfield Urban Districts and parts of Cuckfield and Chailey Rural Districts.

At Manchester City Police Court on the 20th inst., Mr. H. H. Hayhurst, an electrical contractor, was fined £2 for UNLAWFULLY CONNECTING AN INSTALLATION to the Corporation supply mains in contravention of their regulations. An inspector from the electricity department found the wires connected to the service-boxes when visiting the premises to test the installation.

The Leicester Tramways and Electricity Committee recently applied for sanction to the borrowing of £723 000 for the equipment of the first section of the new electricity station, but the Electricity Commissioners only authorised the borrowing of £425 000 on account. The Committee now recommends the acceptance of tenders for the supply of a 10 000 kW turbo-generator at £91 394, and for the erection of buildings at £187 300.

The Preston Finance Committee, having considered a report of Mr. J. A. Robertson on the proposal to purchase the undertaking of the National Electric Supply Company and to erect a new generating station on the south side of the Ribble, the Corporation are recommended to apply to the Electricity Commissioners for a special order authorising the completion of the purchase and the supply of electricity, &c.

The Electricity Commissioners have fixed the local inquiry into the London and Home Counties Electricity District for June 14, and already six schemes for improving the organisation of electricity supply in the district have been submitted. One of these is by Poplar Borough Council and provides for "compartment" development in the East End of London. It is likely to meet with a good deal of opposition and already Hackney Borough Council has pronounced against it.

The Manchester Electricity Committee reports that there is a surplus, after meeting income tax, of £67 492 on the trading for the year ended March 31, compared with £87 634 in 1919-20. The net surplus, after charging loan interest, debt redemption and income tax, is 1·73 per cent., against 2·43 in the previous year. Last year £37 231 was set aside in aid of the rates. but in the coming year it is unlikely that the Committee will make any contribution. The sales of current increased by 9 per cent. The increase in the first half year was very marked, but much of it was lost in the latter half through the effect of trade depression. On the assumption that last year's sales will be maintained at the same prices, and that there will be an increased consumption of electricity for street lighting, the Committee estimates that there will be a considerably smaller surplus in the current year, as the increased assessment and the abolition of the three years' basis of assessment for income tax will also affect the department seriously. As soon as costs fall sufficiently, either through reduced expenditure on coal and wages or through a revival in trade, the Committee will consider the question of lowering the charges to consumers.

Electric Traction.

The employees of the Hastings Tramways Company are out on strike as a protest against the dismissal of an inspector for alleged inefficiency.

In consequence of the serious coal crisis many provincial TRAMWAY SERVICES have had to be reduced. In the majority of cases the Sunday service has been withdrawn and cars cease running earlier in the evening. Public lighting is also to be cut down by 50 per cent.

Hull Tramways Committee has received the approval of the Ministry of Transport to its schemes for carrying out additional repairs to the tramway track at an estimated cost of £11 000, and the renewal of certain lines at a cost of £16 500.

The Hull Corporation tramways department is happily able to give a normal tramway service notwithstanding the miners' strike. The general manager (Mr. E. S. Rayner) has had three boilers equipped with oil-burning apparatus and he has reduced the coal consumption from 230 tons to 80 tons per week.

In the draft Provisional Order lodged by Dundee Corporation power is sought, *inter alia*, to borrow a further sum of £362 000 for the acquisition of land and property necessary for the construction of the works authorised by the Improvements and Tramways Act of 1913 and the Order of 1915.

In a recent report on tramway extensions at Glasgow, the general manager (Mr. J. Dalrymple) favours an experiment with the trackless trolley system. This appears to be the cheapest form of traction, and it would be well to delay consideration of the omnibus question meantime. For the railless system it is absolutely necessary that there should be a good road surface which would stand the traffic. In some instances the system had been a failure, owing to the bad condition of the roads.

The financial position of the Brighton Corporation tramways undertaking is far from satisfactory. The traffic receipts for the year just ended were £128 066, compared with £115 756 in the previous year. The total expenditure was £113 993, against £102 174. Renewals cost £23 766 and the net result is a deficit of £21 428. Two years ago there was a surplus of £30 000, partly due to the deferment of renewals. Since then repairs and wages have increased and fares have been revised. In order to avoid a call upon the rates, the Tramways Committee recommend the raising of a loan for £30 000.

Miscellaneous.

In the schedule of revised duties on GOODS IMPORTED INTO India, which came into operation on March 1, telegraphic instruments and apparatus imported by or for railway companies (formerly duty free) are classified under item 50, and the duty is 2½ per cent. ad. val.

In reply to a question in the House of Commons, the Assistant Postmaster-General (Mr. H. Pike Pease) stated that about 9 800 TELEPHONE SUBSCRIBERS had given notice to terminate their agreements during the four months ended March, 1921, but as far as could be ascertained only some 3 000 of these notices were the result of the increased telephone charges.

It will be remembered that in 1919 the Managing Committee of the Union Internationale de Tramways et Chemins de Fer d'Interet Local decided to dissolve the Association owing to the impossibility of holding a general meeting. It had been hoped that a general meeting would have been held this year at Brussels, but the difficulty which a large number of associated companies would have in travelling from countries a long distance from Belgium make this course impossible. In addition most tramway and light railway undertakings are at the moment faced by very grave problems which make it inadvisable for their management to leave their headquarters. In spite of these difficulties the Association membership has not been unduly reduced, and there are at present 250 members. It may therefore be said that the Association is very much alive, and with the return of more normal conditions it may be expected to exercise its old activities. Exception has been taken by certain members notably those in Holland to the way in which the Union was dissolved, but owing to the impossibility of convening a general meeting it would seem that no other course was possible. Those interested in the work of the Association should apply to Monsieur H. Camp, 23, Rue l'Arlon, Brussels, for further particulars.

At an INQUEST, which was held at Rhymney on Friday last on a youth named Evan W. Jones, who was killed on the 18th inst. by coming into contact with the electric wires of the Powell Duffryn Company, a verdict of "death by misadventure" was returned. The wires were carrying current at a voltage of 11 000. As deceased with his companions was walking along the Rhymney River he stated he was going to have a slide and crossed the river. The next thing his companions saw was that deceased was in flames on the electric wires, having evidently climbed up the pole to the cables. Deceased's hands and feet seemed to be in flames for a moment, then he fell unconscious. There was a large "Danger" sign which deceased must have seen.

Medical evidence was to the effect that the left foot of the boy was off at the ankle, and the right foot and the fingers of both hands were charred to the bone. His right thigh was also fractured, and he passed away about three hours later.

Mr. Ivor Williams, engineer of the company, said they had contemplated putting up barbed wire as an effective preventive. They were going to do this straightway. They had put up the poles to comply with the Board of Trade regulations, and they had been passed by the Board. The line was one of the best in the country and had only been in commission a month.

Institution Notes.

On Thursday, May 19th, Prof. A. V. Hill will deliver the fourth Silvanus Thompson memorial lecture of the Röntgen Society, the subject being "Electrical Instruments and Phenomena in Physiology."

Lieut.-Col. F. A. Cortez Leigh, T.D., R.E., and Mr. W. C. P. Tapper have been nominated for election as ordinary members of Council of the Institution of Electrical Engineers. These are additional to those already made by the Council.

At the Royal Institution on Saturday, May 7, Prof. E. C. C. Baly will begin a course of two lectures on Chemical Reaction. The Friday evening discourse on May 6 will be delivered by Sir Robert Robertson on War Developments of Explosives.

Members of the Institution of Electrical Engineers will be glad to hear that the work of redecorating the Institution building is being rapidly proceeded with. There is every prospect that the Institution will be reinstated, at least on the ground floor, by the middle of May.

The presentation of the first award of the Kelvin Medal will be made by the Rt. Hon. A. J. Balfour, O.M., F.R.S., at the Institution of Civil Engineers, to Dr. William Cawthorne Unwin, F.R.S., on the 4th prox., at four o'clock. The medal was founded in 1914, principally by British and American engineers, to commemorate the achievements of Lord Kelvin in those branches of science which are especially applicable to engineering. The award is dealt with by a committee of the presidents of representative British engineering institutions, after considering recommendations received from similar bodies in all parts of the world, and it is made to the person found to be most worthy to receive this recognition of pre-eminence.

We have received a circular letter from the North Midland Territorial Centre of the Institution of Electrical Engineers, soliciting the support of members of the Centre and others for Mr. Thomas Roles, city electrical engineer of Bradford, in his candidature for the Council of the Institution. This support is requested on account of the excellent work which Mr. Roles has done for the electrical industry, and about this we have nothing to say, except heartily to endorse his entire suitability for a seat on the Council. Whether, however, it is quite in order or quite politic for the Committee of the Territorial Centre, which, through its chairman, has direct representation on the Council, to support one of the official nominees in this way, is, we think, rather open to doubt.

The annual smoking concert of the Finsbury Technical College Old Students' Association, at which nearly 100 old students and their friends attended, was held at Anderton's Hotel, London, on Friday last. During the evening a "Wallis-Jones" medal was presented to Mr. L. Gowing-Scopes, F.C.S., for the best Paper contributed during the year by an old Finsbury student, his Paper being on "The Properties of Some Chlorhydrocarbons and their Uses in Chemical Analysis." Old students who are not members of the Association may obtain application form for membership from the hon. secretary, Mr. H. P. Guy, 209, Northumberland Park, London, N.17.

In our issue of December 24 we announced that Mr. E. M. Hughman, of Bombay, had offered a donation of £250 to the Benevolent Fund of The Institution of Electrical Engineers on condition that nineteen similar donations were received before June 30, 1921. The Committee charged with raising the fund have obtained Mr. Hughman's consent to the sums of £250 not being contributed solely by single donors, but by group subscriptions. The Territorial Centres of the Institution are taking steps to organise such group collections which will doubtless be supported by members of the Institution of all classes. The Secretary of the Institution of Electrical Engineers, 1, Albemarle-street, London, W.1, will reply to any enquiries on this subject. We sincerely hope the necessary sum will be raised.

Business Items, &c.

Arthur Jas. Wager and Ernest Wm. Coller, trading as Wager & Coller, electrical engineers, 108, St. Benedict's-road, Small Heath, Birmingham, have dissolved partnership. Debts by Mr. Wager, who continues the business.

The partnership between Stanley Pendlebury, Samuel Sugden and Waite Northrop, trading as Pendlebury, Sugden & Company, electrical engineers, General-street, Blackpool, has been dissolved. Debts by Mr. Pendlebury and Mr. Sugden, who continue the business.

We learn that the equipment for the Mount Everest Expedition, which starts from India later in the year under the organisation of the Alpine Club, is being prepared. So far as electrical hand-lamps are concerned, the "Leverlight" Lamp Company, 30, New Broad-street, W., have supplied models of their lamps to the expedition.

We are informed by the Record Engineering Company, Ltd., Tutbury, Burton-on-Trent, that the demand for their "Silent Record" engines, "Record" steam traps and other goods is so great that they have gone into voluntary liquidation with a view to reconstructing and forming a much larger company to enable them to meet the demands. We also learn that practically the whole of the additional share capital is being taken up by the present holders and their associates.

The electrical engineering business, formerly carried on under the name of Guy V. Laycock, Cloth Hall-street, Huddersfield, has been converted into a private limited company under the title of Guy V. Laycock, Ltd., at the same address. The business is now under the management of Mr. H. P. Ripley, A.M.I.E.E., who has had 25 years' experience in the trade, and for the last 15½ years has been chief of the electrical department of Messrs. Thos. Broadbent & Sons. In addition to electric power and lighting installations the Company undertake the repair and rewinding of d.c. and a.c. generators, motors, &c.

Catalogues, Price Lists, &c.

A booklet has been issued by Messrs. Herbert Morris, Ltd., of Loughborough, giving illustrated particulars of the Morris elevating trucks. By their use considerable economies are effected in the handling and transport of materials, &c. Prices, dimensions and other details of various standard types of truck are included.

An instruction book on the installation and operation of Metropolitan-Vickers power transformers has been compiled by the Metropolitan-Vickers Electrical Company, Ltd. Clearly and concisely written, the booklet, which is 32 pages, deals with points of importance likely to arise in connection with the erection, inspection, operation, and maintenance of the transformers. Resident engineers and those who have these machines under their control will find the publication of great assistance, more especially as it contains a number of illustrations and diagrams of connection.

Messrs. Marconi's Wireless Telegraph Company, Ltd., have issued a further batch of publications, giving illustrated descriptions of some of their apparatus. The present pamphlets deal with the Marconi aircraft wireless telephone, type A.D.1, the aircraft wireless telephone combined transmitter and receiver, type A.D.2, the aircraft receiver, type A.D.3, the ½-kW continuous wave transmitter sets, types M.C.1 and M.C.2, and the 3-kW and the 6-kW continuous wave transmitters for telegraphy. In all cases there are general descriptions of the apparatus with particulars of the design, operation, dimensions, weight and other details.

The world's longest transmission line is of aluminium. Why? This is the question which is asked in a letter from the British Aluminium Company, enclosing a useful pamphlet on H.D. wire and strand for overhead lines. The answer is apparently because its employment leads to substantial economy, while years of service under severe conditions have demonstrated that it is both a reliable and efficient conductor. The reasons for this are set out in more detail in the pamphlet in question, which gives a good deal of interesting information as to the handling of aluminium, its jointing, and the sags and tensions which are met with in practice.

Messrs. Etchells, Congdon & Muir, Ltd., 15, Cannell-street, Ancoats, Manchester, have issued a catalogue relating to their electric lifts. The firm, who are specialists in the manufacture of lifts, both electric and hydraulic, have over 15 years' experience in the manufacture of electric lifts. Illustrated particulars are given of the design and construction of the various parts of the E.C.M. lift, and it is stated that over a thousand of these have been supplied by the firm to public buildings, hotels, industrial establishments, business houses, &c., within a radius of 20 miles of Manchester alone. The lift is fitted with control devices which, it is claimed, render impossible accidents from failure of the lifting ropes or mechanism, crushes between the cage and the door lintels, or falls down the well owing to inadequate fencing of the doorways.

Personal and Appointments.

Mr. E. F. **Kent** has been appointed temporary first assistant electrical engineer at Portsmouth Dockyard.

Mr. A. G. **Lobley**, B.Sc., has been appointed Reader in Electro-Chemistry at the University of Manchester.

Sir **James Henderson**, D.Sc., has been appointed expert adviser to the Admiralty on the application of gyroscopes.

Mr. F. **Flynn** has been appointed acting borough electrical engineer by **Limerick** Corporation, and Mr. Grund as acting assistant engineer.

It is announced that Prof. **Einstein** has accepted an invitation from King's College, London, to give a lecture or lectures at the college on his return from America early in May.

Mr. F. **Freshwater**, who has retired from the position as manager of the Teesside Tramways upon the municipalisation of the system, has been presented by the staff with a gold-mounted walking-stick and a wallet of notes, together with a gold brooch for Mrs. Freshwater.

Mr. E. P. **Lucking**, who has been closely associated with the firm of Nathan & Allen for the past seven years, has accepted a seat on the board of the new company. Mr. J. H. Wild, M.I.E.E., for many years with the Lancashire Dynamo & Motor Company, and since 1916 assistant superintendent of electrical manufactures to Messrs. Vickers, Ltd., has also joined the board of Messrs. Nathan & Allen, Ltd., 25, Victoria-street, S.W. 1.

Educational.

The most urgent need of the Hebrew University at Jerusalem, which is now in process of formation, is an abundant supply of books. In Palestine, there is a real book famine, and it will need a great effort and every assistance to build the present University Library of about 40 000 volumes into an up-to-date library worthy of the Jewish University. Serious works dealing with all branches of knowledge are required, and the Jerusalem University Library Committee therefore appeal through us to our readers to send all the books they can spare as a free-will offering to those who will treasure them in Palestine. Gifts of books may be sent either direct to the University Library, Jerusalem, or to the Hon. Secretary, Mr. D. D. Stanhill, 75, Great Russell-street, London, W.C. Mr. Stanhill will, if necessary, arrange for collection.

Tenders Invited and Accepted.

Manchester Electricity Committee require tenders by May 10 for the supply of weldless steel lamp columns. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Annfield Plain Urban Council requires tenders by May 2 for wiring two blocks of houses at Catchgate, Annfield Plain. Particulars from Mr. H. Adam, Electricity Substation, West-road, Annfield Plain.

Kilmarnock Tramways Committee require tenders by May 15 for the supply of stores, including cable, lamps, insulating tapes, overhead material, varnishes, paints, oils, &c. Forms of tender from the Manager.

Tenders for the installation of electric lighting in the church of Sarum St. Edmund, Salisbury. Particulars may be obtained from the Churchwardens, and tenders by May 7 to Mr. E. Usher, Churchwarden, 44, Saltland, Salisbury.

Glasgow Corporation require tenders by May 3 for six (or 12) months' supply of materials to the Tramways Department, including castings, oils, rubber and asbestos goods, wires, &c. Specifications from the general manager.

Swinton and Pendlebury Urban Council requires tenders by April 30 for wiring 30 houses on the Temple Lodge Estate, Manchester-road. Specifications from Mr. John Knight, 15, Cross-street, Manchester.

The County of Ayr Northern District Committee require tenders for electric lighting work in connection with the housing scheme at Townend, Dalry. Names of intending tenderers are to be sent by May 2 to the District Clerk, Kilwinning, or Messrs. Fryers & Penman, architects, Largs.

The Uruguayan Ministry of Public Works invite tenders for three electric gantry cranes and a "Temperley"-type aerial transporter for the port of Paysandu. Tenders (in Spanish) by June 28. A translation of the specification may be seen at the Department of Overseas Trade.

The Australian Commonwealth Postmaster-General's Department invites tenders by May 25 for ironwork, including couplings, piping, bolts, rings, &c. (schedule 704), and by May 31 for porous cells (schedule 1685), and of ammonium chloride (schedule 1683). Specifications can be seen at 35, Old Queen-street, Westminster, S.W.1.

Manchester Education Committee require tenders by May 4 for electric lighting installations in the junior and infants' departments of the Ardwick school, and in the Ardwick Central, Ducie-avenue Central and Cheetham Central schools. Specifications, &c., can be obtained at the Education Offices, Deansgate, Manchester.

Tenders are invited in connection with the electrification of the Cape Town–Simonstown and Durban–Pietermaritzburg Railways, for the supply of turbo-alternators, boilers, condensing plant, passenger and freight locomotives, motor coaches and underframes, motor bogies, electrical equipment of coaches, sub-station equipment and transformers. Specifications and forms of tender from the High Commissioner for the Union of South Africa, or the General Manager, Johannesburg. Further technical information can be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, London, S.W.1. Tenders to the High Commissioner by May 3.

Tenders are also invited for the overhead equipment of permanent way and overhead transmission lines, switchgear and accessories and track bonds. Specifications and forms of tender from the High Commissioner, Trafalgar-square, London, W.C., or from the General Manager, Johannesburg, and further technical information may be obtained from the consulting engineers, Messrs. Merz & McLellan, 32, Victoria-street, S.W.1. Tenders to the High Commissioner by June 22.

Birkenhead Corporation has placed an order with the Enfield Ediswan Cable Works for the supply of five miles of service cable at £1 260.

Rochdale Tramways Committee are ordering steel tyres from Belgium, the tender being £25 5s. a ton. After adding freight charges, there will be a saving of £17 10s. a ton compared with British tenders. The latter, strangely enough, all quoted the same price, £45 a ton.

London County Council Highways Committee has accepted the tender of the Western Electric Company, at £3 767 (lowest tender), for the supply of l.t. cables, &c., in connection with the construction and reconstruction of the tramways from West India Docks to Mare-street.

Messrs. Ransomes, Sims & Jefferies, Ltd., have recently secured, through their agents, Messrs. Pollon & Crisp, Ltd., Karrier Works, Cheetham Hill road, Manchester, an order for four 2½ ton electric chassis for the L. & Y. Railway. The machines are of the latest pattern, such as were recently supplied to the Corporation of Manchester, Sheffield, Derby, Lincoln and Rotherham, and to Messrs. Smith, Stone & Knight, of Bristol.

Bankruptcies and Liquidations.

Walter Hedgecox, electrical engineer, 121, Salop-street, Wolverhampton, has been adjudicated bankrupt.

An application for the discharge of David Suchtawer, engineer, 1, First-avenue, Acton, will be heard on May 27, at the Court House, Half Acre, Brentford.

A meeting of creditors of Tyne Electric Steel Foundries Ltd. (in voluntary liquidation), will be held on May 2 at 31, Mosley-street, Newcastle-on-Tyne.

Herbert Doyle, trading as the Accessories Supply Company, factor, in electrical accessories, 56, Hardman-street, Deansgate, Manchester has been adjudicated bankrupt.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

13 335/14 Soc D'Electricite De Paris. Electric relays. (21/6/13.)
133 973 Dahl. Electrical commutators (17/10/19. Convention date not granted.)
135 517 U.S. Light and Heat Corporation. Method of preparing storage batteries for shipment or storage. (8/9/17.)
135 843 Jane. Electro-magnetic switches. (29/3/16.)
136 840 Perfect Re-Fillable Fuse, Inc. Re-fillable electric fuses. (18/12/19.)
137 271 Armstrong. Method for receiving wireless signals. (30/12/18.)
139 475 Landers, Frary & Clark. Controlling device for rotary electric switches and the like. (1/11/18.)
140 449 Western Electric Co., Ltd. Production of electric oscillations. (4/6/17.,

Relates to a generator for producing electrical oscillations comprising an electrical discharge device including a space current path and a source of current therefor, in which a path of high ohmic resistance is connected in series with said source, said resistance being of such a high order that the space current remains practically constant irrespective of the conditions of the oscillations, slight changes in the voltage of said source, or of the impedance between the discharge electrodes of said device and that a path of low impedance to alternating current consisting of high capacity and low resistance is connected in parallel with said space current path, whereby, for a given adjustment of said device and associated circuits, oscillations of constant amplitude are supplied to a work circuit.

142 076 Moser. Electric Switches. - (19/4/19.)
142 463 Celli. Portable electrically driven vacuum cleaners. (24/4/29.)
144 993 Adt Akt.-Ges. Geb. Electric switches. (13/6/19.)
147 126 Krupp (Akt.-Ges.) Arrangement for the electrical long distance control of the valve gear of a hydraulic gun pointing gear. (27/11/16.)
149 611 Scintilla. Voltage regulators for electric current generators. (8/8/19.)
153 582 Metropolitan-Vickers Electrical Co., Ltd. Electrical speed-regulator systems. (6/11/19.)
158 911 Schuster. Galvanic cells. (12/3/17.)
158 919 Jones. Sparking-plugs. (6/8/19.)
158 923 Manson. Means for detecting proximity of submarine cables, particularly for guiding ships or for locating faults or breaks in the cable. (29/8/19.)
158 927 Franklin. Aerial systems employed in wireless signalling. (24/9/19.)
158 930 Suckling. Electric and mechanical couplings or connectors. (6/10/19.)
158 932 British Electric Transformer Co., Ltd., & Roothaan. Insulating means for electrical apparatus. (9/10/19.)
158 938 Thomas & Thomas. Electrical heater. (14/10/19.)
158 962 Bishop & Chadwick. Electric trackless tramway cars. (7/11/19.)
158 978 Murray & Telephone Mfg. Co., Ltd. Telephone receivers and ear-pieces therefore (12/11/19.)
158 982 Mond. (International Precipitation Co., Inc.) Apparatus for electrical treatment of gases. (13/11/19.)
158 994 Automatic Telephone Mfg. Co., Ltd., & Hudd. Electro-magnetic relays., (15/11/19.)
158 996 Brown. Holders for electric lamps. (15/11/19.)
158 997 Parnell-Smith. Electrical heating devices. (15/11/19.)
159 003 Franklin, Picken & Robb. Aerial systems for wireless signalling. (17/11/19.)
159 061 Schroeder. Cooling or ventilation of dynamo-electric machines. (5/12/19.)
159 063 Aspinall. Collectors of electric locomotives. (8/12/19.)
159 070 Scholes & Claremont. Devices for securing electric fittings and the like. (10/12/19.)
159 077 O'Neill. Electrical signalling and indicating devices for ships and other vessels. (17/12/19.)
159 078 Taylor, Tunnicliffe & Co., Ltd., & Scrivener. Telegraph and Telephone insulators. (22/12/19.)
159 087 Moser. Electric Switches. (21/1/20. Addition to 142,076.)
159 100 Smith. Electric light distribution devices, decorative plaster work and the like. (17/3/20.)

APPLICATIONS FOR PATENTS.

September 13.

26 182 Wheatcraft. Electric soldering iron
26 194 Powell. Electric geyser.
26 241 Brydon & Johnson. Wireless telegraphy.
26 244 Galletti. Syntonization of circuits for wireless signalling.
26 246 Harris & Rose. Electrolytic cell.
26 257 B. T.-H. Co. (G. E. Co.). Induction motors.
26 267 Heasman. Electrode holders.
26 268 Sterling Telephone Co. (Bell & Clark). Indicating ringing of electric bells, &c.
26 273 Bastic & Moy. Automatic circuit breakers.

September 14.

26 295 Ellmore. High voltage indicator.
26 317 Edgeworth. Submarine telegraph apparatus.
26 344 Optalite & Coulson. Batteries.
26 347 B. T.-H. Co. & Trenchman. Electric power distribution systems.

September 15.

26 382 McGregor. Electric warning signals.
26 386 Falconbridge. Current regulators, rheostats, &c.
26 396 Greengate & Irwell Rubber Co. & Povey. Cable junction boxes.
26 408 British Insulated & Helsby Cables, Ltd. Supporting devices for trolley wires, &c.
26 418 Lunzer. Means for supporting telephone receivers.
26 419 Royce. Electric turning gear for engine starting.
26 447 B. T.-H. Co. (G. E. Co.). Transformers, &c.
26 461 Maackinenban A. G. Seebach. Switches. (20/1/21, Germany.)
26 473 Gruber. Rotating field magnet. (15/9/19, Germany.)

September 16.

26 505 Rand. Railway and tram rail joint.
26 516 Parks. Electric lighting device.
26 525 Rogers ((Krupp Akt. Ges.). Release for overload switches.
26 538 Western Electric Co. Ringing arrangement for carrier signalling systems.
26 539 Etablissements Deese. Distribution for magneto. (8/10/19, France.)
26 540 Etablissements Deese. High tension ignition magneto. (27/12/19, France.)
26 551 Gehrig. Generators for high-voltage ignition and lighting. (16/9/19, Germany.)
26 576 White. (U.S. Light & Heat Corporation). Electric machines.
26 577 B. T.-H. Co. (G. E. Co.). Systems of electric control.

September 17.

26 582 Mathew. Telephones.
26 650 B. T.-H. Co. (G. E. Co.) Electric power limiting systems.
26 655 Bartlett. Actuating braking or stopping devices by electric current.
26 634 Rosenthal (Loewy). Electric heating and cooking apparatus.
26 654 Western Electric Co. Repeaters for multiplex signalling. (30/9/19, U.S.)
26 676 Callender's Cable and Construction Co., Urmston, & James. Measuring capacities of conductors.

September 18.

26 683 Berry. Electric conduit.
26 711 Bailey. Wireless apparatus.

September 20, 1920.

26 786 Earle & Klytmans. Electric heating apparatus.

26 807 Conway. Indicating and safety gap device for electrical ignition of internal combustion engines.

26 808 B.T.H. Co. (G. E. Co.) Transformers, &c.

26 826 Durtnall. Thermo-electrically driven floating forts, ferries, &c.

September 21, 1920.

26 870 Dutt. Electro-magnets.

26 871 Dutt. Generation of electricity from latent energy.

26 873 Gunn & Tibbles. Electric heating and ventilating apparatus.

26 875 Radio Communication Company & Binyon. Electromagnetic wave systems, &c.

26 887 Lefeuille. Resistances. (22/9/19, France.)

26 888 B.T.-H. Co. & Boddy. Oil-immersed transformers.

26 889 B.T.-H. Co. (G. E. Co.) Controlling electric switches.

26 894 Lucas & Turner. Switches.

26 899 Magerle. Electro-magnetic horns, &c. (10/4/21, Austria.)

26 901 Western Electric Co. High frequency signalling. (29/9/19, U.S.)

26 915 Negromanti. Device for heating by electricity. (19/9/19, Italy.)

26 923 Imray. (International Radio Telegraph Co. & Hogan.) Wireless receivers.

26 935 Evershed & Vignoles & Needham. Electrical means for indicating at a distance the motion of apparatus.

26 940 Drury. Hydro-electric plant.

September 22, 1920.

26 944 & 26 945 Crompton & Jones. Electric resistances.

26 946 Crompton & Jones. Rheostats or resistances.

26 950 Willmot & Booth. Telegraph keyboard perforator.

26 983 Gardner. Miners' electric lamps.

26 990 Illingworth. Cut-out.

26 994 Oosterhuis, Holst & Phillips Gloeilampenfabricken. Purifying inert gases in vacuum tubes, &c. (23/9/19, Holland.)

26 999 B.T.-H. Co. (G. E. Co.) Regulating systems for a.c. circuits.

27 004 Akt.-Ges. Brown, Boveri et Cie. Regulation of voltage in vapour rectifier installations.

27 009 Volet. Commutators formed from a ring of wedge-shaped elements. (21/5/21, Belgium.)

27 011 Metropolitan-Vickers Electrical Co. & Miller. Electric speed regulator systems.

27 022 Robinet de la Pichardais. Switch with automatic contacts. (23/9/19, France.)

27 034 Boswell. Arc lamps.

27 042 Durtnall. Bodies for thermo-electric self-propelled vehicles.

September 23, 1920.

27 050 Sullivan & Joseph. Loading coils for superimposed telephones, &c.

27 074 Henson. Electric device for control of belt-driven machinery.

27 077 Bennett & Garde. Switches.

27 084 Blair-Snelling. Electric motor-cycle.

27 092 Insell. Electric power plant for steam railways.

27 104 Waygood-Otis, Ltd. Motor control systems for electric lifts, &c.

27 107 Cramer & Marryat. Carbon commutator brushes, &c.

27 112 B.T.-H. Co. (G. E. Co.) Electrical distribution systems.

September 24, 1920.

27 177 Sibthorpe. Accumulators.

27 178 Modart. Motor generator.

27 181 Turton. Barrel apparatus for electro-deposition of metals.

27 188 Binyon & Scott-Taggart. Electromagnetic wave systems, &c.

27 189 Radio Communication Co. & Scott-Taggart. Relay devices, &c.

27 190 Radio Communication Co. & Scott-Taggart. Valve generators, &c.

27 191 Radio Communication Co. & Scott-Taggart. Electro-magnetic wave systems, &c.

27 238 Barr. Switches for water heaters.

27 242 B.T.-H. Co. (G. E. Co.) Electric heating devices.

27 291 Durtnall. Generation of thermo-dynamic and electrical power, &c.

27 292 Edison Swan Electric Co. & Shergold. Make and break devices for switches and fuses.

September 25, 1920.

27 325 Allingham. Insulated conductors.

27 326 Allingham. Caps for sealing ends of insulated conductors.

27 327 Allingham. Bonding and earthing connections.

27 340 Drury. Electric generating plant.

27 349 Fernie. Insulation of conductors.

27 360 C. L. I. Mfg. Co. & Watson. Control of electrical circuits.

27 361 M. L. Magneto Syndicate & Watson. Dynamo-electric machines.

27 380 Wood. Electric welding apparatus.

September 27, 1920.

27 388 Automatic Telephone Mfg. Co. Apparatus for controlling operation of signals, &c.

27 396 Automatic Telephone Mfg. Co. & Hudd. Arrangements for detecting position of points on railways.

27 411 Guiducci. Protection of l.c. circuits from abnormal charges.

27 461 Loya. Electrically-propelled boat.

27 467 Moore. Regulation of hydro-electric installations.

27 477 Automatic Telephone Mfg. Co. Electro-magnetic relays. (31/12/19, U.S.)

27 478 Automatic Telephone Mfg. Co. Automatic telephone systems. (28/1/20, U.S.)

27 486 Thompson. Storage battery testers.

September 28, 1920.

27 500 van Slooten. Electric cells.

27 509 Lofts. Electric irons.

27 510 Lofts. Alloy for electric heating appliances.

27 522 Electric Construction Co. Automatic starting, regulating or controlling switchgear.

27 553 B.T.-H. Co. & Wedmore. Protective devices for a.c. distribution systems.

27 557 Metropolitan-Vickers Elec. Co., Coates & Davies. Switchgear.

27 559 Cosmos Lamp Works & Orange. Metal filament lamps.

27 561 Metropolitan-Vickers Elec. Co. Thermal relays for electrical circuits. (6/10/19, U.S.)

27 572 Wall. Alternating current generators.

27 573 Adam & Antonoff. Electrolysis.

27 579 Holland & Skinner. Separators for elements of storage batteries. (17/5/19, U.S.)

27 583 Ges. fur Drahtlose Telegraphie. Maintaining constant periodicity. (29/9/19, Germany.)

September 29, 1920.

27 629 Brit. Insulated & Helsby Cables, Ltd., Bayles & Higham. Electric condensers.

27 653 B.T.-H. Co. (G.E.Co.). Switches.

27 666 Mellersh-Jackson (Weeks' Photo Engraving Co.). Electrically etching printing plates, &c.

27 692 Shanghai Elec. Construction Co. (McColl). Trolley heads.

September 30, 1920.

27 709 Radio Communication Co. & Scott-Taggart. Electromagnetic wave systems, &c.

27 727 Thompson (Plauson). Electrodes.

27 728 Automatic Telephone Mfg. Co. & Taylor. Automatic telephone systems.

27 748 Automatic Telephone Mfg. Co. Telephone systems.

27 755 Booth & Willmot. Telegraph keyboard perforator.

27 762 B.T.-H. Co. (G.E. Co.). Casings for electrical apparatus.

27 772 Whittaker-Swinton. Vacuum or thermionic tubes and valves.

27 796 Amherton. Casings, &c., for ammeters, &c.

27 805 Bosch Akt. Ges. Securing electric lighting machines, &c., on cycles. (2/10/19, Germany.)

October 1, 1920.

27 814 Green. Electric reading lamps, &c.

27 831 Atkinson. Rotors of induction motors.

27 876 Telephone Mfg. Co. & Murray. Telephone transmitters.

27 883 Beckmann. Wireless apparatus.

Companies' Reports, &c.

ENGLISH ELECTRIC COMPANY, LTD.

Works Fully Occupied During Year.

The annual meeting of this company was held at the Connaught Rooms, London, on Wednesday (April 27), Sir Charles Ellis, G.B.E., K.C.B. (chairman of the company), presiding.

In moving the adoption of the report and accounts the Chairman said: That although the total of the credit side of last year's profit and loss account amounted to £410 835, that figure included a special item of £230 000 representing undivided profits brought in by certain subsidiary companies, which could not be taken into account when comparing the results of the two years. The recent issue of 8 per cent. six-year notes for raising additional working capital in face of the steady rise in the prices of materials affected the accounts of this year to the extent of £150 000, the balance being received early in January. The whole expense of the issue had been written off, and provision made for the whole of the premium payable on redemption, so that the profits of future years would be entirely relieved from these expenses. During the year their principal task had been that of consolidating the organisation, and satisfactory progress had been made in adapting the Coventry Works and restoring the other factories to their normal activities in pursuit of the fixed policy of the Company of devoting each works to that class of machinery for which it was best suited. At Coventry they manufactured large turbine-electric units, rolling mill equipments and the larger classes of engineering products. Preston, which had long been well-known for traction work, now specialised even more completely in that branch, and electric locomotives were being made there in addition to all forms of electric traction equipment. At Rugby and Stafford there had been further development of the medium sizes of steam turbines and electrical machinery. Bradford, which was specially laid out for smaller industrial motors, had now its own machine moulding plant. Following the unfortunate effect of the moulders' strike, there had recently been a welcome improvement in the foundry position. The business of the Company both at home and abroad was well maintained up to the later months of the year, but the general depression became noticeable in the electrical trade a little later. They had fortunately a considerable order book still to be executed, and it was not unreasonable to hope that it would be sufficient to carry them over until trade revived.

Electric Traction.

Railway electrification in the United Kingdom was delayed, mainly by difficulties of finance, but the technical advantages were not in dispute. The Company's contract with the New Zealand Government for the electrification of the Arthur's Pass section of the Midland Railway was proceeding satisfactorily. In pursuance of the policy of economy in selling expenses, the working agreement with Siemens Brothers & Company, Ltd., had been followed by the formation of the English Electric & Siemens Supplies, Ltd., which would deal exclusively with the marketing of the minor products of the two concerns and electrical supplies generally.

Labour and Wages.

In regard to the labour position, the Chairman said they had so far no complaint to make in the main as to the manner in which their workmen had settled down. They had worked hard and well, and through their ready co-operation on Works Committees differences of view had been brought to light as soon as they had arisen, and had shown themselves susceptible to treatment by full and frank discussion. None the less, the wages rates in British engineering, and even more in the industries supplying materials, were leading to the loss of many important contracts in world competition. If they were to extend or fully regain pre-war business considerable reductions would be necessary in the price of these materials, and, therefore, in the cost of the whole range of processes through which they were built up from the basic materials of coal and iron. He had no doubt they would be able to meet the crisis if both employers and workers could be assured that the necessary sacrifices were distributed as fairly and equitably as is humanly possible. The immediate future must be an anxious time, for industry as a whole, apart from wages and questions of internal organisation, had to reckon with factors essentially political, exercising a profound influence on the whole system of international trade. The revival of trade would come sooner or later, and the electrical industry had an assured future, because it was bound up in those improvements and economies in productive organisation which they all regarded as a necessary element in the future prosperity of the world.

METROPOLITAN-VICKERS MEETING.

The 21st annual meeting of the Metropolitan-Vickers Electrical Company, Ltd., was held last week, the chairman, Mr. J. Annan Bryce, presiding. In moving the adoption of the report and accounts, Mr. Bryce gave particulars of the present capital and of the various items in the balance-sheet. The result of the past year's operations was that the gross profit was £81 555 and the net profit £83 231 larger than in 1919. Considering the interruption of business caused by the railway strike and the moulders' strike at the end of 1919, which greatly affected the results of 1920, he thought it satisfactory to be able to appropriate £100 000 to reserve, £35 000 to special depreciation, increase the carry over, and raise the dividend on the ordinary shares from 8 to 12½ per cent. The orders received during 1920 were in value about 80 per cent. greater than those received in 1919, while the orders completed were about 50 per cent. greater. The tonnage of orders completed represented an increase of about 30 per cent., a remarkable improvement in view of the fact that electrical machinery was always becoming lighter in weight owing to increase of efficiency in the material used. The increase of tonnage completed reflected great credit on the efficiency of their organisation. Had it not been for strikes their output would undoubtedly have been much greater. Since the return of their moulders in January, 1920, they had done their best to increase the output. They began the current year with a largely increased volume of transactions, the completion of which would give them work for a considerable time.

Labour and Wages.

Mr. Bryce said one might look to the future with confidence were it not for the factors adverse to the prospects of industry generally. They had a reputation second to none for their products, a first-rate equipment, admirably efficient administrative and technical staffs and excellent relations with their workers. In the home market they should get at least their share of what was going, and if the present troubles were settled he believed there would be a good deal going, while abroad they might, with normal conditions, expect a large share of the abundant work of reconstruction all the world over at a time when every day opened new fields for the introduction of electricity. But at the moment they found themselves in a storm centre and dark clouds lowered on the horizon in every direction. The supply of coal, the life-blood of every industry and the basis of the prosperity of the country, was suspended. The ranks of unemployment, already counted by millions, were being day by day reinforced, and day by day millions of pounds were being lost. The coal crisis had not been altogether the fault of the miners. For several years Continental consumers had had to pay exorbitant prices and were at last driven to other sources of supply. When the collapse was in sight nothing was done to bring the miners and owners together to make timely arrangements against the new conditions, and then suddenly decontrol was anticipated by many months. In those circumstances it was impossible not to feel some sympathy with the miners.

Foreign Competition and Output.

Another difficulty before them was the competition of other countries —America, Belgium, Germany and France. In none of those countries was the reduction of output per man a feature as it was with us. In America the production per man in almost all the great industries was about thrice as great as with us, and so though the workman had high wages, and a possibly higher standard of life, the cost of production was lower than ours. The present coal crisis was caused by America underselling us in every continental country, in spite of the handicaps of a much longer haul to the port of shipment, 3 000 miles extra by sea and 20 per cent. in exchange. Then there was Germany, where unskilled labour got 14s. to 17s. per week, skilled labour 35s. to 42s. per week, and with a 10-hour day. The German exporter was favoured by a very low exchange, and so in almost every article for which he need not import the raw material he could undersell them by 50 per cent. and make profits up to 50 per cent. A few months ago an English concern had to place a large order for constructional steel. The lowest British tender was one million pounds. A German firm of repute tendered at £550 000, and got the order. Here, in England, as long as the recent legislation imposing a 50 per cent. reparation duty was in force, there would be little imported from Germany, but the competition from it would have to be met everywhere except in France, the only other country which had imposed similar legislation. In Belgium and France also exports were favoured by a low exchange, and their labour, especially in Belgium, was working much harder than ours.

The chairman gave an interesting account of welfare work at Trafford Park and of the operation of the Works and Staffs Committees. The new research buildings were partly occupied and the rest would soon be ready for occupation. The laboratory would be ready in a few weeks. The department was doing most valuable work, not only in testing but in scientific investigation for the company and its allied concerns. The staff numbered 130, about 40 per cent. of whom were technically trained, most of the British universities being represented. The Education Department, admirably managed, like the Research Department, by Mr. Fleming, continued to expand. At the end of 1920 it had under training some 1,450 boys and men, of whom 100 were college apprentices of the university graduate type, 100 school apprentices from public and secondary schools, and 800 trade apprentices. Owing to the high reputation of the department, applications for admission were about ten times greater than the number accepted. It was found necessary to maintain those high numbers to meet the constant demand for junior staff by the various branches of the organisation. The company had lately taken over the management of the electrical department at Messrs. Vickers' works at Sheffield. That arrangement avoided the necessity of the provision of further buildings and equipment at Manchester and would in other ways prove of advantage.

The directors of the Mexborough & Swinton Tramways, Ltd., have declared a dividend of 2½ per cent., tax free, for the past year, after devoting £10 199 to repairs and maintenance, and placing £1 000 to reserve and renewals, &c., a sum of £593 being carried forward.

At the recent meeting of the London Stock Exchange, Mr. W. A. Barrow stated that there was an increase of nearly £4 000 in electric power, working expenses and maintenance in connection with the scheme for improving the lighting of the House, which would eventually run into about £12 000.

The board of the Calcutta Electric Supply Corporation, Ltd., recommend a final dividend for the year 1920 of 6 per cent., making 10 per cent. for the year, with an added bonus of 1 per cent. Both the dividend and the bonus will be paid free of the amount allowed for Indian taxation.

The profit of the Canadian General Electric Company, Ltd., for 1920 was $2 213 731, less $326 300 for interest and $530 741 for depreciation, leaving net profit $1 356 689. Dividends at rate of 8 per cent. per annum and bonus of 2 per cent. were paid on the common and 7 per cent. on the preference stock, leaving $342 574, plus $436 097 brought forward, making $778 672.

In regard to the recent offer of 300 000 8 per cent. second preference shares at par and 94 050 ordinary shares at 22s. 6d. of the City of London Electric Lighting Company, we learn that, in spite of the issue having been made at an inopportune time owing to the coal crisis and the labour situation, £173 000 of the preference shares were applied for by the public and the ordinary shares were considerably oversubscribed. Letters of allotment have been posted.

The gross receipts of the London United Tramways, Ltd., for 1920 were £532 742, an increase of £36 200, and the working expenses were £482 597, leaving a balance of £50 144, compared with deficit for previous year of £1 144. After charging debenture and loan interest there is £695 as a deduction from deficit for years 1918 and 1919. The effect of increased fares was only felt during part of year, while the increased working expenses prevailed throughout the whole of the year.

The revenue of the South Metropolitan Electric Tramways and Lighting Company, Ltd., for 1920 was £140 287. After deducting expenses, including debenture interest, and setting aside £10 500 to renewals fund, there remains £15 756, plus £1 507 brought in, making £17 264. The directors propose placing to debenture stock sinking fund £1 910, dividend on ordinary shares at rate of 2 per cent. per annum, carrying forward £1 556. Gross receipts from tramways and light railways amounted to £102 631, compared with £86 644.

The directors of the Rhondda Tramways Company, Ltd., have declared a final dividend of 2 per cent. for 1915, and 6 per cent. for 1916 on the preference shares. A sum of £14 000 has been placed to reserve, £39 404 appropriated for repairs, and £1 725 carried forward. The directors recommend that the 6 per cent. cumulative preference shares be converted into 8 per cent. non-cumulative preference, with participating rights to the extent of 25 per cent. in the surplus profits to be distributed. Arrears of dividend are to be waived.

The directors of the Indian Electric Supply & Traction Company, Ltd., state that the surplus on working in Cawnpore in 1920 was £34 969. With transfer fees, interest, &c., the total is £40 557. London expenditure was £2 462, and after providing £3 113 for debenture interest, profit is £34 981, plus £3 803 brought in, making £38 784. After placing to reserve for depreciation and renewals £6 000, to general reserve £6 500, and writing off certain items, the directors recommend final dividend of 7 per cent. (making 10 per cent. for the year), and carrying forward £5 074.

The report of the Radio Communication Company, Ltd., for the period from March 13, 1920, to the end of the year states that issued capital was increased by the subscription of 50 000 preference shares by a number of shipowners. This enabled the company to clear off charges upon its assets and to undertake establishment of a traffic clearing department, training operators and other development work. Trading did not commence until some time after the beginning of the period comprised in accounts, and consequently the total sales figure (£15 027) is low in comparison with expenses. The net loss is £8 878.

The gross operating revenue of the Western Union Telegraph Company for 1920 was $119 991 825, and after deducting expenses, depreciation, &c., the balance was $13 153 111. With $1 481 860 income from dividends and interest, the total is £14 634 972. Interest on bonds of the Western Union Company absorbed $1 331 850, and $517 400 was transferred to reserve for depreciation of securities, leaving $12 785 722, and with miscellaneous income, the total was $16 606 245. Dividends declared during the year absorbed $6 982 538, and the balance at Dec. 31 last was $40 685 210.

The accounts of the British Electric Transformer Company, Ltd., for the year 1920 show, after paying all manufacturing costs and expenses of administration, a net profit of £70 267, and with £10 523 brought forward, the total available balance is £80 790. The board recommend that £10 000 be placed to reserve and £3 000 to depreciation reserve. The preference dividend for the year absorbed £18 836 and it is proposed to pay a dividend of 10 per cent. on the ordinary shares (3 per cent. of which was paid as an interim dividend on Sept. 1 last), and a bonus of 2½ per cent., absorbing £40 625. The amount of extra remuneration to the directors is £2 150, leaving £6 178 to carry forward.

It is proposed to convert the 6 per cent. cumulative preference shares of the Rhondda Tramways Company into 8 per cent. non-cumulative participating preference shares with a 25 per cent. participation in the surplus divisible profits, the arrears of dividend being waived as consideration for the suggested alteration. The issued share capital is £150 002, in 100 000 cumulative preference, and 50 002 ordinary shares of £1 each, all fully paid. In 1919 the company declared a dividend of 8 per cent. on the preference shares, being as to 4 per cent. for 1914, and 4 per cent. on account of 1915, and it is anticipated that a dividend on the preference shares of 8 per cent. will again be declared for 1920.

The gross earnings of the Shawinigan Water & Power Company for 1920 were $3 943 359 and the operating expenses $228 467. After providing for repairs, taxes and insurances, general expenses, &c., the balance was $2 525 543. Interest on 5 per cent. consolidated mortgage bonds absorbed $250 000, interest on 5½ per cent. first refunding mortgage sinking fund gold bonds $306 131, interest on 7½ per cent. six-year gold notes $148 726, and after transferring $200 000 to depreciation, the net revenue was $1 609 042, plus balance from 1919 ($30 550), making $1 639 593. Dividends for year absorbed $1 400 000, reserve and sinking fund $50 000, and after making minor appropriations the balance is $39 593.

The accounts of the BRUSH ELECTRICAL ENGINEERING COMPANY, LTD., for the year ended Dec. 31, 1920, show a net profit of £191 096, to which must be added £74 726 brought forward, making a disposable total of £265 822. A sum of £13 000 is placed to depreciation account; the expenses of the new issue of ordinary shares made in 1920 (£15 576) are written off, a sum of £2 044, being a further 4 per cent. for the year, is paid to the 6 per cent. second prior lien debenture holders, £533 777, being added to general reserve, raising this account to £75 000. A dividend of 15 per cent. per annum on the ordinary shares, absorbing £38 557, will be recommended to the shareholders, leaving £143 268 to be carried forward, subject to taxation demands and directors' additional remuneration.

Mr. T. M. C. Steuart, who presided over the annual meeting of the PARA TELEPHONE COMPANY, LTD., last week, stated that the profit for the year on the issued capital of £72 000 amounted to £12 718, and with £6 426 brought forward, the total available was £19 144. An interim dividend of 3 per cent. had been paid on the ordinary shares, and the directors recommended a final dividend of 7 per cent., making a total distribution for the year of 10 per cent., both the interim and final dividends being tax free. A sum of £8 605 would be carried forward Although the telephone subscribers had increased during the year, the number was not so large as anticipated owing to the abnormal conditions in Para. A considerable extension had been made in the telephone system in order to incorporate districts hitherto outside the company's system and the directors anticipated that the opening up of the new districts would substantially add to the number of subscribers.

The directors of the BRITISH L. M. ERICSSON MFG. COMPANY, LTD., recommends a dividend of 8 per cent. (tax free) on the ordinary shares for the past year, after placing £10 000 to reserve and £18 721 to depreciation account and making other appropriations. The balance carried forward is £39 094, subject to taxation demands. Last year 10 per cent. was paid and £48 656 carried forward.

At the annual meeting of the URBAN ELECTRIC SUPPLY COMPANY, LTD., last week the chairman, Mr. P. D. Tuckett, pointed out that although they were doing largely-increased business, the shareholders were not earning anything on their capital. It was an utterly fantastic conception to suppose that a progressive business could be carried on under such conditions. With regard to the current year's prospects, their contracting profits were likely to be substantially smaller, and the power loads in the industrial towns had shown a marked reduction during the past three months, but the most serious and certain reduction of profits was that which faced them in connection with their Cornish undertakings. For the past three years they had received a dividend of £7 200 from the Cornwall Power Company. Last year that company experienced the best year it had ever had, realising a gross profit of nearly 10 per cent. on its entire capital expenditure, but this year it appeared doubtful whether it would realise any profit at all, owing to the collapse of the tin mining industry.

The accounts of the MADRAS ELECTRIC TRAMWAYS (1904), LTD., for the year 1920 show a gross profit of £41 103. After debiting interest and London office expenses, making provision for debenture stock sinking fund and transferring £15 000 to depreciation and renewal account, the balance is £15 693. Adding £4 944 brought forward, the total available is £20 637. The dividends on the preference shares absorbed £6 000 and the interim dividend of 4 per cent. on the ordinary shares (paid in September last) £2 290. The directors recommend that out of the balance of £12 346 a further dividend of 4 per cent. be paid on the ordinary shares, making 8 per cent. for the year (tax free), that a contribution be made to employees' gratuity fund of £1 000 and that £3 500 be transferred to general reserve, leaving to be carried forward £5 556. The traffic receipts and running expenses in rupees show increases of 16·6 per cent. and 24·4 per cent. respectively on 1919. The balance from running account shows a considerable increase, but, in comparing the figures with previous years, regard must be had to the par value of the rupee, which was 2s. for 1920 instead of 1s. 4d.

Mr. D. Sinclair, who presided over the first ordinary general meeting of the INTERNATIONAL AUTOMATIC TELEPHONE COMPANY, LTD., last week, explained that the company held shares in the Automatic Telephone Manufacturing Company and was formed for strengthening the position. A large number of questions, many of them of an international character, had to be considered, and Mr. Adams, president of the company, and Mr. Mellinger, a director, were now on the Continent in order to arrange matters in the interests of the company, for it was necessary to be in touch with telephone interests in almost all parts of the world. The company had secured and handed over to the Manufacturing Company orders for large exchanges in South America, Japan, India and other countries, including an order from Mesopotamia for about £28 000 of equipment. When a country like Mesopotamia could do that it could readily be understood that when the forward countries really took up automatics the field was very large. It had not been possible to pay a dividend for 1920, but it was hoped that the work done and the large amount of money put into the business would in the near future earn profits, which would recompense those who had done the work as well as the shareholders.

The net revenue of the NORTH METROPOLITAN ELECTRIC POWER SUPPLY COMPANY for 1920 amounted to £96 175, compared with £62 381 for 1919. Adding interest and dividends received and balance brought forward, the total is £103 395. After paying mortgage, loan and debenture interest (£18 701), providing £2 000 for debenture reserve fund and placing £16 011 to reserve, there is a balance of £66 683. The directors propose to appropriate £35 999 for the year's dividend on the 6 per cent. cumulative preference shares and to pay a dividend on the ordinary shares at the rate of 7½ per cent. per annum (£26 251), leaving, to be carried forward, £4 433. The total number of units sold showed an increase of about 18 per cent. compared with 1919. Since Dec. 24 last a supply of electricity in bulk has been given to the Harrow Electric Light & Power Company and a bulk supply agreement has been concluded with the Welwyn Garden City, Ltd., for distribution in the Welwyn Garden Estate. As the outcome of negotiations with the Metropolitan Electric Tramways, Ltd., and Middlesex County Council for an increase of the rates of supply to the 56 route miles of tramways and light railways operated by the Tramway Company, a satisfactory arrangement has been made. The pre-war supply contracts with the Metropolitan Borough of Stoke Newington have been annulled and negotiations are proceeding with the Council for a continuation of supply upon improved terms. The North Metropolitan Electrical Power Distribution Company, in which the Company is interested, has made satisfactory progress and is paying an ordinary dividend at the rate of 4 per cent. for 1920. Under orders obtained from the Minister of Transport, increased rates of charge for supply for private purposes were introduced at the commencement of the midsummer quarter in 1920. Additional generating plant has been installed at Brimsdown Power Station and will be ready for use within the next few months. Extensive alterations and improvements are in progress at this station for the installation of further generating plant. The consent of the Minister of Transport under the Public Utility Companies (Capital Issues) Act, 1920, has been obtained to the increase of the borrowing powers by the creation and issue of mortgage debentures or debenture stock or the raising of loans to an extent not exceeding one-half the amount of the share capital issued and paid up.

The ninth ordinary general meeting of the AUTOMATIC TELEPHONE MFG. COMPANY, LTD., took place at Liverpool last week, the Chairman (Mr. Jas. Taylor, J.P.) presiding. In moving the adoption of the report and accounts, he said the year's profit was £15 369, and after taking into account the balance brought forward and making provision for depreciation, preference dividend and other outgoings, a balance of £6 861 was being carried forward. It was regretted that it was not possible to pay a dividend on the ordinary shares. The agreement made in March, 1920, with the International Automatic Telephone Company for the promotion of sales of the Strowger automatic telephone in colonial and foreign territories was proving successful and would be justified. The directors' efforts had been chiefly concentrated on the arrangement necessary to cope with a larger volume of business, and that had involved the expenditure of a large amount of money, which had not shown any immediate profit-earning result. Nevertheless, the first-fruits were manifesting themselves in valuable orders received from Japan, India, South America and elsewhere, and it was indicated that many large telephone administrations had finally decided that for economic reasons the advantage of automatic over manual telephones was already beyond dispute. The directors had found it necessary to increase the Company's engineering and manufacturing capacity to a very great extent. After detailing some of the additions made, he said that as the expense involved was for development purposes, which should favourably reflect on future business, they had decided to charge only two-thirds to the 1920 account, the balance being charged to a development account. During 1920 they had to carry out a large amount of reorganisation and construction work, which had temporarily militated against their earning capacity, but such work was necessary and the directors had confidence in the results, provided the workpeople did not prejudice by adherence to a policy of limited output the Company's ability to meet foreign competition, and provided also that general international business was of a normal character. A hopeful feature was the company's railway signalling department, because, when released from Government control, the railways of the country would necessarily have to spend money in improvements, and from the opinions expressed by railway engineers on the different devices introduced by the Company, it would appear that a fair share of that business should be secured.

New Companies.

The following list is compiled from information supplied by Messrs. Jordan & Sons, Ltd., company registration agents, Chancery-lane, London, W.C.2:—

EAGLE INDUSTRIAL CORPORATION, LTD. (174 135).—Reg. April 9, capital £1 000 in £1 shares, to carry on business of mechanical, electrical, and general engineers. Subscribers: E. Howard (3, Howard-street, Strand, W.C.) and Emily F. Scaplehorn. Private company.

ELECTRICAL DEVICES, LTD. (174 038).—Reg. April 4, capital £1 000 in £1 shares, to carry on the business of electrical supplies. Subscribers: J. R. Cox (17, Douglas-road, N. 1), J. Dunscombe and A. T. Dowles. Private company.

GLOBE & SIMPSON, LTD. (173 934)—Reg. March 29, capital £2 000 in £1 shares, to acquire and carry on business of electrical equipment engineers. Directors: R. C. Globe, T. W. Globe and S. Higgs. Reg. office: 32, Burgess-street, Barker's Pool, Sheffield. (Private company.)

MANCHESTER ELECTRICAL MAINTENANCE COMPANY, LTD. (173 969).—Reg. March 31. Capital £1 000 in £1 shares, to carry on the business of electrical, mechanical and sanitary engineers. Directors: W. Fazackerley, D. Foofe, H. Renshaw and W. Walfenden (12, Mattison-street, Openshaw, Manchester). Private company. Reg. office: 183, Stockport-road, Ardwick, Manchester.

M. C. WHITAKER, LTD. (173 667).—Reg. March 12, capital £500 in £1 shares, to carry on the business of import and export merchants and dealers in lamps, shades, lamp fittings and gas and electric light fittings. Directors: A. McWhirter and H. C. Laker. Reg. offices: 18, Benjamin-street, E.C. 2.

MIDLANDS TELEPHONE DIRECTORIES, LTD. (173 651).—Reg. March 11, capital £2 500 in £1 shares, to enter into an agreement for the purchase of the right of publishing a Classified Commercial Telephone Directory. Directors: A. R. Tidswell and A. Howard. Reg. office: 3, Broad Street-buildings, E.C.

OLDHAM ELECTRICAL CONTRACTORS, LTD. (174 140).—Reg. April 9, capital £1 000 in £1 shares, to acquire and carry on business of electrical engineers and electrical contractors. Directors: F. Lord (chairman). Reg. office: 46, Barker-street, Oldham. Private company.

Arrangements for the Week.

FRIDAY, April 29th (to-day).

INSTITUTION OF ELECTRICAL ENGINEERS—STUDENTS' SECTION.

6.30 *p.m.* At the City and Guilds (Engineering) College, South Kensington, London, S.W. Annual General Meeting and Paper on "Radio-telegraphic Transmitting Apparatus," by Mr. A. C. Warren.

INSTITUTION OF ELECTRICAL ENGINEERS—SCOTTISH CENTRE.

7.30 *p.m.* At the Technical Institute, Dundee. Paper on "Some Thermal Characteristics of Electric Ovens and Hotplates," by Messrs. E. Griffiths and F. H. Schofield.

JUNIOR INSTITUTION OF ENGINEERS.

8 *p.m.* At 39, Victoria-street, London, S.W. Lecturette on "Rambling Remarks on Expert Evidence," by Mr. W. A. Tookey.

MONDAY, May 2nd.

INSTITUTION OF ELECTRICAL ENGINEERS—WESTERN CENTRE.

7 *p.m.* At the Grand Hotel, Broad-street, Bristol. Presidential Address by Mr. Ll. B. Atkinson.

WEDNESDAY, May 4th.

UNIVERSITY OF LONDON.

5 *p.m.* At University College, Gower-street, London, W.C. Lecture on "Wireless Telegraphy and Telephony by Continuous Waves," by Prof. J. A. Fleming, F.R.S. (Lecture II.)

INSTITUTE OF METALS.

8 *p.m.* At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Annual May Lecture on "The Casting of Metals," by Prof. T. Turner, M.Sc.

THURSDAY, May 5th.

IRON AND STEEL INSTITUTE.

10 *a.m.* At the Institution of Civil Engineers, Great George-street, London, S.W. Annual Meeting. Papers to be read: "The Welding of Steel in Relation to the Occurrence of Pipe Blow Holes and Segregates in Ingots," by Mr. H. Brearley; "Solid Solution of Oxygen in Iron," by Mr. J. E. Stead, F.R.S.; "Scientific Control of Combustion," by Mr. H. T. Ringrose; "Open-hearth and other Slags—their Composition and Graphic Methods for Determining their Constitution," by Mr. J. E. Fletcher; and "Notes on the Cleaning of Blast-furnace Gas," by Mr. S. H. Fowles.

INSTITUTION OF ELECTRICAL ENGINEERS.

6 *p.m.* At the Institution of Civil Engineers, Great George-street, London, S.W. Continuation of discussion on "Tariffs."

7.30 *p.m.* At the Connaught Rooms, Great Queen-street, London, W.C. Annual Dinner.

FRIDAY, May 6th.

IRON AND STEEL INSTITUTE.

10 *a.m.* At the Institution of Civil Engineers, Great George-street, London, S.W. Papers to be read: "The Prevention of Hardening Cracks and the Effect of Controlling the Recalescence of a Tungsten Tool Steel," by Mr. S. N. Brayshaw; "On the Cause of Quenching Cracks," by Messrs. K. Honda, T. Matsushita and S. Idei; "Slip-lines and Twinning in Electro-deposited Iron," by Mr. W. E. Hughes; "Cupric Etching Effects Produced by Phosphorus and Oxygen in Iron," by Mr. J. H. Whiteley and "Röntgen Spectrographic Investigations of Iron and Steel," by Mr. A. Westgren.

JUNIOR INSTITUTION OF ENGINEERS.

8 *p.m.* At Caxton Hall, London, S.W. Lecturette on "Fire Resistance of Aggregates for Reinforced Concrete," by Mr. D. W. Wood.

RÖNTGEN SOCIETY.

8 *p.m.* At the University, Manchester. Paper by Prof. W. L. Bragg and a Demonstration of Some Electro-physiological Experiments, by Prof. A. V. Hill.

Forty Years Ago.

(THE ELECTRICIAN, April 30, 1881.)

AMPÈRE'S LETTERS.—The correspondence of Ampère, which was in the possession of M. Charles Levêque, has been given to the Library of the French Institute.

THE SWAN & CROMPTON LAMPS.—A successful experiment has been made at Norwich in having a Swan incandescent lamp in the same circuit with a Crompton arc lamp of 6 000 c.p.

THE PARENTAGE OF THE TELEPHONE.—The little city of Brantford, Ontario, claims the honour of being the place where Professor Bell carried on his first experiments which led to the discovery of the telephone.

THE FINSBURY TECHNICAL COLLEGE.—The laying of the foundation of this institute, which was fixed for the 3rd of May, is postponed until the 10th of May, owing to Prince Leopold, who is to perform the ceremony, being unable to attend on the first-named date.

ELECTRICITY FOR DOMESTIC USE.—*La Lumière Electrique* says that M. Regnier is engaged at the laboratory of M. Phillipart in the Rue Bazen, Paris, in the solution of the problem of storing electricity, and utilising it for the production of light and motive force for domestic use.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics": "The Monaco Seaplane Meeting"; and "Flying Boat Construction," by D. Nicholson.

"The Cabinet Maker": "Wages in the Furniture Trade"; "The Decoration of Furniture"; and "Reflections on the Furniture Exhibition."

"The Chemical Age": Special Paints and Varnish Issue: "Preservation of Chemical Works Plant and Structures," by C. B. Jones; "Substitutes for Linseed Oil in the Paint Industry," by P. J. Fryer; and "The Chemistry of Paints and Varnishes," by R. S. Morrell.

"Farm and Home": "Men and Affairs in the Agricultural World"; "Rabbit Keeping for Profit"; and "1921 Tractor Trials."

"The Fruit-Grower": "Visit of the Prince of Wales to the Chamber of Horticulture" (Illustrated); and Commemoration Banquet.

"Gardening Illustrated": "Narcissus Imperator" (Illustrated); "Cinerarias"; and "Some Early Flowering Rhododendrons."

"Hardware Trade Journal": "Notes on Pumps" (I.), by Joseph Horner; "Retail Prices"; and "The Material and Construction of Dairy Utensils."

Prices of Metals, Chemicals, &c.

TUESDAY, April 26.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£71 10 0	10s.	—
Electro Wirebars	,,	£74 0 0	—	—
H.C. wire, basis	per lb.	0s. 11½d.	—	—
Sheet	,,	1s. 0½d.	—	—
Phosphor Bronze Wire (*Telephone*)—				
Phosphor-bronze wire, basis	,,	1s. 3½d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1d.	—	—
Wire, basis	,,	1s. 1d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£6 10 0	5s.	—
Galvanised steel wire, basis 8 SWG	,,	£27 0 0	£1 0 0	—
Lead Pig—				
English	,,	£22 5 0	—	—
Foreign or Colonial	,,	£20 15 0	2s. 6d.	—
Tin—				
Ingot	,,	£174 5 0	£5 0 0	—
Wire, basis	per lb.	2s. 4¾d.	0s. ¾d.	—

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £13 10s.

,, (Roll-Brimstone).—Per ton £12 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £32 10s.

Boric Acid (Crystals).—Per ton £69.

Sodium Bichromate.—Per lb. 7½d.

Sodium Chlorate.—Per lb. 5d.

Rubber.—Para fine, 10½d.; plantation 1st latex, 11d. to 10¾d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

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Notes.

The Institute of Physics.

We welcome most heartily the further step which was taken last week towards the establishment of an Institute of Physics. At the inaugural meeting which was then held, addresses were delivered by Sir J. J. Thomson, the President-Elect of the Institute and by Mr. A. J. Balfour, Lord President of the Council. The causation and history of the new body are well known to readers of The Electrician. But, shortly, the Institute of Physics may be said to have sprung from the need which the war showed for the work of the applied physicist, as distinct from that of the engineer on the one hand and from the chemist on the other; and consequently for a body more representative of the interests of these workers than those excellent societies the Physical Society, the Optical Society and the Faraday Society could hope to be. How great the need for such an Institute is and how numerous the ranks of those from whom its members may be recruited is clear from the remarks of Sir J. J. Thomson, which we summarise on another page of this issue.

Development, Great but not Sufficient.

Extraordinary as the development has been in the short space of 50 years, it is obvious that much more remains to be done and that we are still not taking real advantage of that potential knowledge which exists among our students to-day. This is evident from the fact that in 1916 the number of scientific men, including engineers, who took first or second class honours degrees was less than 500. Even allowing for war conditions, this is in all conscience small enough. At the same time at one end of the scale we need in industry the work and advice of the applied physicist and at the other end a realisation by our young men and women that physics is a branch of knowledge in which they may find a useful, though unfortunately not yet a remunerative, livelihood. For, as might be expected, this double lack is due to the almost criminal indifference of our Government to the necessity of financing what may be conveniently called research. For all that great development of which Sir J. J. Thomson is justly proud has been achieved in spite of rather than because of Government grants or Government sympathy; and if Mr. Balfour is to be understood aright that lack of funds and assistance is to be equally evident in the future. Mr. Balfour's attitude and Mr. Balfour's speech indeed represent very justly the outlook of that better sort of politician who takes a dilettante interest in science and scientific development in the hope apparently that in some vague way it may be turned to political advantage. With this end in view such politicians do something in the way of honouring scientific aims and results with their lips, but almost nothing towards showering *largesse* from the Treasury chest.

Encouragement of Physical Science a Necessity.

In a word it is still not realised, even by such enlightened politicians as Mr. Balfour, that money spent on such objects as the Institute of Physics wishes to promote is not only well, but is essentially spent. For by increasing the educational standard of those who work in physical science we not only raise individual knowledge to a higher plane, but assist, as has been so often shown, in the development of our industrial activities. So that while it is generally agreed that the present is not the time for launching out into fresh expenditure of the taxpayers' money, we may well ask whether some of the money now spent on armaments, overgrown departments like the Ministry of Transport and the Ministry of Agriculture, on unemployment doles and on ministerial salaries might not be diverted to assist science and invention, a policy which, as Mr. Balfour truly pointed out, would give comfort and leisure instead of discomfort and labour to the world at large.

The Knell of British Trade.

The seriousness of the disabilities under which British industry is suffering at the moment can hardly be overstressed. During the month of April the coal trade, our great key industry, was entirely stagnant; and now we are simply living on our stocks. As the days pass without the miners' dispute being settled matters will naturally become worse and even if the dispute were settled to-morrow many weeks must elapse before the conditions that existed before April 1st, bad as they were, could once more be retrieved. Discussion, statistics, polemics, invective and arguments for and against national "pools" and wages boards have led this phase of the problem to be obscured. And blame must be awarded to all parties for sticking so steadfastly to their original case and thus allowing, not only their own industry, but the trade of the country generally, to be brought to the brink of ruin—how near we cannot yet conceive. On the other hand, it must be admitted that any settlement which does not contain permanence as one of its essential ingredients would be worse than no settlement at all. For the country's real need is industrial stability, so much so that it would be worth while making almost any concession to obtain it.

A General Lack of Stability.

It is not going too far to say that this stability is generally lacking. For the results of the coal dispute are brought home so nearly to everyone that the fact that matters are running by no means smoothly between employers and employed in other industries is likely to be overlooked. If anyone doubts the truth of this, however, they need only refer to certain statistics issued recently by the Minister of Labour. These show that during March alone the total number of trade disputes involving stoppages of work was 42, while in addition 63 disputes, which commenced before March, were still in progress at the beginning of the month and the estimated aggregate duration of all trade disputes during the month was about 469 000 working days. Faced by such conditions, it is obvious that we can never hope to recover our previous industrial pre-eminence and it is equally certain that such instability is bad, not only for Capital, but for Labour as well. Until we can once again build up our trade on a sure foundation, as Mr. F. W. Harbord rightly pointed out in his presidential address to the Institution of Mining and Metallurgical Engineers, there is not the slightest chance that our industrial outlook will ever be better than it is at present. A truly appalling prospect!

Too Much Overhauling.

We admit that the industrial machine might be improved in many ways. But what we do not admit is that it can be improved by constant interference with its mechanism or by constantly stopping it in the hope in some vague way of increasing its efficiency. If Labour would consent to desist temporarily from striving for an ideal and Capital would realise that its best interest lies in paying as high a wage as is economically possible and in rendering the conditions of employment as comfortable as present conditions will allow, our return to stability would be much more rapid and a large number of those obstacles to progress which now seem insuperable would automatically disappear. Such a state of things can, in our opinion, be most easily brought about by the moderate men on both sides taking a more leading part in the discussion and regulation of matters tending to their mutual interest. Thus a solution of present difficulties that would be both just and stable would be obtained.

English Electric Progress.

Notwithstanding the adverse industrial conditions prevailing, the English Electric Company succeeded during 1920 in showing an increased profit of £86 101 compared with the previous year. The report indicates that the ordinary dividend is maintained at 8 per cent. and that after creating a capital reserve account of £125 000, writing off the expenses of the debenture issue and the 8 per cent. six-year notes, an increased amount is carried over. Not only this, but stocks and works in progress have been written down on a very conservative basis to present-day values, all pointing to prudent administration and auguring well for the future of this important company.

A Policy of Consolidation.

As our readers are aware the English Electric Company owns and controls a number of works which were formerly under other management, and in the past year successful efforts have been made to consolidate the organisation into one living whole. Satisfactory progress was made in the adaptation of the Coventry works originally belonging to the Ordnance Company, and in the restoration of the other factories to their normal activities. Apparently the policy is to devote each works to the manufacture of that class of machinery for which, by reason of its lay-out and past history, it is best adapted. In spite, however, of the volume of work in progress, and of the necessity of taking no action which would impair their power to meet commitments, substantial progress has been made with the scheme for the best possible utilisation of their five works. At Coventry the Company manufacture turbo-electric units of very large sizes, rolling mill equipments and the larger classes of engineering products. Preston, which has for long been well-known as an important centre of traction work, has now specialised even more completely in that branch of the industry; and at present electric locomotives, in addition to every kind of electric traction equipment, are being manufactured there. At Rugby and Stafford the manufacture respectively of medium size steam turbines and of electrical generating and industrial machinery has been further developed. The Bradford works, which have been specially laid out for the smaller range of industrial motors, have now in addition their own machine moulding plant. Such a policy is obviously the correct one, and cannot, we feel convinced, fail of success.

The Future

In common with the majority of electrical manufacturers the English Electrical Company has a considerable number of orders in hand. It has just secured another important contract for generating plant at Leicester, and among interesting colonial and foreign contracts we notice that it is proceeding with the work of converting to electric traction the Arthur's Pass section of the Midland Railway of New Zealand. There is, therefore, no immediate fear of lack of work even though the industrial outlook is far from cheerful at the present. Nevertheless the Board is wisely devoting close attention to the question of economy in selling expenses at home and abroad, and no doubt when the scheme of reorganisation and consolidation is completed even better results than those of 1920 will be shown in future years. It is gratifying to learn, on the authority of the chairman, Sir Charles Ellis, G.B.E., K.C.B., that the company has a loyal and devoted staff, while its relations with its workmen are excellent. We hope that these happy conditions will continue. Like other engineering firms, the English Electric Company was affected in 1920 by the unfortunate effects of the moulders' strike, which began in 1919 and was protracted into the early part of the year. In recent months there has been a welcome improvement in the position, and the company has been able to enlarge and improve the foundry capacity of its own works, thus becoming to a greater extent independent of outside suppliers.

Ship Lighting.

The lighting of ships, which was discussed at the last meeting of the Illuminating Engineering Society, is a subject on which comparatively little has been written, though it certainly deserves fuller treatment. On large liners the illumination is probably in general good, at any rate in the part of the ship used by first-class passengers. On many cargo vessels, however, there is little doubt that the lighting often falls considerably below the standard customary on land. Yet there seems no valid reason for parsimony. Mr. W. J. Jones, who read the introductory Paper at the meeting in question, pointed out that, on large ships, energy for lighting at present usually forms only 1 to 2 per cent. of the total generated. Electric lighting has naturally become pre-eminent on steam vessels, in view of its being comparatively unaffected by gales and severe weather conditions. There are, however, special problems to be taken into consideration, such as the confined space available for fittings, which must also be unaffected by the motion of the ship and are, therefore, invariably mounted direct on the walls or ceilings. Care must also be taken that in lighting compass-dials, &c., there is no electro-magnetic disturbance of the needle. The illumination of charts by concealed methods also offers room for study, and was the subject of discussion at the meeting. Some of the measurements of illumination recorded by Mr. Jones seem unduly low, judging by standards on land. We notice that in one case even the chief electrician's room only received 0·6 ft.-candles, and the steward's bathroom only 0·3! The importance of adequate lighting in the hold and engine-room should be evident; the painting of all surfaces a dead white is a great help in such cases. It would certainly be useful if the Illuminating Engineering Society, in co-operation with the Admiralty the Mercantile Marine Service Association and other bodies represented in the discussion, could prepare some form of standard schedule for ship lighting as has already been done for many kinds of buildings on land.

Recording Telephone Calls.

Those ardent critics of our telephone system, the daily newspapers, seem at last to have got hold of a case which really calls for investigation, not only from the organising but from the technical point of view. It appears that a subscriber in Cardiff recently closed his house for about three weeks, but that during his absence he was debited with 74 calls in spite of the fact that there was nobody in the house. Protests of this kind, though not of quite so definite a character, have been made before, and the official reply has always been that such accidents cannot occur as the call is not booked until proper communication has been established. There have been grave suspicions, suspicions amounting almost to certainty, that this is not the case and that, especially in busy exchanges, the operator presses the necessary button for registering the completion of the call before she is certain that communication has been satisfactorily established. We hope, therefore, that not only will this case be investigated but that the Post Office engineering department will push on as quickly as possible with the installation of recording meters on subscribers' premises. Only in this way will the very real doubt which exists among telephone users that their calls are not being properly registered be removed. An instrument of this kind is already being tried by the Australian Postal Authorities, but we do not know with what result.

Reduction of Peak Loads.

The British Electrical Development Association is doing excellent work in calling attention to possible ways and means of reducing peak loads and so effecting economies which come from such reductions. One of the ways in which this might be done with a little co-operation is in persuading works, offices and, we might add, shops to close at times differing by some short period such as half an hour. The effect which such staggered hours of closing have on smoothing out the load curve is evident from results of an investigation made recently in Boston. This investigation showed that at least 15 000 kW in generating capacity would be saved on the system of the Edison Electrical Illuminating Company if thirty industrial establishments would change their working hours by as little as thirty minutes. It may be pointed out that 15 000 kW represents about one-sixth of the total estimated peak load of the system at the present time, so that the comparatively small change in closing hours required to obtain so large an increase in available capacity is very striking.

Local Authorities and Public Lighting.

A case of considerable interest, involving the liability of provincial local authorities to keep places within their district properly lighted during the hours of darkness came before the Court of Appeal recently. The Glossop Corporation were sued by a man who suffered severe personal injuries through their alleged negligence in not lighting a lamp at the junction of three highways. Two of these thoroughfares were repairable by the Corporation, but the third had not been taken over. For reasons of economy, the lights in the borough were ordered to be extinguished at 9 p.m., and at the Manchester Assizes Mr. Justice Greer held that the effective cause of the plaintiff's accident was that there was no light at the cross roads, and that by causing the lamp to be extinguished the defendants, who were the lighting authority, had created a dangerous trap. Consequently, he awarded plaintiff £279 10s. as damages. The Court of Appeal agreed that the place where the accident occurred was dangerous, but held that Sec. 161 of the 1875 Act, though it gave the defendants authority to light their district, created no obligation on them to do so. It gave them, in fact, a discretion whether they would light the whole or only some portion of the district, and also as to when the lamps were to be lighted. Judgment was therefore entered for the Corporation on appeal. This is one of the cases where law and justice seem to part company. For while we believe the enunciation of the law by the Court of Appeal to be correct so far as local authorities outside the metropolitan area are concerned, we confess that we have a great deal of sympathy for the plaintiff, who not only had to suffer, but had to pay for doing so. It only shows that as a gamble going to law beats horse-racing hands down.

Insurance of Electrical Plant.

We are not surprised to learn that the insurance on machinery and plant has been increased during the past year. The principal reasons for this increase may be said to be delayed repairs and difficulties of maintenance during the war, together with higher wages for engineering inspectors. In consequence of the postponement of maintenance work, breakdowns have occurred which should, under ordinary circumstances, have been prevented. We learn from the speech of the Chairman of the British Engine, Boiler and Electrical Insurance Company that during the past year a number of particularly heavy losses were caused through the breakdown of large generating sets in public electricity supply stations. These breakdowns, with great impartiality, sometimes occurred at the steam end and sometimes at the electrical end. Reference is made to the recent accident at the Woolwich station, which involved the disintegration of a generator, a piece of which was flung across the Thames. No reasons are given for these accidents, and the Company's report would certainly be more interesting if it gave some more details. The Company states that public authorities are now more disposed to insure against these losses, especially since repairs to electrical machinery must be paid for at overtime rates, and cost three or four times as much as in prewar days. It is also to be noted that the Company decline to accept the risk of insuring German submarine engines, which have been acquired for land work. May we take this as an indirect compliment to British workmanship ?

An Interesting Omission.

An amusing exercise in journalistic circles is to write an article on the spring without mentioning the cuckoo or to indite a few paragraphs on cricket without mentioning the Australians. But Lord Montagu of Beaulieu has gone one better showing once again that the amateur can out-distance the professional, by writing an article in last Sunday's "Observer" on some ways of doing without coal and while suggesting oil, gas, anthracite, peat and wood, as possible substitutes and even putting in a word for tidal power has omitted all mention as to how present conditions might be improved by a greater use of electricity. We are not altogether surprised at this omission. And we certainly are not at all upset, for we feel sure that, whatever the other results of the present coal dispute, one of them will be an increased demand on the part of both manufacturers and of domestic consumers for electrical devices and apparatus. The reasons for this are not far to seek. Economy is certainly one; reliability is certainly another. For though after five weeks of coal stoppage there has inevitably been a serious reduction in the supply of electrical energy to factories, supply has not been cut off altogether, while the domestic consumer up to now has suffered scarcely at all. In addition, the use of electricity brings to the power consumer a relief from all responsibility connected with coal purchase, plant upkeep and labour questions connected with his own generating plant and instead provides him with a means of driving his machinery whose only care, so far as he is concerned, is to pay a quarterly bill, the amount of which he can determine for himself within narrow limits. In electricity, therefore, many of the inhabitants of the country will find a means of doing without coal, better, more economical and more convenient than the substitute methods suggested by Lord Montagu.

A Fuel Commissioner.

We are glad to see how much more attention than hitherto is being given to the subject of fuel economy. This is evident not only in the pronouncements of speakers and writers on engineering and allied subjects, but in the catalogues which we receive from makers of fuel consuming plant of all kinds. But while propaganda and technical improvements are both useful factors in ensuring a better use of our fuel resources we feel that much more might be done in modifying some of the processes at present used in the various industries. This would allow the fuel to be more efficiently employed and so lead not only to a decrease in the cost of production of a particular commodity, but to the well-being of the community generally. In our opinion a sure means to this end would be found not only in interlinking all fuel consuming plant in an area with the main electrical distribution system but by co-ordinating all industrial consumers, so that a common policy for the employment of fuel might be laid down. As fuel is at present employed waste is inevitable, and under modern conditions waste of any kind is almost criminal. But it can only be avoided by co-ordination. Incidentally by the help of such a policy many labour problems would be solved, and a great improvement in many manufacturing conditions achieved.

The Great Tariff Question.

In a country like the British Isles, where the population per acre is high, where industrial processes are usual, where people live crowded together and where a well-organised system of transporting goods and passengers is therefore a necessity, it is not a little extraordinary that the consumption of electricity per head is still so low. There are probably as many reasons for this state of things as there are inhabitants, and these reasons are controversial.

Dealing in this article solely with the effect of price on use, we might say that the price of electricity is too high to be attractive or, on the other hand, that if the value received by the consumer of electricity is worth the money he is paying to get it, sufficient public attention has not been called to its virtues. We might say that the price is too high to allow of increased consumption and that until the consumption is increased it will be impossible to quote a lower price. We might say that the various classes of consumer are not treated with relative fairness—that is, one class is penalised at the expense of the others; that the fact that certain classes of the inhabitants must use electricity has not been economically taken advantage of; that supply and demand have not been allowed to exercise their full influence and that there has been too much science and not enough commerce in fixing the rates charged.

Heresy and Orthodoxy.

Of these alternatives, we are inclined to think that the last is a truer explanation than any of the others. This is a change of view from the time when, some thirteen years ago, Mr. E. W. Cowan suggested that charges for electricity should be based, not on the cost of its production, but on its value to each class of consumer; and when we roundly condemned him as a heretic. We are glad to see that Mr. Cowan's head is still unbowed. For the heresy of yesterday is the orthodoxy of to-day, and, in any event, present conditions indicate very clearly that this complicated question of tariffs must be considered objectively rather than subjectively—*i.e.*, from the point of view of the consumer's ability or willingness to pay—rather than from the point of view of what it costs the undertaking to supply him with a particular unit at a particular time of the day or for a particular purpose. This fundamental factor is often obscured. Nevertheless, its essential truth remains.

Let us make our meaning quite clear. There is obviously a point below which the price cannot go if the undertaking is to remain sound. That does not affect our fundamental proposition. There is obviously also a need for a simplification of tariffs; but that also does not affect it. Nor should tariffs be fixed solely by a consideration of the coal costs, load factors, or capital charges; but by a consideration of the revenue which a consumer or groups of consumers may be expected to yield when a particular price is charged. This may seem an heretical method of determining charges, but it is the one followed in most other branches of commerce. Moreover, a simple tariff and low price per unit, even if not scientifically sound, will bring with them benefits which, theoretically, are supposed to be quite impossible of attainment.

Six and Seven Day Loads.

We hasten to add that it is both valuable and desirable for each undertaking to know what each unit supplied to each consumer or class of consumer costs, not for tariff framing purposes, but to check the working of the undertaking as a whole, just as costing systems are used to check and improve production, not primarily to fix the selling price. It is from this point of view that the Paper on "Electricity Supply: Present Conditions and the Hopkinson Principle," read by Mr. J. R. Blaikie before the Institution of Electrical Engineers last week, is especially valuable.

Stated shortly, Mr. Blaikie's argument is that the Hopkinson principle of charging is as sound as ever it was. Like most good things, however, it requires bringing up to date and he would do this by dividing his consumers into two big groups, those who require a supply for seven days a week, and those who require a supply only for six days a week. The prices charged the two classes of consumer would then be fixed on the basis of the cost of supplying each as a whole. A casual consideration will show that the cost per unit to the six-day consumer, or power user, with his large consumption spread over a shorter period, is much lower than to the seven-day or domestic consumer, with his smaller consumption spread over a longer period. Apart from that, however, coal costs are now a much more important factor in the fixed charges than they were in Hopkinson's day. Indeed, it may be said that the capital charges proper are quite submerged in the fixed cost of coal.

The Economic Advantages of Differentiation.

In making this attempt to revise the Hopkinson principle, Mr. Blaikie enunciates what is not only a new principle, but one that we think is economically sound. For there is a great deal in the argument that a consumer should not have to pay for what he never wants. His argument to make the fixed charges depend as directly as possible on the cost of coal, his statement that the "value-of-service" theory of charging is the only one of practical value, and his remark that the aim of the management should be substantial profits, with an eye to future competition, are all good. And we can equally heartily agree that "we should try and bring electricity supply more into accord with other forms of trading by aiming at a little higher profit and accepting a little higher risk." Would that such a policy had been more often followed.

The Advantages of the Firm Price.

We are not sure, however, that Mr. Blaikie does not counteract these sound arguments by suggesting that the fixed charges clause should contain a sliding scale depending on the variation of coal prices andthat, in addition, the price charged per unit should also vary with the price of coal. This, we feel sure, will not do. What happens under similar circumstances in business? When we buy any other commodity, such as bread in small quantities, we pay a price which is fixed day by day. If we buy it in large quantities we pay a price which is fixed over a longer or shorter period. The seller averages out the probable rise or fall in his costs and charges accordingly. What happens to these prices in the meantime is no business of the purchaser. And it is a little difficult to see why electricity supply should not be conducted on the same lines. Even the small consumer would benefit by knowing what each unit is going to cost him during a particular quarter and if this price varies from quarter to quarter he would still prefer to know what he was to be charged beforehand to the introduction of some vague percentage into his quarter's bill which will upset all his calculations. We cannot, therefore, too strictly insist that in electricity tariffs the need is for greater simplicity.

Sound Multi Part Tariffs.

The Paper read by Mr. J. W. Beauchamp at the same meeting as Mr. Blaikie's Paper is a considered argument for the replacement of flat rates by multi-part tariffs in domestic electricity supply for the reason that they are the only ones that are economically sound. Unfortunately, too many of them take into account the lighting load only. That is, sufficient regard has not been paid to the growth of the maximum demand which would follow the more extensive use of domestic apparatus. To overcome this difficulty Mr. Beauchamp would arrange the "fixed" part of his rate on a sliding scale depending not only on the kilowatt capacity of the apparatus but on its character and how it was used. That is, lighting apparatus would be charged at a comparatively high rate per kilowatt installed, large heating and cooking apparatus at a somewhat lower rate, "100 per cent. load factor" apparatus at a much lower rate, while small domestic apparatus, such as flat irons, would be free of capital charge at all. In addition, there would be a small price for each unit consumed and this price would be the same whatever the apparatus used. Experience will show, in Mr. Beauchamp's opinion, that the fixed rate can be determined not by the demands of each consumer, but by the demands of groups of similar consumers.

The Non-Technical Consumer.

This is all very well, but to us the one great difficulty about the idea is that which arises in every system based on equally sound principles—the difficulty of explaining to the non-technical consumer exactly how the fixed rate is made up and why his fixed rate should be different from the man's across the way. For here the fixed rate covers no renting of instruments or hiring, but simply that intangible thing demand. From this point of view the more simple the tariff the less the explanation, and the less the explanation the better for everyone. It is here that such systems as those suggested by Major Richardson, though we know they are not scientific, score, for any consumer can appreciate the equity of his fixed charges depending on the size of his rooms or even on his rateable value, but adequately to explain to a consumer why he should pay a different fixed charge for his lighting apparatus than for his cooking apparatus will require the production of some simple formula in which holes cannot be drilled by the ingenious.

The Dangers of an Illicit Union.

The advantages of Papers of this kind is that they tend to clarify ideas and to remove misapprehensions. Their disadvantage is that they tend to puzzledom and misapprehension. We have no doubt that Mr. Blaikie's and Mr. Beauchamp's Papers are open to both charges. Especially will this be the case with the supply engineer who is torn between the rival beauties of the purely scientific and the purely commercial scales. "How happy could I be with either," he exclaims, "were t'other dear charmer away." Let us advise him to discard in this one instance that clear-eyed lady Science, enter into a binding contract with her austerer sister Commerce and so escape all dangers of a bigamous union. The course of the discussion of these Papers shows that such advice is opportune.

Measurement of Power at Low Power Factors.

By H. COTTON, B.Sc., M.B.E.

The reading of a wattmeter is only equal to the true power in the circuit if the current flowing through the wattmeter pressure coil is in phase with the applied P.D. This, of course, is not the case since the pressure coil must have a finite inductance in order that it may produce a magnetic field.

If the current in the main circuit lags an angle θ and the current in the wattmeter pressure coil lags an angle φ, then the wattmeter reading must be multiplied by a correcting factor.*

$$K=\frac{\cos\theta}{\cos\varphi\cos(\theta-\varphi)}.$$

If current and potential transformers are used with the wattmeter then the angle φ is the algebraic sum of the phase angles of the wattmeter and the two instrument transformers.

$$\varphi=\alpha+\beta+\gamma$$

where α=phase angle of the wattmeter pressure coil.
β=phase angle of the potential transformer.
=phase angle between the primary applied P.D. and the secondary P.D. reversed.
γ=phase angle of the current transformer.
=phase angle between the primary current and secondary current reversed.

Fig. 1 shows the phase relations for a wattmeter used without instrument transformers E is the P.D., I the current and Ip the current in the wattmeter pressure coil. Fig. 2 gives the phase relations with transformers. A comparison of these figures shows that since the angle $(\theta-\varphi)$ in the correction factor is the phase angle between the current in the wattmeter pressure coil and the current in the wattmeter current coil, β is positive if the secondary P.D., E_1 (reversed), of the potential transformer lags behind the primary P.D. E (this is the case in Fig. 2).

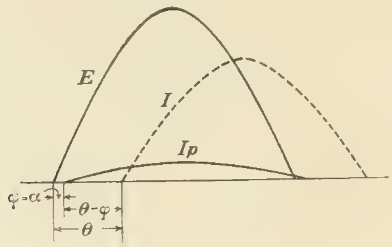

FIG. 1.

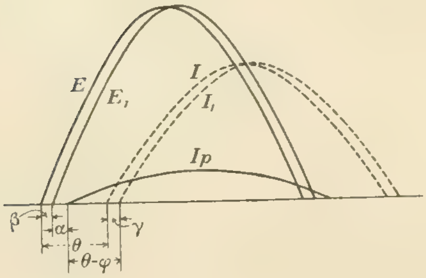

FIG. 2.

β is negative if the reversed secondary P.D. leads the primary P.D.

γ is positive if the secondary current I_1 (reversed) of the current transformer leads the primary current I.

γ is negative if the secondary current (reversed) lags behind the primary current (this is the case in Fig. 2).

α is practically always positive, and in a good standard instrument should not be greater than 10 minutes. On the other hand the phase angles of instrument transformers may be several degrees.

In order to use the above correcting factor it is necessary to know $\cos\theta$ the true power factor, but the wattmeter only gives the apparent power factor. This is taken into account as follows:—

True power is proportional to $\cos\theta$; apparent power is proportional to $\cos\varphi\cos(\theta-\varphi)$, which is proportional to $\cos\theta_1$.

Where $\cos\theta_1=\dfrac{\text{wattmeter reading}}{\text{volts}\times\text{amps.}}$=apparent power factor.

Therefore $\cos\theta_1=\cos\varphi\cos(\theta-\varphi)$
$=\cos(\theta-\varphi)$ very approximately, since φ being very small its cosine can be taken as unity.

Therefore
$$\theta_1=\theta-\varphi$$
$$\theta=\theta_1+\varphi$$

Correcting factor $K=\dfrac{\cos\theta}{\cos(\theta-\varphi)}$ (putting $\cos\varphi=1$)
$$\frac{\cos(\theta_1+\varphi)}{\cos\theta_1},$$

K is thus given in terms of the known apparent power factor $\cos\theta_1$.

The values of the correction factors are worked out in Tables I. and II. and plotted in Fig. 3. If θ_1 and φ are of the same sign, *i.e.*, if φ is positive and the current in the main circuit is lagging, or if φ is negative and the current in the main circuit is a leading one, the factor given in Table I. is used. If θ_1 and φ are of different signs, *i.e.*, φ negative and the main current lagging, or φ positive and the main current leading, then Table II. is used.

Table I.—*Apparent Power Factor*=cos θ.

φ	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
0° 20′	0· 942	0·9714	0·9814	0·9866	0·9898	0·9922	0·9940	0·9956	0·9971
0° 40′	0·8841	0·9429	0·9629	0·9732	0·9797	0·9844	0·9880	0·9912	0·9942
1°	0·8262	0·9143	0·9444	0·9598	0·9696	0·9766	0·9820	0·9868	0·9914
2°	0·6521	0·8284	0·8885	0·9194	0·9389	0·9529	0·9638	0·9732	0·9824
3°	0·4778	0·7422	0·8323	0·8787	0·9080	0·9288	0·9452	0·9594	0·9733
4°	0·3034	0·6557	0·7758	0·8377	0·8767	0·9045	0·9264	0·9453	0·9638
5°	-0·1289	0·5692	0·7191	0·7965	0·8452	0·8800	0·9072	0·9308	0·9540

Table II.—*Apparent Power Factor*=cos θ.

φ	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9
0° 20′	1·0578	1·0284	1·0185	1·0133	1·0100	1·0077	1·0059	1·0043	1·0028
0° 40′	1·1156	1·0568	1·0369	1·0265	1·0200	1·0154	1·0117	1·0086	1·0055
1°	1·1734	1·0853	1·0554	1·0398	1·0300	1·0231	1·0176	1·0129	1·0083
2°	1·3466	1·1703	1·1104	1·0793	1·0598	1·0459	1·0349	1·0256	1·0163
3°	1·5193	1·2550	1·1651	1·1185	1·0893	1·0684	1·0520	1·0379	1·0240
4°	1·6920	1·3392	1·2194	1·1574	1·1184	1·0906	1·0687	1·0498	1·0313
5°	1·8634	1·4231	1·2733	1·1960	1·1472	1·1124	1·0851	1·0616	1·0384

The expression for the correcting factor K can be transformed into the form

$$K=\frac{1+\tan^2\varphi}{1+\tan\theta\tan\varphi}.$$

Since φ is as a rule very small, $\tan^2\varphi$ can be neglected in comparison with unity. Thus if φ is as large as 2°

$$\tan\varphi=0\cdot0349$$
$$\tan^2\varphi=0\cdot00122$$

so that the error in neglecting $\tan^2\varphi$ is only of the order of 0·1 per cent.

The correcting factor is then

$$K=\frac{1}{1+\tan\theta\tan\varphi}.$$

If the wattmeter is used without instrument transformers $\varphi=\alpha$, the phase angle of the wattmeter,

$$K=\frac{1}{1+\tan\theta\tan\alpha}.$$

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* See any advanced text book on Alternating Currents *e.g.*, Kemp, "A.C. Electrical Engineering," p. 140.

Now $\tan \alpha = \frac{L\omega}{R}$.

Where L=Inductance of the pressure coil,

R=resistance of pressure coil,

$\omega = 2\pi \times$ frequency,

$$K = \frac{1}{1 + \tan\theta \times \frac{L\omega}{R}},$$

let W=true watts.

W_1=instrument reading.

$$W = \frac{W_1}{1 + \tan\theta \times \frac{L\omega}{R}}.$$

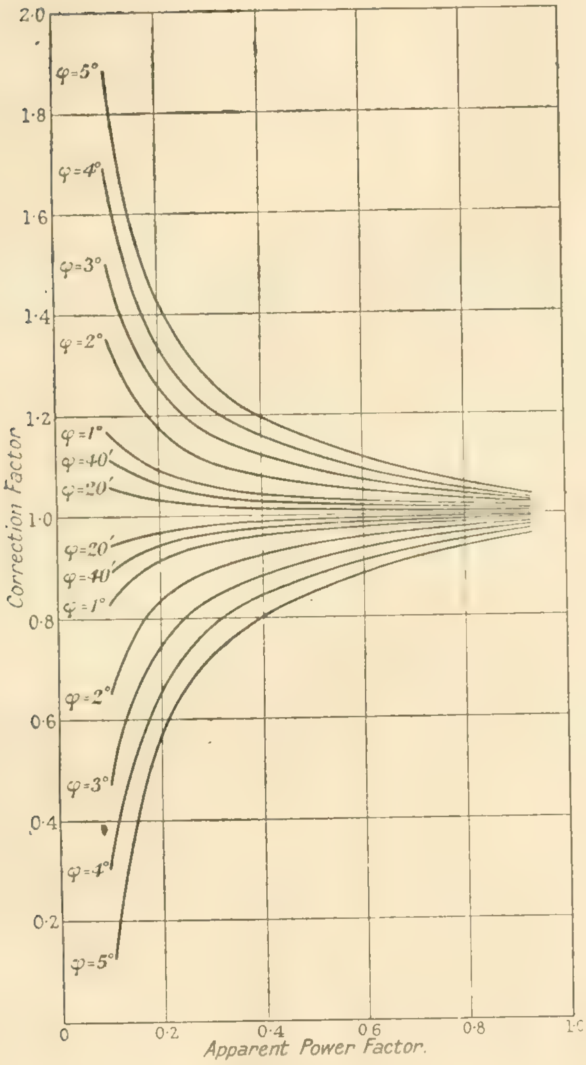


FIG. 3.

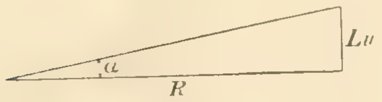


FIG. 4.

Therefore $W + W\left(\tan\theta \times \frac{L\omega}{R}\right) = W_1$

$$W\left(\tan\theta \times \frac{L\omega}{R}\right) = W_1 - W$$

$$= \text{Error}.$$

Suppose now a small coil of negligible resistance and of inductance equal to that of the pressure coil is placed in series with the wattmeter pressure coil; then if

W_2 = new reading.

$W_2 - W$ = the new error.

$$= W\left(\tan\theta \times \frac{2L\omega}{R}\right)$$

$$= 2 \times \text{the old error}.$$

Hence $W_2 - W_1$ = the error.

In this way the tables of correcting factors can be dispensed with.

For very low power factors the error in the wattmeter reading is so large that if the power to be measured is also small it is better to use some other means for measuring the power. This applies particularly to the determination of the iron losses in sheet iron. In such case the author has found the three voltmeter method to be useful.

The coil AB in which the power consumption is required is connected in series with a non-inductive resistance R and the voltages V_1 V_2 and V_3 measured across AB. R and the whole as shown in Fig. 5. Then the power:

$$W = \frac{1}{2R}(V_3^2 - V_1^2 - V_2^2).$$

In order to avoid the use of three voltmeters with the possibility of errors caused by slight differences between the instruments, a single voltmeter can be used by connecting it

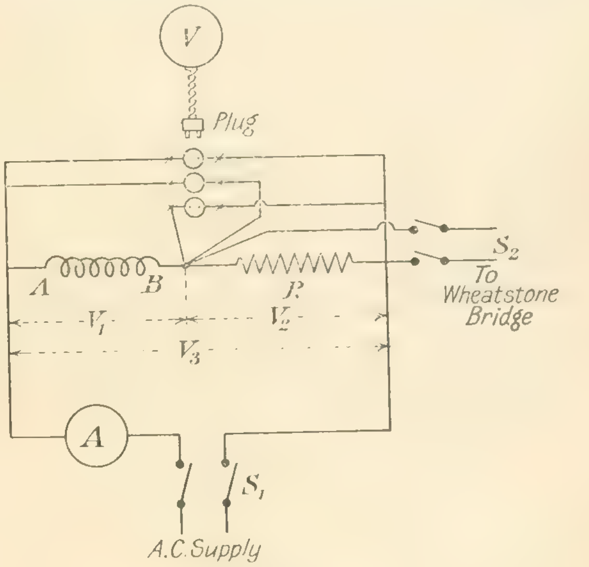


FIG. 5.

to an ordinary two-pin plug and connecting a number of sockets mounted on a board to the pairs of points between which the differences of potential are required. The most accurate results are obtained by making V_1 and V_2 as nearly equal as possible, that is, the supply voltage must be about twice that required across the coil AB. A water resistance is suitable, or a woven wire resistance in which the woof is the resistance wire doubled backwards and forwards, and the web an insulating thread (such resistances are made by the Cressall Manufacturing Company).

The advantage of a water resistance is that it can be adjusted to any desired resistance merely by moving the electrodes. Its disadvantage is that as it is gradually warmed up by even a small current its resistance decreases. Hence it is necessary to measure its resistance by the Wheatstone bridge or other similar means, immediately after each reading of the three voltages. This is easily done by opening the main switch, $S1$, and closing the switch $S2$, connecting AB to the bridge. With a wire resistance this is, of course, unnecessary, since its resistance can be determined beforehand.

The Theory of the Three-Phase Variable Speed Shunt Commutator Motor.

By J. L. D. RIDSDALE, M.Sc.

(*Concluded from page* 517.)

SELF-COMPENSATION.

In developing the foregoing theory, the leakage reactance of the windings of the motor and transformers has been taken as constant. It appears, however, as has previously been stated, that the leakage reactance of the rotor decreases as the speed increases. It will readily be seen that if this is so, a smaller "compensating" E.M.F. or brush shift will be required than would otherwise be the case, the extent of the reduction in either case for any value of speed depending on the extent to which the rotor leakage reactance varies with the speed, and on the ratio of the rotor leakage reactance at standstill to the leakage reactance of the transformers. If this ratio is sufficiently large, and the speed sufficiently high, the motor will become "self-compensating," *i.e.*, will attain unity power factor without any externally applied "compensating" E.M.F., or brush shift. In the case of the Schrage motor in which the leakage reactance of the whole of the secondary circuit is proportional to the slip (owing to the frequency of the currents in the secondary circuit being proportional to the slip and their phase rotation reversing at speeds above synchronism), the foregoing theory, which can readily be modified so as to be applicable to this type of machine, indicates that the motor becomes self-compensating at speeds approximating to 50 per cent. above synchronous speed, the exact speed of course depending on the constants of the motor.

SHUNT MOTOR WITH COMPENSATING WINDING.

In the type of motor last considered, the rotor ampere-turns are neutralised by inductive action, and, neglecting the impedance of the stator winding, the field strength is constant for all values of the speed, the variation of the no-load speed being produced by varying the magnitude of the E.M.F. impressed on the rotor brushes. The rotor ampere-turns may, however, be neutralised by means of a compensating winding placed on the stator and connected in series with the rotor, in which case the field may be provided by means of a seperate exciting winding placed on the stator. In this type of motor the variation of the no-load speed is obtained by varying the strength of the field, for which purpose the field-winding must be connected to a variable ratio transformer or auto-transformer. A diagram of connections is shown in Fig. 19.

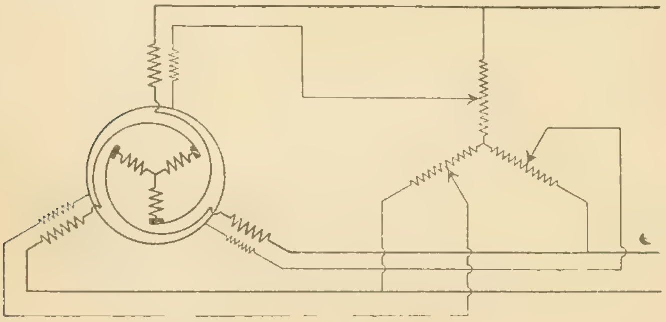
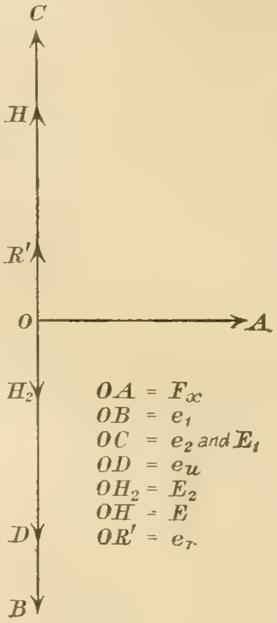


FIG. 19.

It will be clear that the E.M.F.s induced by the field in rotor and compensating winding are equal but opposite in phase and hence, neglecting for the moment the impedance of the motor, the rotation E.M.F. must be equal to the E.M.F. impressed on the terminals of the motor, and thus the speed of the motor will vary inversely as the strength of the field. The impressed E.M.F. must also be equal and opposite to the algebraical sum of the E.M.F. induced in the compensating winding and the rotor E.M.F. The E.M.F. e_1 induced in the compensating winding will be in phase opposition to the impressed E.M.F. E, and will be less than, equal to, or greater than the impressed E.M.F., when the motor is respectively running at hyper-synchronous speeds, at synchronous speed or at speeds below synchronism; correspondingly, the rotor E.M.F. will be in phase opposition to the impressed E.M.F., zero, or in phase with the impressed E.M.F. These relations will be rendered more clear by a reference to the diagram (Fig. 20), which is drawn for the case when e_1 is greater than E.



$OA = F_x$
$OB = e_1$
$OC = e_2$ and E_1
$OD = e_u$
$OH_2 = E_2$
$OH = E$
$OR' = e_r$

FIG. 20.

It will be seen that the effect is the same as if an E.M.F. E_1 equal and opposite to OB in the diagram were applied across the terminals of the compensating winding and an E.M.F. E_2 equal and opposite to OR' in the diagram were applied between the rotor brush and the neutral.

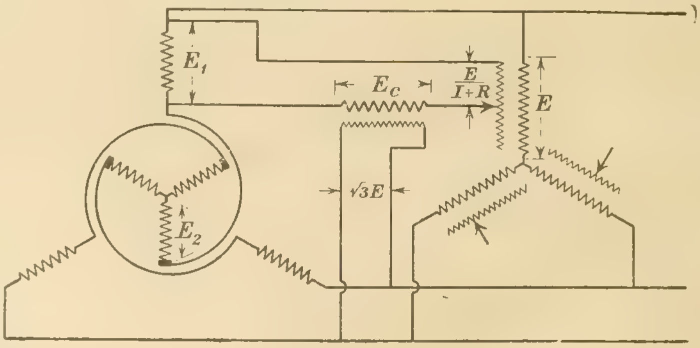


FIG. 21.

From the diagram (Fig. 20) the follwing approximate relations are at once obtained :—

$$e_u=e_2+E_2,$$

$$\frac{u_0}{u_1}=\frac{e_u}{e_2}=1+\frac{E_2}{e_2}=1+\frac{E_2}{E_1}=1+R,$$

or

$$u_0=(1+R)u,$$

which is the same relation as for the type of motor previously considered if in that case R_m be put equal to unity.

It is thus clear that both in the case of the conductively neutralised motor and the inductively neutralised motor, the speed can only be varied by varying the ratio, R, of the E.M.F.s across rotor and stator.

Further, it will be clear that if, whilst keeping the line E.M.F. E constant, there is actually impressed on the compensating winding an $E.M.F.$ E_1 or on the rotor an $E.M.F.$ E_2, then the speed of the motor can be varied by varying E_1 or E_2, as the case may be, and there is no longer any necessity for the separate exciting winding, as the windings of the motor will carry the necessary magnetising current. In Fig. 21 is shown a diagram of connections for a motor of this type having the "exciting" E.M.F. impressed on the compensating winding. (The connections for one phase only are shown.) As in Fig. 5 a compensating E.M.F. E_c is introduced for the purpose of compensating the reactance of the motor. Thus, the E.M.F. applied to the stator is not in phase with the line E.M.F. E, but consists of two components, one in phase with E and the other in quadrature with E.

In Figs. 22 and 23 are shown vector diagrams for the motor running at a speed below synchronism and at hyper-synchronous speed respectively. The notation corresponds to that used in the previous vector diagrams.

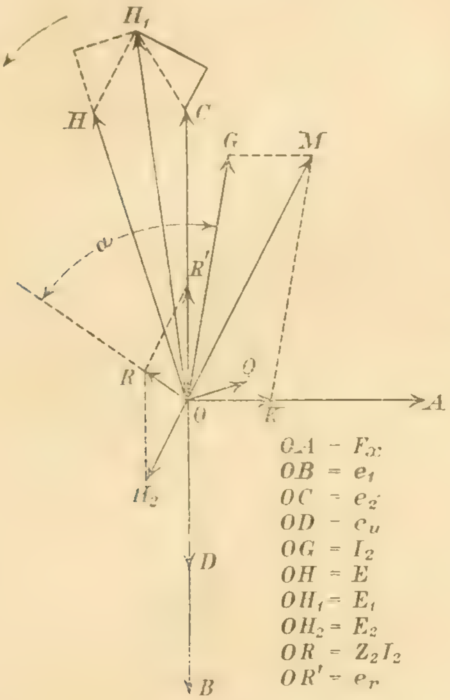


FIG. 22.

The vector diagrams apply both to the case where the "exciting" E.M.F. is impressed on the stator and to the case where the "exciting" E.M.F. is impressed on the rotor. In either case, it is the compensating winding which carries the exciting current. Thus, for a given speed and torque, the currents in the compensating winding and the rotor winding have respectively the same values, whether the "exciting" E.M.F. is applied to the stator or to the rotor. On the other hand, providing the speed is less than double synchronous speed the "exciting" E.M.F. has a smaller value when applied to the rotor than when applied to the stator.

From the diagrams, Figs. 22 and 23, the following vector equations are obtained :—

$$E_1 = Z_0 I_0 + Z_1 I_1, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (32)$$

$$E_2 - e_r = Z_2 I_2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

$$I_1 = I_2 + I_0, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (34)$$

also

$$E_1 = E\left[\frac{1}{1+R} - jQ\right],$$

$$E_2 = -E\left[\frac{R}{1+R} + jQ\right],$$

$$e_r = Z_0 I_0 S,$$

where R is the ratio of E_2 to E_1 when E is zero and $Q = R_c = E_c/E$.

As before, the effect of the "drop" in, and the magnetising currents of the exciting and compensating transformers is neglected.

Solving (32), (33) and (34) for I_0 and I_2 gives

$$I_0 = \frac{E_1 Z_2 - E_2 Z_1}{Z_2(Z_1 + Z_0) + Z_1 Z_0 S}, \quad . \quad . \quad . \quad (35)$$

$$I_2 = \frac{E_1 Z_0 S - E_2(Z_1 + Z_0)}{Z_2(Z_1 + Z_0) + Z_1 Z_0 S}, \quad . \quad . \quad . \quad (36)$$

and

$$I_2 = e_2 \cdot \frac{E_1 Z_0 S - E_2(Z_1 + Z_0)}{Z_0(E_1 Z_2 - E_2 Z_1)}. \quad . \quad . \quad . \quad (37)$$

It will be assumed that $r_2 = r_1$ and $x_2 = x_1$. Thus $z_2 = z_1$. Substituting for Z_0, Z_1, Z_2, E_1, E_2 and e_2, rationalising and separating real and imaginary terms, equations (35) and (37) become

$$I_0 = E\left[\frac{r_1\left(\frac{1-R}{1+R}\right) - 2Q(x_1 + x_0 . \overline{1+S}) - j\left[(x_1 + x_0 . \overline{1+S})\frac{1-R}{1+R} + 2Qr_1\right]}{r_1^2 + (x_1 + x_0 \overline{1+S})^2}\right] \quad . \quad . \quad . \quad (38)$$

whence the algebraical value of I_0 is

$$I_0 = \frac{E}{x_0}\sqrt{\frac{\left(\frac{1-R}{1+R}\right)^2 + 4Q^2}{(r_1/x_0)^2 + (x_1/x_0 + 1 + S)^2}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (39)$$

and

$$I_2 = \frac{e_2}{r_1(1+\tan^2\alpha)}\left[\frac{\left(\frac{R.\overline{1-R}}{(1+R)^2} - 2Q^2\right) - QK + S\left[\left(\frac{1-R}{(1+R)^2} + 2Q^2\right) + Q\tan\alpha\right]}{\left(\frac{1-R}{1+R}\right)^2 + 4Q^2}\right.$$
$$\left. - j\,\frac{\left(\frac{R.\overline{1-R}}{(1+R)^2} - 2Q^2\right)K - Q + S\left[\left(\frac{1-R}{(1+R)^2} + 2Q^2\right)\tan\alpha - Q\right]}{\left(\frac{1-R}{1+R}\right)^2 + 4Q^2}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (40)$$

Substituting for e_2 and converting into real form gives

$$\frac{I_2}{I_s} = 2\sqrt{\frac{\left[\left(\frac{R}{1+R}\right)^2 + Q^2\right]\left[(r_1/x_0)^2 + (1 + x_1/x_0)^2\right] + 2S\left\{\left[\frac{R}{(1+R)^2} + Q^2\right]\left(1 + \frac{x_1}{x_0}\right) + Q\frac{r_1}{x_0}\right\} + S^2\left[\frac{1}{(1+R)^2} + Q^2\right]}{(r_1/x_0)^2 + (x_1/x_0 + 1 + S)^2}} \quad . \quad . \quad . \quad (41)$$

where $I_s = \frac{E}{2\sqrt{r_1^2 + x_1^2}}$ is the short circuit current.

Since the slip is approximately equal to $-R$, equation (39) shows that if the impressed E.M.F. E is maintained constant the strength of field varies approximately as $\frac{1}{1+R}$.

The torque per phase in kg. metres is

$$T_q = \frac{E^2}{61{\cdot}6\,x_1 r_1(1-\tan^2\alpha)} \cdot \frac{1}{(1+R)^2}$$
$$\left[\frac{R.\overline{1-R} - 2Q^2.\overline{1+R}^2 - Q.\overline{1+R}^2.K + S[\overline{1-R} + 2Q^2.\overline{1+R}^2 + Q.\overline{1+R}^2.\tan\alpha]}{(r_1/x_0)^2 + (x_1/x_0 + 1 + S)^2}\right]. \quad . \quad . \quad (42)$$

The torque vanishes when the slip is

$$S_0 = -\frac{R.\overline{1-R} - 2Q^2.\overline{1+R}^2 - Q.\overline{1+R}^2.K}{\overline{1-R} - 2Q^2.\overline{1+R}^2 + Q.\overline{1+R}^2\tan\alpha}. \quad . \quad . \quad (43)$$

If $S=1$, *i.e.*, at standstill, the torque vanishes when

$$R = \frac{1 - Q(K - \tan\alpha)}{1 - Q(K + \tan\alpha)}.$$

This corresponds to the "short circuit" position. The "no-load" position corresponding to $R=-1$ cannot, of course, be attained as the difference between the E.M.F.s across the stator and rotor must always be equal to the impressed E.M.F. E.

The total current taken by the motor is easily obtained. For referring to Figs. 21, 22 and 23, the current flowing into the compensating winding from the mains is I_2, the current in the primary of the "exciting" transformer is $\frac{I_0}{1+R}$ and will be in phase with the vector OK. The current in the primary of the compensating transformer will be $Q\,I_0$ and will lag behind the impressed E.M.F. E by the same angle as that by which the vector $O\,K$ lags behind the vector OQ. Thus the primary of the compensating transformer takes a current $Q\,I_0$ in phase in the diagram with the vector $O\,C$. The total current taken by the motor is, therefore,

$$I-I_2+I_0\left[\frac{1}{1+R}+jQ\right], \quad . \quad . \quad . \quad . \quad (44)$$

and it will be easily seen that this expression represents the value of the total current when the "exciting" E.M.F. is applied to the rotor.

Inserting the values of I_2 and I_0, rationalising and separating real and imaginary parts, equation (44) becomes

$$I=\frac{E}{r_1(1+\tan^2\alpha)}\left[\frac{\begin{aligned}&\frac{R}{1+R}\left[(r_1/x_0)^2+\left(1+\frac{x_1}{x_0}\right)^2\right]+\left[\frac{1-R}{(1+R)^2}+2Q^2\right]\left[(r_1/x_0)^2+(x_1/x_0)^2\right]\\&+Q\left[\tan\alpha\left(1+\frac{x_1}{x_0}\right)-\frac{r_1}{x_0}\right]+S\left[\frac{1}{1+R}\left(1+2\frac{x_1}{x_0}\right)-Q\frac{r_1}{x_0}(\tan^2\alpha-1)\right.\\&\left.\qquad+\frac{R}{1+R}\right]+S^2\left[\frac{1}{1+R}-Q\tan\alpha\right]\end{aligned}}{(r_1/x_0)^2+(x_1/x_0+1+S)^2}\right.$$

$$\left.-j\,\frac{\begin{aligned}&\frac{R}{1+R}\left[\left(\frac{r_1}{x_0}\right)^2+\left(1+\frac{x_1}{x_0}\right)^2\right]\tan\alpha+\left[\frac{1-R}{(1+R)^2}+2Q^2\right]\frac{r_1}{x_0}\left(1+\frac{x_1}{x_0}\right)\Big(1\\&+\tan^2\alpha\Big)-Q\left(1+2\frac{x_1}{x_0}\right)+S\left[\frac{R}{1+R}\cdot 2\frac{r_1}{x_0}+\left(\tan\alpha\left(1+\frac{x_1}{x_0}\right)-\frac{r_1}{x_0}\right)\right.\\&\left.+\left(\frac{1-R}{(1+R)^2}+2Q^2\right)\left(\frac{r_1}{x_0}+\frac{x_1}{x_0}\tan\alpha\right)+2Q\frac{x_1}{x_0}\right]+S^2\left[\frac{1}{1+R}\tan\alpha+Q\right]\end{aligned}}{(r_1/x_0)^2+(x_1/x_0+1+S)^2}\right] \quad . \quad . \quad . \quad . \quad . \quad . \quad (45)$$

Curves for current speed and power factor, each as a function of the torque, can be obtained from equations (41), (42) and (45), and will be found to be similar in character to those in Figs. 8, 9 and 13.

Appended is a short bibliography of English and American literature on the subject of polyphase commutator motors.

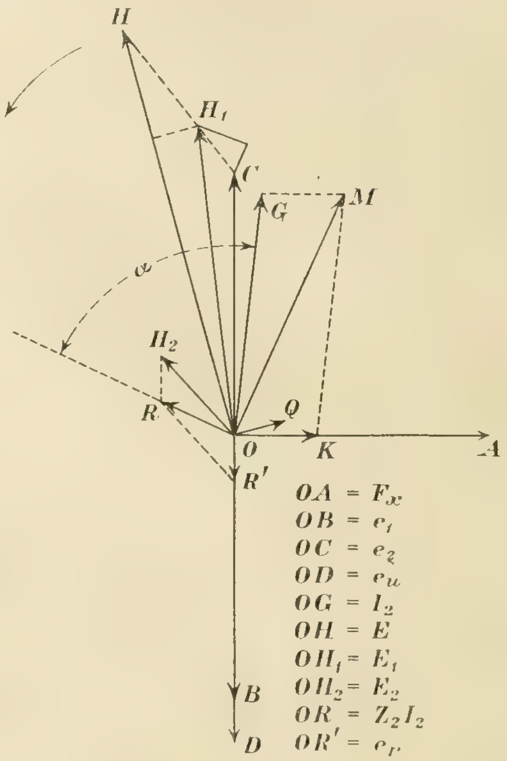


Fig. 23.

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Magnetic Storms and Railway Telegraph Apparatus.

In a Paper recently read before the Institution of Railway Signal Engineers Mr. W. J. Thorrowgood referred to the effects of several severe magnetic storms encountered in 1919-1920, which affected various circuits.

Generally speaking, results show that metallic circuits are slightly affected compared with earth-connected circuits. The remedy, therefore, appears to be to provide metallic returns, a number of circuits being conveniently served by a common wire. Return wires should, however, be sectionalised to assist in tracing faults. Resistances of instruments and circuits are preferably relatively high, with a view to diminishing induced currents. It is also suggested that special instruction should be given to signalmen, with a view to their noting and recording any irregular working of apparatus. A list of points on which records should be kept during magnetic storms is also presented.

Multi-part Tariffs for Domestic Electricity Supply.*

By J. W. BEAUCHAMP.

At present we are interested in modernising the home, and in finding out to what extent science and mechanical devices can reduce labour and make housekeeping easier under present conditions, without entailing too much capital expenditure. One of the most important factors in bringing about the fuller use of electricity for domestic purposes will be the principle of charging adopted for the electricity supply.

MULTI-PART TARIFFS.

The multi-part tariff is generally accepted as the most promising and equitable, and its progress has been delayed perhaps by too strong a desire to fix upon a correct or uniform tariff, rather than acceptance of the underlying principle. Proposed tariffs should be considered in relation to groups of consumers, not individuals. The multi-part tariff and its calculation involves consideration of the running rate or rates per unit for the energy supplied, easily determined and the fixed charges which present greater difficulties.

A new method of charging should be such that an immense consequent development will be profitable. Some engineers think of the fixed charge in terms of what to-day appears to be the normal lighting bill for a particular consumer. But a big increase in the heating and cooking load, due to such a tariff, may call for extensions in mains and plant which the fixed charge would not cover, and which would have to be met by the unit charge. This would entail an average charge too low for the consumer who makes but little use of electricity, and too high to encourage the one who employs it extensively.

Hence the fixed charge should be a function of the standing costs which the consumers or groups of consumers may entail as development proceeds; it must be related to kilowatts installed or maximum demand, allowance being made for the character and diversity of the load resulting from the different uses of the supply. The maximum lighting demand of consumers seems likely to decrease by reason of development of the lamp and by the more scientific use of it. It is not, however, likely that he will obtain apparatus for turning electricity into heat or power with an efficiency increasing greatly from year to year. Consequently the relation between maximum demand, units used and service rendered may be stable for a long time to come in the case of heating and cooking, but subject to progress and inventions in regard to heat storage.

It is suggested, therefore, that lighting should be dealt with by itself, and an annual charge in regard to it determined, after which further annual charges should be evolved for all other uses of the supply by considering the consumers where possible in groups. In this way one can obtain a clear view of the influence of groups of houses on the load curve and the mains. The home supply tariff may start with quite a high rate for normal lighting, and may secure a fair price for small additional use in fans, kettles, &c., but should continue to decrease through the consumption in cookers, fires, &c., ending in a minimum value which would apply to storage heaters or other 100 per cent. load-factor uses.

THE MINIMUM CHARGE.

The necessity of collecting a definite amount per year for standing charges has been recognised in the minimum charge. Usually this amounted to the equivalent of 20 kWh per quarter at the statutory maximum price, which, at 8d., gives £2. 13s. 4d. per annum. Recently it has become usual to allow 15 kWh for each winter quarter, and 10 kWh for each summer quarter, or 50 kWh per annum at the maximum rate, say, 1s. per unit, or £2. 10s. per annum. In many places to-day a consumer who pays less than £5 per annum is a source of loss to the undertaking.

Any minimum charge is difficult to understand and this has led some of the larger undertakings in the past either to reduce or waive it. This action has caused trouble to small undertakings who could not afford to do the same. When the minimum of 80 kWh per year was established, carbon lamps were in use. A small consumer might use two 30 c.p. lamps for 1 000 hours per annum requiring 240 kWh at 6d., *i.e.*, a cost of £6. To-day he would use only 60 kWh at 1s., or £3. In the first case his maximum demand was 240 W, in the second 60 W. Thus, for the same light value the consumer's bill has fallen to one-half, in spite of the charge per unit being doubled.

The best method of bringing home the soundness and advantages of the multi-part tariff lies in putting it forward as an alternative to a very high flat rate, and it will be necessary either to secure the right to associate such tariffs with much higher statutory maximum rates than now possible; or to introduce the new systems by means of very active propaganda, and support them by hiring out many of the appliances which the consumers will need if they are to take the fullest advantage of such tariffs.

Such new methods of charging are essential if the domestic load is to be secured and the benefits of fuller electrification obtained in the near future. The Electricity Commissioners should have the power to make such tariffs compulsory in any district or part of a district where the suppliers desired it.

SUGGESTED SKELETON DOMESTIC TARIFF.

Fixed Charge per Annum.—On capacity of apparatus in use or usable (divided quarterly into equal parts or otherwise).

(1) *Lighting.*—Up to and including 250 W, £x per annum. Above 250 W, per complete 50 W, £$x/10$ per annum.

(Intermittent lighting can be excluded, or a percentage only of installed lighting taken into account).

(2) *Heating and Power.*—Small appliances (say, up to 600 W each, with an aggregate limit of 2 000 W) having a very high "group" diversity in time and extent of use. No fixed charge.

(3) *Heating and Power.*—Appliances as (2), above 600 W each and 2 000 W aggregate. Ranges, fires, water heaters, &c. At the rate of 250 W for £$x/20$ per annum in steps of 250 W.

Running Charge per Unit.—A flate rate for all purposes.

The author analyses the average cost of energy under such a system, showing an average for lighting of 5·5d. per unit, diminishing to 4·5d. with small accessories to 2·16d. with electric range, and to 1·9d. with electric fires in addition.

TARIFFS FOR WORKING-CLASS HOUSES.

The introduction of electricity supply into the new housing colonies affords a good opportunity for experimenting with multi-part tariffs on account of the standardised character of the houses and the probable similarity of habits amongst those who will occupy them.

The best and most flexible method is to impose a fixed charge and record all supply by one meter for each consumer at a simple flat rate for all purposes. These installations may need only 80 to 100 kWh per annum for lighting at 8d. per unit, say. 52s. to 66s. 8d. per year, or 1s. to 1s. 3½d. per week.

Even a flat-iron used for two hours per week would increase the revenue by 13 to 10 per cent., while the use of a cooker might increase the revenue (at 2d. per unit) 2 to 2½ times. Hence the lighting business should be regarded rather as a means than an end.

WATER HEATING.

Every encouragement should be given to devices of the heat-storage class. There will no doubt be a field for small geysers, and the use of very large numbers would produce a valuable load, but the heavy cost of internal wiring must also be considered. To raise 6 gallons of water from 58°F. to boiling point requires (at 90 per cent. efficiency) 3 kWh; on a 200-V supply an appliance to effect thus in 20 minutes would be of 9 kW capacity and take 45 A and in 10 hours would be of 0·3 kW capacity, and take 1·5 A.

EXPENDITURE ON DISTRIBUTION.

The following figures indicate approximately the relation between capacity and cost of low-tension cables laid under average road conditions:—

Copper area.	Ratio of area.	Cost laid.
sq. in.	Per cent.	Per cent.
0·0145	100	100
0·0225	155	104
0·06	413	134
0·1	690	163

Future success may depend largely on ability to invest freely in such works at first, and the will to load them up by the proper use of publicity, hire of appliances, &c. The possibility of offering to large possible consumers small redeemable shares or bonds to support a special extension fund, deserves attention. Something of this kind has been done on a larger scale in connection with power supplies. The 6 per cent. Housing Bonds offer an analogy.

The number of consumers on public electricity supplies in the United Kingdom is stated to be between 900 000 and 1 000 000 (services), or, say, 10 per cent. of the total number of buildings and dwellings; assuming that 25 per cent. are at present beyond the reach of the supply, the remainder, 65 per cent or 6½ million, are waiting for the progressive supply engineer who, in entering these premises, also admits the manufacturer and the contractor.

In an appendix to the original Paper the author works out examples for a flat or villa, and a working-class home, showing how, by the use of accessories, cooking and fires increases of revenue of from 100 per cent. to 600 per cent. may be anticipated.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

Electric Supply: Present Conditions and the Hopkinson Principles.*

By J. R. BLAIKIE.

The Paper draws attention to the changes that have come about since the late Dr. John Hopkinson devised the system of dividing the costs of electric supply under fixed and running charges. The fixed charge consisted of three items, interest and redemption of capital, certain wages, rents, rates, &c., and a proportion of coal.

At that time, and for many years later, capital charges were over 50 per cent. of the total fixed costs. It was not worth while to distinguish between classes of consumers with regard to the remaining portion of the fixed charge. When large factory loads developed, important differences arose. The cost per kilowatt demanded for capital charges for factory loads may be half that for lighting. Moreover, the factory runs for a limited number of hours a week at definite times, with a proportional reduction in coal per unit.

Since the war, the rise in the price of coal and rates of wages has altered matters. The whole capital charges may be from 25 to 30 per cent. of the whole fixed charge, instead of over 50 per cent. Again, the metal-filament lamp has entirely altered the position as regards lighting. Also the development of electric power in individual factories has made it possible for such concerns to install their own generating plant. Hence the time is ripe to divide consumers into two groups, in regard to the coal and wages portion of the fixed charge. The Paper gives a practical method of making this distinction.

In the Paper the author next reviews the problems discussed in Dr. Hopkinson's classic Paper, showing in greater detail how the original conclusions have been modified by new developments. He proposes to divide consumers broadly into two groups, (*a*) requiring a supply for seven days a week (public lighting, domestic lighting and some heating, some power, and sometimes traction supply), (*b*) requiring a supply for six days a week only (practically all factory power and lighting supply, shop lighting and some heating). Heating demands in the seven-day group may be regarded as balanced by shop lighting in the six-day group, which simplifies the problem. The following table compares typical present-day conditions with those in former years:—

Fixed Charges.

	Hopkinson Hypothetical Station.	Actual Case, 1914-1915.	Actual Case, 1919-1920.
	Per cent.	Per cent.	Per cent.
Coal	21	23	32
Other charges	22	37	42
Capital	57	40	26
Total	100	100	100

Now that the costs of coal and wages predominate differences between classes of consumers are important. If the central supply does not take full credit for savings due to limited hours of demand, the margin of profit becomes very narrow, in view of competition with private plant. The factory load deserves careful study, so that companies may feel sure of their ground in offering sufficiently low rates to consolidate business and yet work profitably.

Six and Seven Days Load.

The author attacks the problem by following Dr. Hopkinson's methods in regard to a hypothetical station running under present conditions, assuming a plant of four turbo-generator sets, each of 1 000 kW, the service being designed to meet demands of 800 kW for lighting and 1 600 kW for power. The whole station load factor is taken as 20 per cent. 5·43 lb. of coal are used per unit sold for power, 8·05 per unit sold for lighting. It is deduced that approximately 5 000 000 kWh are developed for the six-day group (power) and 7 000 000 kWh for the seven-day group (lighting). The percentage of output to plant works out as follows:—

		Usual load factor
Lighting	12½ per cent. ...	12½ per cent.
Power	67½ per cent. ...	23·7 per cent.

Typical data for a number of districts, including Bedford, Derby, Burton-on-Trent and West Ham, are presented. The ratio of the coal consumed by the six-day group to the seven-day group in these cases proves to be:—

Bedford	10 lb. to 28·6 lb. per unit sold
Derby	10 lb. to 25·0 lb. per unit sold
Burton-on-Trent	10 lb. to 27·0 lb. per unit sold
West Ham	10 lb. to 40·7 lb. per unit sold

The author next considers fixed charges, the wages increase since 1915 having been out of all proportion to output, and it is suggested that a ratio between the two groups should be found from the average of the four years preceding 1915, which can be applied throughout the disturbed years. Here, again, data on existing supply concerns are provided. Data sheets giving running cost per unit for 1914-15 (0·252d.) and 1915-16 (0·356d.), and values for standing charges. The latter work out to £17·64 and £4·932 per kilowatt demand for seven-day and six-day groups respectively in 1914-15, and to £21·08 and £5·888 in 1915-16. Revenue sheets for both years are also tabulated. In 1915 the cost of the various services was private lighting 4·15d.; public lighting, 1·91d.; power and heating, 0·907d.; with coal at 12s. 10d. and an overall factor of 19·4 per cent. The ratio of prices is believed to be in accordance with several experiences. In 1920, with coal at 32s. 9d. and other costs in proportion, the corresponding figures would be: private lighting, 9·35d.; public lighting, 3·72d.; power and heating, 1·73d.

Suitable Charges.

In the concluding portion of the Paper, the author endeavours to frame suitable charges for the six-day and seven-day classes of consumers. Thus for the six-day group the tariff might include: (1) 1d. a unit and/or a sliding scale percentage according to load-factor; (2) a coal clause (*e.g.*, 4d. per 1 000 units for each 6d. variation in the price of coal); and (3) a fixed-charge clause, a sliding scale per 1 000 units, according to load factor for each 6d. variation in the price of coal per ton.

The total rate should not exceed 3d. a unit.

The author finally summarises his conclusions as follows:—

(1) It has been shown by a hypothetical case and by actual figures that there is a substantial difference in the cost of supply depending on the degree of readiness to meet the demand.

(2) It has been shown that there is a substantial difference in capital charges to supply different classes of consumers.

(3) A method has been shown by which consumers may be segregated to satisfy (1) and (2) within reasonable limits.

(4) A system of analysis has been shown, making it possible to produce systematically revenue account sheets, year by year, indicating the profits and losses on the several services.

(5) Protective clauses, coal and "fixed charges," have been reviewed and discussed.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

The Institute of Physics.

On Wednesday, April 27, the inaugural meeting of the Institute of Physics took place at the Institution of Civil Engineers, and addresses were delivered by Sir J. J. Thomson, O.M., F.R.S., the prospective President of the Institute, and the Right Hon. A. J. Balfour, O.M., F.R.S.

Sir Richard Glazebrook, who presided, said it took some time, in the early stages of the war, to convince the Government and those responsible of the assistance that physics could give to the nation in its time of trial, but in the end that was done and they now realised how fully physics and physicists were necessary and how fully they assisted in the work that was undertaken. It seemed necessary to some of those who thought about the matter that there should be an Institution to do for the physicist what was done by the great Institution in whose room they were now meeting for the profession of the engineer, and so a few physicists, representing the Physical Society, the Optical Society, and the Faraday Society, came together in 1918 and devised a scheme for the foundation of an Institute of Physics. Yeoman work was done by the gentleman first responsible for the organisation of the Institute, including Prof. Lees, Prof. Porter, Dr. Eccles, Mr. Cooper and others. Already about 300 gentlemen and ladies had become members and they welcomed there that evening one Honorary Member, Sir J. J. Thomson, who had allowed himself to be nominated as President of the Institute and would, no doubt, be elected at the annual meeting a month hence.

Progress of Physics.

Sir J. J. Thomson said the Institute had become necessary because there were now no inconsiderable number of men and women earning a livelihood as physicists, and he estimated the potential members in the Kingdom, possessing the necessary qualifications, at between 800 and 1 000. It was only lately that the need for an Institute of Physics had become acute in consequence of the establishment of research institutes, and in the National Physical Laboratory and the National Services there were physicists who had no direct representation. He remarked that in a few months he would have been for 50 years a student of physics, and he went on to contrast with the present time the numbers and size of physical laboratories, the cost of equipment, the number of instruments available and the number of students 50 years ago. The estimate for the equipment of the Cavendish Laboratory, for instance, was only £6 300. At that time the positions open to physicists were a few badly professorships and worse paid masterships in public schools, and the only people who then made physics their profession were those enthusiasts to whom the delight of research far more than compensated for the smallness of their salaries. That inducement was a potent one, because it attracted to physics men like Kelvin, Stokes, Maxwell, Crookes, Balfour Stewart, Osborne Reynolds, and others of similar calibre who did great work. In those days there were few instruments, and fewer students wishing to use them, but now the number of students had multiplied by a still higher factor than the instruments, and a director of a laboratory had to exercise some of the functions of a League of Nations, who had to keep the peace, he was going to say, between belligerents. A physical laboratory then was a rare thing, but now there was hardly a respectable secondary school without one. One satisfactory feature of the present time was the increased belief in the use of physics to our various industries. Some large firms had their own laboratories, but there was still need for the physicist in the work itself—for scientific supervision of the process when it got to the scale in which articles were manufactured in large quantities. He thought the demand for physisicts was far in excess of the supply and there was every possibility of that continuing. A Commission of which he was president went into the question of how many men in the universities took first or second-class honours in science, and came to the conclusion that at that date (in 1916) the number was less than 500, including engineers, chemists and medical men who took tripos in some biological subject.

Need of Support for Research.

To increase the output of physicists was somewhat difficult. Lately, thanks to the Advisory Committee on Scientific and Industrial Research, he thought the circumstances had materially improved. That Committee, on which he had the honour to sit, awarded grants for students in training which provided the expenses for a year's training in research. In the last 12 months 37 of those grants had been made. Research was not only expensive for the student, but also for the University—the increase in the cost of apparatus was horrible. But he thought it had been met by recognising that research was as much a function of the University as education, and that the grants made to Universities should be made on that principle. Thanks to the generosity of the Government and of private individuals much more money was now available for research than had ever been the case before. The result of that was that the output of scientific work had been enormously increased. According to "Biedermann's Beiblatter," there were 400 Papers on physics produced in the whole world in 1873, whereas in the last year before the war the number had increased to 2 700. With all the development of physics, stimulated perhaps by the needs of our industries, he saw no disposition to neglect or undervalue pure science, which was undertaken without any thought of an industrial application. Apart from its industrial applications, the increase of pure research was deserving of encouragement. If it did not yield a material harvest, it would yield an intellectual one, and he thought the increase in our intellectual pleasure derived from our increased grasp of the order and unity that ran through Nature was to many minds a higher reward than increased comfort or convenience.

Research Organisation.

Mr. A. J. Balfour said he was deeply gratified at having an opportunity of taking part in that meeting, although he was not easy to say what his special title was to address such a gathering. He wished he could say that he had an inspiring effect upon the Council on Scientific and Industrial Research, of which he was President. The public knew little about their work—the public very seldom knew much about the things which most deeply concerned them. When he saw great industrial disputes going on about the distribution of the results of industry he could not help thinking, "Why do you not devote half the energy and half the amount of money involved to increasing the power of man over Nature, which would increase the total result which has to be divided amongst the members of the community, instead of devoting all your energies to saying how the relatively petty amount we produce is to be divided amongst the producers." The mere expenditure of money, the mere growth of laboratories or the multiplicity of students would not of themselves bring to maturity some great discovery, but organisation and money were required if great discoveries were to be encouraged and bring admirable fruits to knowledge and industry. It was a grief to him that the Treasury was compelled to cut down the sum at its disposal for the aid of scientific and industrial research. No money was better spent than money spent for that purpose. Both Edinburgh and Cambridge Universities, of both of which he happened to be Chancellor, were groaning under this disability. It arose from the fact that they had done so much and meant to do so much in the future in connection with science, and not least physics, that it was impossible to carry on the work as it ought to be carried on without more assistance than an impoverished state could easily give or than wealthy men in the community seemed prepared to give. He was surprised that the imagination of those magnates was not stimulated by the idea that they could actually add to the wealth of the whole world by encouraging industrial research. There was nothing selfish or narrow about the results of physical knowledge. They were a gift to all mankind. The reasons why men who did not lack the spirit of liberality nor the means of exercising it did not do more was due, he thought, to a misapprehension of the real facts of the case, and to that fatal desire to see an immediate result of any effort that might be made. The hope for the world was that the growth of science and invention would give comfort and leisure where at present discomfort and labour were the only means of producing an article. That was all based upon the work of men who were engaged as they were in probing to the bottom the secrets of Nature.

Carrier Current Telephony and Telegraphy.*

By E. H. COLPITTS and O. B. BLACKWELL.

(*Concluded from page 487.*)

Line-Balancing for Two-way Operation.

The general problem of line balancing is much the same as with balancing at ordinary frequencies for telephone repeaters. The original contains brief notes on one or two special features occurring in carrier systems. A typical arrangement is shown in Fig.11.

Interference Between Circuits—Transpositions.

The transpositions existing in open-wire telephone circuits are generally inadequate to balance the circuits sufficiently accurately for the higher frequencies of carrier transmission.

Fig. 12 shows the values of interference at different frequencies between two pairs of wires which are adjacent on the cross-arm. Curve A shows typical values for circuits as measured with the ordinary telephone transpositions in them. Curve B indicates the great reduction made in the cross-talk by inserting transpositions in both of two circuits extending between Toledo, Ohio, and South Bend, Indiana, making the average number per circuit about six per mile. Inasmuch as these circuits are adjacent pairs on the line, the exposure between them is the maximum possible.

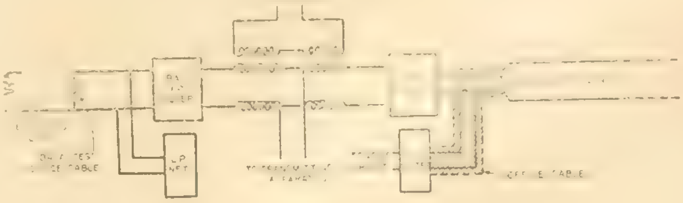

Fig. 11.

Where carrier systems employ the same frequencies for transmission in the two directions, it would not be practicable to operate systems on all the pairs of a line, since the number of transpositions required would be prohibitively large. In fact, in a lead carrying a considerable number of circuits, the transpositions would have to be more closely spaced than are the poles under present standard construction. It is possible, however, to reduce greatly the effect of interference between circuits, by employing systems using different frequencies in the two directions, and arranging so that all the systems employ the same range of frequencies in each direction.

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*Abstract of a Paper presented at the 1921 Midwinter Convention of the American Institute of Electrical Engineers.

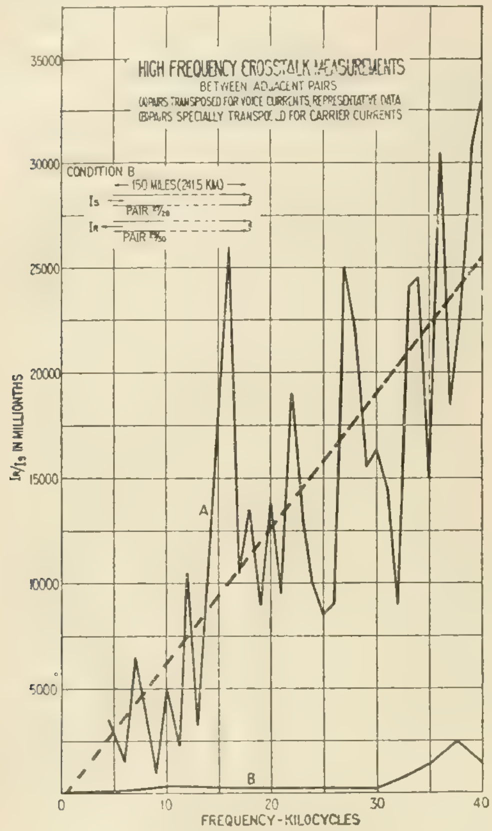

Fig. 12.

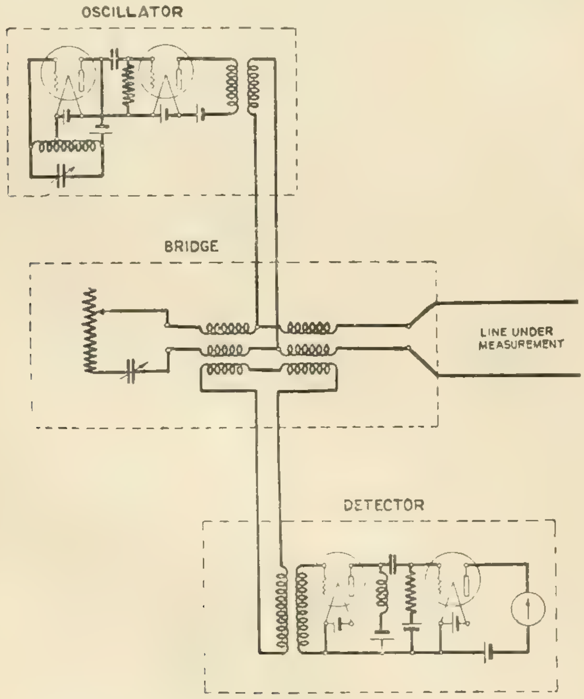

Fig. 13.

This reduces, of course, the number of two-way channels which may be obtained per pair. It is not certain, however, that even with this arrangement of carrier systems it would be economical to apply carrier to all pairs of a pole line.

Noise Interference.

As the frequencies used in carrier systems are considerably higher than the harmonics which are generally present in power systems, these circuits are less subject to noise from power interference than are the ordinary telephone circuits. They are not free from such interference, however, since high frequencies may be set up in power systems by the charging of lightning protectors, switching, &c. Since the circuits cannot in general be as well balanced to earth at carrier frequencies as at ordinary telephone frequencies, the carrier channels have shown a certain amount of interference from atmospheric electrical effects—that is, so-called static. Some interference has also been experienced from high-power long-distance radio systems, which are now employing frequencies within the same range.

Line-Measuring Apparatus.

Methods and apparatus for making measurements on lines at the working frequencies have been developed. Photographs of portable test sets are given in the original. Attenuation measurements on lines up to 250 miles have been carried out by the use of thermo-couple meters and oscillators having an output of 50 mA at frequencies from 100 cycles to 50 000 cycles. For longer circuits comparison methods using a sensitive amplifier detector have been used. Impedance measurements are made with a high-frequency bridge of the differential transformer type. The circuit of oscillator, bridge and detector is shown in Fig. 13.

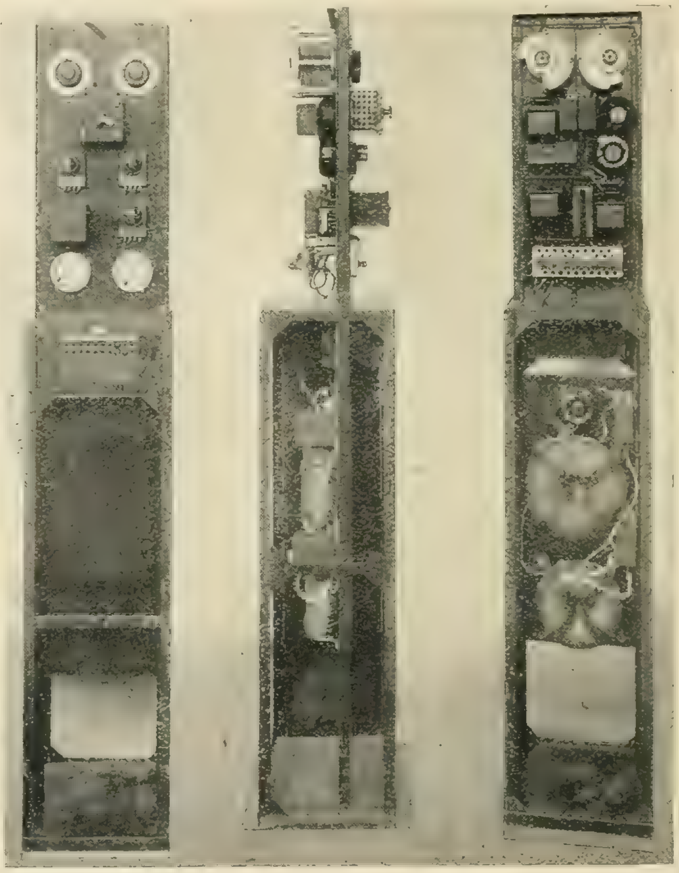

Fig. 14.

Commercial Apparatus and Installations.

Under the section of commercial apparatus and installations descriptions are given of the three distinct types of multiplex carrier systems in commercial use, as follows :—

1. A carrier-telephone system in which the carrier is transmitted.
2. A carrier-telephone system in which the carrier is suppressed.
3. A carrier-telegraph system.

Space permits a detailed abstract of only one of these ; the second is probably the most representative and interesting. The original Paper contains descriptions and illustrations in similar detail of the first and third.

Carrier Telephone System with Suppressed Carrier.

Fig. 15 is a circuit diagram of one terminal of one two-way channel, together with the common carrier-supply circuits. The transmission circuits are indicated by heavy lines while the light lines show the carrier-supply and the signalling. The system indicated is one designed to use the same carrier frequency for both directions of a two-way conversation. Therefore, the harmonic generator is shown as feeding through the same selective circuit and harmonic amplifier into the modulator *M* and the demodulator *DM*. The harmonic generator is supplied with the base frequency from the oscillator, and in addition to supplying the harmonics also supplies the base-frequency to the terminals of the base-frequency amplifier, which selectively amplifies this frequency and supplies it to the line as shown. In the transmission circuit it will be noted that in addition to the balanced modulator *M*, already described, a push-pull amplifier *TA* is used to increase the volume of side-band current transmitted. The high-pass filter between the modulator *M* and amplifier *TA* prevents the latter from being overloaded by the voice currents in the output of the modulator. The balanced demodulator *DM* serves to prevent the transmission of the local carrier back over the line. The carrier-supply apparatus shown, including the harmonic generator, is that used at the controlling station. At the distant station the arrangement is modified to provide for amplifying the base frequency received from the incoming carrier line, and supplying it to a harmonic generator which supplies the various frequencies through the amplifier to the modulators and demodulators associated with each channel.

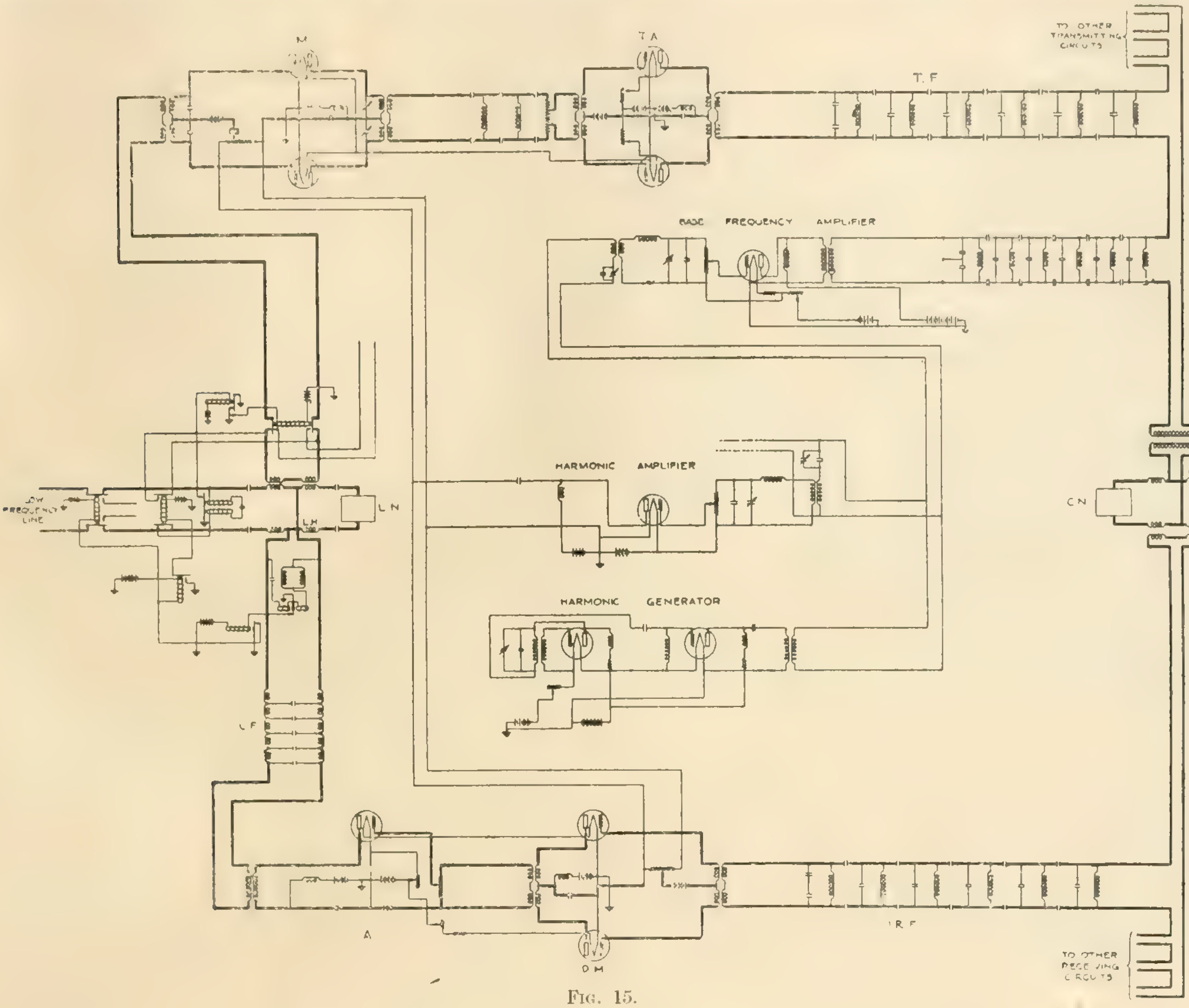

Fig. 15.

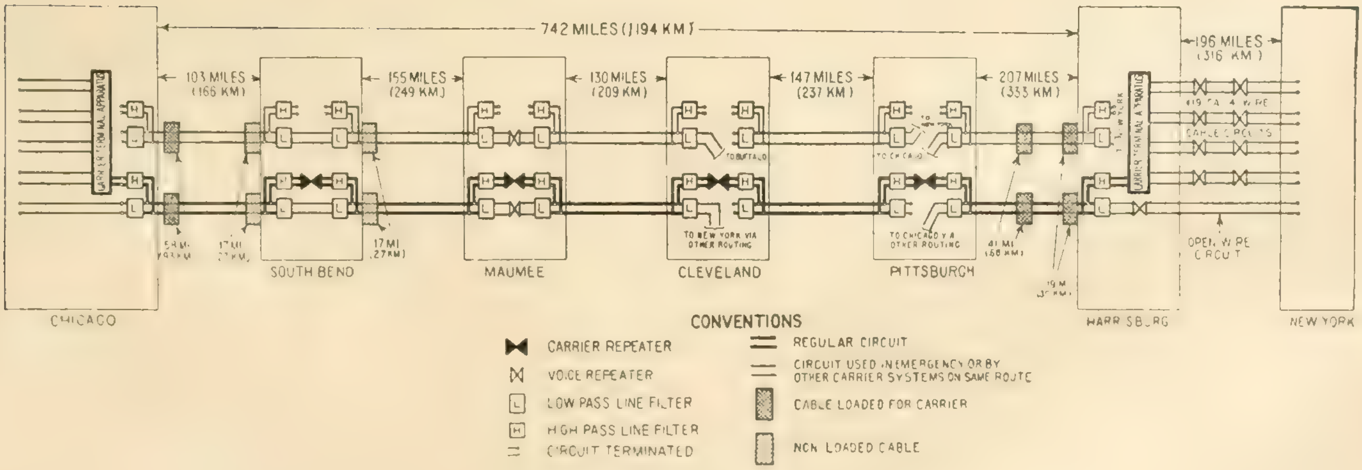

Fig. 16.

The apparatus for this system has been mounted on unit racks of self-supporting type. One such unit holds the sending apparatus for one channel and another the receiving apparatus. An illustration of these is shown in Fig. 14. Apparatus such as tubes and potentiometers is located with convenient accessibility, and the space below is used for filters, condensers and other apparatus, which requires practically no attention or adjustment. Similar racks are used for the base-frequency oscillator and harmonic generator, the harmonic amplifiers, the testing circuits and the auxiliary low-frequency apparatus.

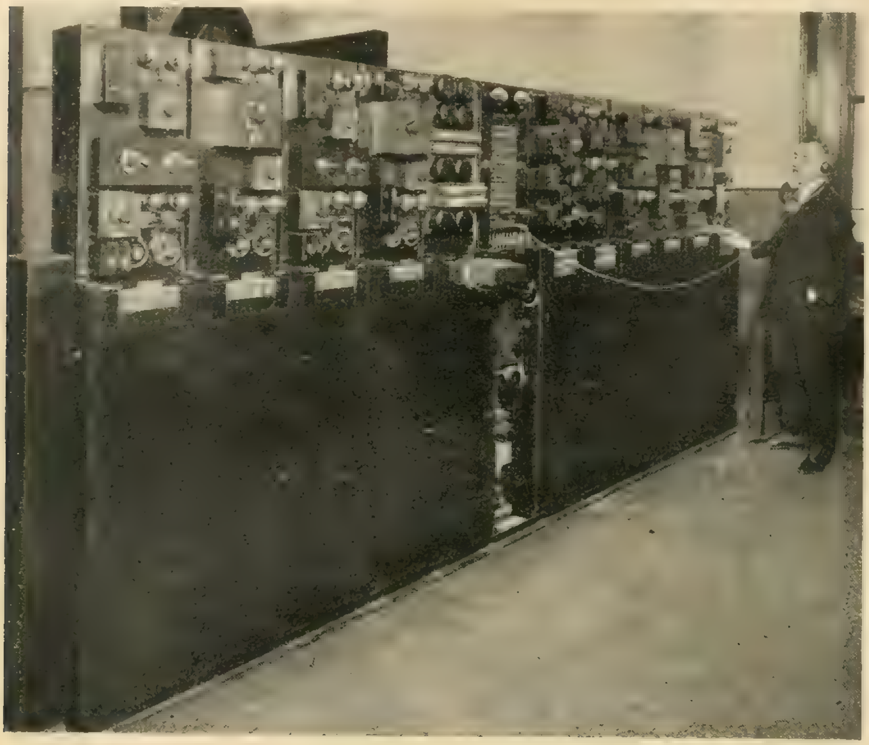

Fig. 17.

This type of apparatus is employed, for example, in the Harrisburg–Chicago system, the circuits of which are extended into New York as voice-frequency circuits in order to provide New York Chicago service. This system spans a somewhat greater distance than the Harrisburg–Detroit, and includes four intermediate carrier repeater stations. Fig. 16 shows diagrammatically the layout of the whole system. For insurance of service a second set of line wires is arranged for carrier operation as illustrated. Because each carrier circuit in this system employs the same carrier frequency for transmission in the two directions, greater care was taken to make the lines of uniform impedance and to simulate them with their associated balancing networks.

In the Harrisburg-Pittsburg section this system is operated over the same pole line as is the one previously described, and also with a multiplex carrier telegraph, later referred to. This has required a special transposing of the line wires between these two points.

The appearance of the apparatus at the terminal offices is shown by Fig. 17, which is that located at the Chicago terminal. In the centre of the group of panels is seen the test panel, by means of which the routine maintenance tests of the apparatus and lines are made.

General Considerations.—An important aspect of the carrier developments described above is that they have placed the art upon a quantitative basis and enabled carrier installations to be engineered and put into operation in much the same way as is done for regular repeater telephone circuits. The transmission layout of the system is determined from a consideration of data on line characteristics and from the characteristics of the apparatus. In carrying out an installation, a certain amount of preparatory work must usually be done on the lines, including particularly the loading of intermediate sections of cable and transposition work. In the offices, the apparatus is installed in much the same way as are the more usual forms of telephone equipment, taking certain precautions, however, to minimise the lengths of office wiring included in the high-frequency circuits, and to avoid cross-talk in the wiring interconnecting the individual apparatus-units. The battery supply-currents for the vacuum tubes are usually furnished from the existing 24-volt telephone batteries and 120-volt Morse batteries.

The grade of service given by carrier circuits, both telephone and telegraph, is as a rule quite up to the high standards which prevail for the long-distance circuits of the Bell plant. Not only is it possible to deliver the volume of transmission necessary for enabling the carrier circuits to be greatly extended by the addition of ordinary circuits at the ends, but also the naturalness and intelligibility of transmission is preserved to a very satisfactory degree.

The carrier telephone channels are terminated in the long-distance switchboards in the usual way, as, for example, at New York and Chicago for the Harrisburg–Chicago system described above ; and connections are put up by the long-distance operators, using the regular toll cords. In fact, to the operators such circuits are indistinguishable from the regular long-distance repeatered circuits. The operator rings at the terminals of the connecting circuits in the standard manner, and the signals are automatically relayed over the carrier-telephone channel as indicated in the circuit diagrams above, so that each carrier-telephone channel is provided from end to end with its own signalling channel. The satisfactory working out of such operating features as these has been of much importance in completing the commercial usefulness of carrier-telephone systems. The technique involved in the art is so fascinating that one may readily lose sight of the more practical matter of costs ; but to the engineer the economics of the situation are all important, for it avails nothing if it is not possible to accomplish by the new method the same, or better, results than were obtainable with the old, at no greater cost. Carrier-telephone systems—at least in the present state of the art—are economical in a general public service communication system only for use over relatively long distances. Of course, whether carrier can be justified in any given case depends upon factors peculiar to that case ; in some instances, for example, it may not be physically possible to provide additional wires over a given toll-line or cable route, in which case the relatively high apparatus costs may be easly justified. The carrier-telegraph system is also essentially a long-distance proposition, although it is sometimes possible to warrant its use for distances somewhat shorter than in the case of telephone systems.

I.E.E. Summer Meeting.

We have received a full programme of the summer meeting of the Institution of Electrical Engineers which is to be held in Scotland from June 7 to 10 next.

The meeting will open with a Paper on the Dalmarnock generating station of the Glasgow Corporation which will be read by Mr. R. B. Mitchell at the Royal Technical College, and a visit to the station itself will follow. At this meeting the Lord Provost of Glasgow and members of the Town Council will extend a welcome to the visitors. Subsequently a lunch will be held at the Municipal Buildings by invitation of the Glasgow Corporation and in the afternoon visits will be paid to Messrs. John Brown & Company's shipyard at Clyde Bank, the Clyde Mills power station of the Clyde Valley Electrical Power Company and to other works, while an excursion by road to some of the Glasgow Corporation reservoirs will also be made. In the evening there will be a reception and informal dance at the Municipal Buildings, Glasgow. There will be a Meeting at the Royal Technical College, on the Wednesday morning when a Paper will be read on "Hydro Electric Resources of the Scottish Highlands," by Prof. Magnus Maclean. In the afternoon of that day a visit will be paid to Messrs. Babcock & Wilcox works at Renfrew, the journey being made by steamer. After the visit the party will proceed on an excursion on the Firth of Clyde by invitation of Messrs. Babcock & Wilcox, tea and dinner being served on board the steamer. On Thursday the party will leave Glasgow by special train for Fort William, where the night will be spent, and on the Friday they will proceed by steamer to Kinlochleven where they will visit the works of the British Aluminium Company and will be entertained to lunch by the company. In the afternoon it will proceed by steamer to Oban where the meeting will terminate.

We understand that up to the present 288 notifications of intention to attend have been received, including 87 ladies.

Engineering in Russia.

At the informal meeting of the Institution of Electrical Engineers held on April 25, Mr. J. F. AVILA was in the chair and a discussion was opened by Mr. C. L. LIPMAN on "Engineering in Russia." The meeting was not as well attended as usual and was the last of the session. The meetings will be resumed at the end of October.

The CHAIRMAN appealed for early notification of subjects for Papers offered for next session.

Mr. **LIPMAN** commenced by stating that for the time being the Soviet Government was the only possible Government capable of maintaining public order. The roots of Bolshevism had gone so deep that to extirpate the system hurriedly would only increase the industrial chaos. Now the Soviets had been able to turn from preparations for war, internal and external, to ambitious schemes for the mobilisation of town and village in the peaceful re-establishment of industry and the engineering industry in particular.

A body called the Eighth All Russian Congress of Soviets had planned this reconstruction. This Congress decided to start with the electrification of the most important industrial regions and, firstly, the coal-mining and metallurgical industries of the Siberian Ural, Moscow and Donetz regions. It was anticipated that during 1921 the Donetz basin alone would yield 8 million tons of coal and 360 000 tons of pig iron. The general destitution and the dearth of engineering materials had not permitted progress much beyond the excavating and layout stage, but considerable pioneer work had resulted. A hydro-electric scheme, the Kashir generating station, to supply Moscow and a number of adjacent counties, was being rushed forward day and night, for it was decreed that all factories in Moscow would use electric power.

A temporary district station on the Shatour Marshes was helping the Bogorodsky transmission station to illuminate Moscow. The electric station at Sudakovak Works had been restored and the Works at Tula were receiving the required power. Seven industrial districts of the Moscow Basin were shortly to receive electricity from the Shatour and other stations with the object of obtaining 1 000 000 tons of coal per annum.

In the Petrograd district electrification was being carried out at an intensified pace; the Ontkin Works were being reconstructed and a new station commenced on the Viazen Marshes. On the River Svir (the Svir Volkhov Station) a huge hydro-electric plant was in hand for the supply of the northern districts of the capital. Simultaneously dredging of the Svir was going on under the Mariinsky water-way project of connecting the Volga with the Baltic. In the Donetz Basin the electricity works reduced to a deplorable state in the fighting with Denekin were already recovering, and at the end of February last 30 stations, with a total energy of 190 000 kW, were working in three of the chief districts, while 3 000 motors of 122 240 total horse-power had been repaired and put to use. In the Kizelovsk coal district in the Ural great efforts were being made to finish the electricity works by 18 months hence.

Nor was it only industrially that electrification went on. Thousands of cottages were receiving light, and in the Kieff district the workers' quarters were lighted free of charge (!).

Mr. Lipman is a young Russian, himself a victim of the present régime, but his outline of these projects of reconstruction tempted him to forget the disaster Bolshevism has encompassed. The subsequent discussion soon showed much of the regeneration he had spoken of was still in the elementary stage.

Mr. AVILA, in opening the discussion, admired Mr. Lipman's optimism in looking to a Russia alive with electric transmission and transport, while we in England had such difficulties with a dense population to justify such operations. He thought Mr. Lipman's address must have increased the interest in Russia of all present.

Mr. H. E. CROWCROFT, who spoke with some recent years experience of residence in Russia, told of the German hold in pre-war days on Russian engineering trade, especially in the Baltic Provinces, where the business correspondence might be conducted in German, and the rules and specifications were simply translations from German. He asked when might traders interest themselves in Russia, and what were the credit arrangements the Soviet Government offers.

Mr. F. POOLEY regretted the meeting did not include some of the technical men who generally attended. He pointed out that all were concerned in the enormous demands for engineering goods that would result when a reliable Government could put Russia's materials into circulation. His transactions with Russian engineers had led him to think that their specifications were designed to hamper the English maker, and for the advantage of the German.

Other speakers, Messrs. A. H. ALLEN, W. G. LAIRD, W. E. ROGERS, E. L. WEBB, A. E. EASON, W. L. WREFORD, B. E. WALKER and H. WHITGIFT asked for information on the engineering and money standards, and of the demand for and status of engineers.

Major R. GRIERSON asked if there were now electricity acts equivalent to our authorisations to supply, and any considered scheme for linking up. He also wondered if the Russian had done years of excavating with, say, two years more in which to erect and complete his stations, and had finally to light the areas free (vide Kieff), he would show a profit by Bolshevist finance. He thought it desirable to get young Russians into English works that they might return home with the correct bias.

Mr. CROWCROFT, speaking a second time, said he did not think there was such entire dearth of skilled labour in Russia as was supposed, he had seen thoroughly sound jobs carried out entirely by Russians. The Russian engineer was often extremely well trained, but frequently was too theoretical. There were no facilities at home for study, and he generally went to Germany, hence his bias for German methods and standards. Russian electrical standards were largely the Deutschen Verbundforschriften standards, which were so much more elastic than our I.E.E. standards—still he was convinced our first-class materials will yet find a market in Russia.

Mr. LIPMAN, in reply, told of the disabilities of the native engineer and the compulsion of going abroad to learn. Germany by her proximity has received most students, and had naturally benefited. Further the German was more complacent and was ready to give long credits but he did not believe the German influence would hold in the future. The trading agreement with Russia has been signed, and he appealed for sympathy with the only possible Government. He believed that things would right themselves, and that the Russian eventually will honestly meet all his obligations.

A Compendium of Electrical Knowledge.[*]

BY W. R. COOPER.

It is about ten years since the last edition of this work appeared, and during the interval the advance in certain directions has been considerable. Thus a good deal of revision has been necessary, and is in fact at once evident. Even the title has passed through the process of transumption, for it has now become "Modern Electrical Engineering," which certainly will appeal rather more readily than "Modern Electric Practice." The authors of individual articles are mostly different, and what is rather curious, they are much less numerous than in the previous edition. This drastic change may be an advantage, but it has the effect of producing a new work rather than a new edition. This view, however, is not wholly justified by further perusal.

The first sections are on electric measurements and they remain very much as they were in the previous edition, but are now attributed to Mr. D. J. Mackellar, instead of to Dr. A. Hay and Prof. E. W. Marchant. Here and there we notice some additions, as, for example, in dealing with supply meters, and there is a certain amount of general alteration, but we doubt if this is sufficient justification for the obliteration of the original authors. This, however, seems to be the method frequently adopted in these volumes. The curious feature of having a short chapter on primary batteries in the midst of electrical measurements remains. This chapter has been brought up to date, but is not altogether adequate. For example, the bichromate cell cannot be described in four lines. Alternating currents have been treated more fully and a few pages have been added dealing with high frequency measurements. Generally, it may be said that a useful account is given of instruments and methods adopted in their use, together with the principles of electric currents, but the treatment is necessarily rather sketchy in parts. The ground as a rule is fairly covered, though we think, for the sake of completeness, that some reference might have been made to the electrostatic oscillograph as well as to the more usual types.

ELECTRIC GENERATORS AND MOTORS.

Electric generators and motors very naturally absorb a good deal of space, though not more than is their due. The treatment here is in the hands of a number of authors. Thus, Mr. H. Vickers deals with continuous-current generators, direct-current (why not continuous-current ?) motors and induction motors ; Mr. R. D. Archibald handles the subject of alternating-current generators ; Dr. S. P. Smith deals with synchronous motors and alternating-current commutator motors ; and Mr. D. J. Mackellar writes on rotary converters. These various articles give a good account of the subject as a whole. We notice that nothing is now said about the turbo-dynamo, although ten pages were devoted to this subject in the previous edition. It is, of course, somewhat unimportant in comparison with the turbo-alternator, but nevertheless we do not think it should be passed over in silence. Some red and black diagrams (which in these days must be considered a luxury) are used in connection with windings and alternating currents, and some beautiful half-tone illustrations are given of turbo-alternator rotors and stators under construction. These are not merely works of art but really add to the technical description. The article on direct-current motors is a distinct advance on that in the previous edition, but we are a little surprised to see series-parallel control discussed in detail here rather than in the section on tramways. The articles on synchronous and alternating-current commutator motors will be appreciated by those engineers who wish to understand the principles underlying these motors, which principles are by no means as widely understood as they should be. The article on rotary converters is short and deals merely with the conversion (as distinct from the motor) and the starting-up of such machines. The articles vary somewhat in their aim, those by Mr. Vickers leaning rather heavily towards design, which, we think, is rather a mistake in a general treatise. Electrical engineers may be classed as designers (comparatively few) and users (the multitude). The designer knows all about design—or at least more than such articles can teach him—and the user will generally be wise not to dabble in the subject.

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[*] "Modern Electrical Engineering." Edited by Magnus Maclean, M.A., D.Sc. Third edition. In six volumes. (London: The Gresham Publishing Company.) 12s 6d net a volume.

Transformers and Accumulators.

The article by Mr. W. Marden only occupies 34 pages. It is interesting and contains much useful information, but we think it scarcely goes far enough. The original article was by Mr. A. F. Berry and was rather more analytical. A few pages have been introduced on insulation and these are most desirable. On the other hand we find that there is now no reference to all-day efficiency, which is a matter of some importance. We notice that some short portions of the original section are reproduced without acknowledgment to the previous author, and the statement that the use of silicon alloyed steel was first due to "Mr." Hadfield indicates a certain inattention to the march of events.

Since the last edition many distinctive makes of accumulators have ceased to exist and thus serious revision was necessary. The present section is by the late Mr. R. Rankin and will certainly be found useful. Apart from a description of cells and their working two short chapters are given on controlling plant and on the propulsion and lighting of vehicles. We are surprised to find, however, that the description of the Edison cell only occupies a third of a page, and we certainly think its importance warrants more serious treatment. More is said on this subject in the section dealing with electric vehicles, but it is preferable to avoid scattering in this way.

Switchgear, Mains and Wiring.

In Volume III. we pass to switchgear, electric mains, electric transmission and wiring. The article on switchgear is in the hands of Mr. H. McEwen and is necessarily rather pictorial. The reader will gain a good idea of the various types now commonly adopted, but we are inclined to think that the ratio of blocks to text is rather higher than is desirable if the best use is to be made of a somewhat limited space, for the article thus becomes almost wholly descriptive. In the article on electric mains, by Mr. R. B. Mitchell, the need for illustrations is not so pressing, and some useful information is given on such subjects as high-tension jointing, disconnecting boxes, &c., as well as descriptions of what may be termed the fundamental systems of main laying. There seems to be a tendency as in some of the other articles to let the previous edition stand. Thus the description of the solid system (p. 85) is nearly a verbatim reproduction of the old article, and we suppose that this is the explanation of the fact that attention is not called to the difficulties which formed the subject of a well-known report by a Home Office Committee, this is unfortunate because this part of the work must be regarded as somewhat conflicting with the views of Mr. B. Welbourn in the article immediately following.

In this article Mr. Welbourn has the handling of a subject which is not yet all cut and dried and he has accepted the opportunity of dealing with certain controversial points. Having regard to recent controversies on transmission from capital power stations on water sites we expected rather more financial detail on this part of the subject, but possibly the space was not available. Be that as it may, this section makes good reading and is critical. It is interesting to note Mr. Welbourn's conclusions, more particularly the view that, owing to the difficulties inherent in three-phase transmission as the pressures become very high, the Thury series system will very possibly receive more and more consideration.

A Misleading Title.

Akin to these subjects is that of electric wiring. This section is handled by Mr. R. B. Mitchell, and is entitled Electric Lighting and Wiring. The title is rather a misnomer, carried forward from the previous edition, for there is very little about illumination, and electric lamps are described in later sections, so that a more correct title would be "Electric Wiring." The usual descriptive matter is given, but there is also a practical discussion on the respective merits of the various rival systems. We are glad to see that the part on fittings, which in the previous edition ran to 42 pages, has been reduced to a single page. Such a subject is of too varied a character to warrant the allocation of much space to its consideration, and is best studied by perusing trade catalogues.

We next come to electric lamps. Arc lamps are adequately treated by Prof. W. C. Clinton, who gives a good, though brief, discussion of the general principles, and includes such subjects as mercury vapour lamps and the photometry of arc lamps. The ordinary type of arc lamp is, of course, much less important than it was 10 years ago, its field of usefulness having been largely curtailed by the gasfilled incandescent lamp.

There is also a noticeable change in the section dealing with incandescent lamps. This is in the hands of Mr. F. J. Hawkins. The carbon lamp now receives but scanty treatment. A good account is given of the manufacture of tungsten wire from the ore to the finished product, and of the subsequent operations in the making of a lamp. A brief description is given of Gaede's mercury and molecular pumps, from which it appears that the latter is now in commercial use. It would, however, be interesting to know how the pressure of 0·000002 mm. of mercury was measured.

Electric Traction.

The greater part of Vol. IV. is concerned with electric tramways. This was formerly in the hands of six authors, but in the present edition Mr. J. J. H. Johnston (of the Glasgow tramways department) is solely responsible. There has been some re-arrangement but much of the old matter remains, and is sometimes reduced. The treatment as a whole is good and practical. Some overlapping is noticeable, for the methods of laying cables are again discussed, although this subject has already received treatment in Vol. III. This is a difficulty that always occurs where several authors are concerned, though the present work is reasonably free from this defect. The section dealing with Surface Contact systems has rightly been very much reduced. A great deal of ingenious effort has been expended on this subject, but the many possible and impossible systems that were evolved are now almost wholly of historical importance. On the other hand, we think that 5½ pages are not sufficient to give to the very important subject of tramway brakes.

The section on Electric Traction on Railways, although much longer than in the last edition, still only occupies 40 pages, and is certainly inadequate. It is good as far as it goes, but there is, for example, no discussion of high-tension continuous-current traction as an alternative to single-phase traction on main lines. This part is followed by a short section on "Electrical Appliances in use on Railways," in which the same author gives an account of the operation of points and signals by electric power, and of track circuiting, &c. Electric Vehicles form the only remaining subject of electric traction. Mr. F. Ayton's knowledge is welcome here, and he deals mainly with general principles, without an undue amount of descriptive matter.

Steam-Raising Plant.

The remainder of Vol. V. is mainly occupied with steam boilers, prime movers, condensers and auxiliary plant. These subjects are in the hands of Mr. J. K. Stothert, Prof. A. L. Mellanby and Mr. R. Royds respectively. In the boiler section the author concentrates still more on boilers of the water-tube type, other types being now somewhat secondary for power purposes, more particularly as steam pressures have become higher. The chapters on mountings and strength of materials no longer appear. This seems a reasonable adjustment, for the user must depend upon the manufacturer rather than upon himself in such matters. In the section on prime movers the steam turbine now receives much more adequate attention, and a great deal of matter which was of interest only in connection with reciprocating engines has now disappeared. In regard to entropy, we think a simple statement would have been acceptable rather than assumed knowledge on this thorny subject. When we come to the part on gas engines, which with its previous treatment of 20 pages was already inadequate, we find that this has now been reduced to eight pages. Of course, it is impossible to give any seriously useful information in so small a space, and consequently such subjects as the oil engine and the choice of plant to suit conditions receive no attention.

ELECTROCHEMISTRY.

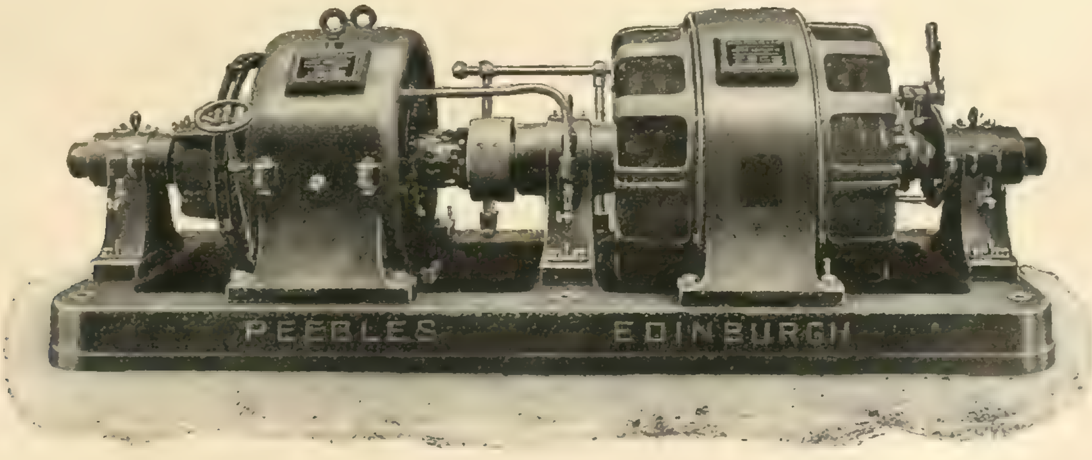
Vol. V. concludes with electrochemistry, for which Prof. A. Campion is now responsible. This section has been expanded so as to include some account of electric furnaces in iron and steel production and the manufacture of nitrates. The subject of electrothermal processes is discussed in a useful way, but there is a curious error in the statement that the I^2R loss when alternating current flows through a resistance is dependent on phase difference. The idea is practically contradicted a few lines lower, and is evidently a survival from the previous edition, where the power factor was actually introduced into the expression. It is due, of course, to mental confusion between resistance and impedance.

Vol. VI. opens with telegraphy and telephony, the former being in the hands of Mr. T. Hetherington and the latter in those of Mr. W. Allan. The space allotted to telegraphy has been reduced from 89 to 63 pages. It is not a subject which is moving with the same rapidity as many others, and therefore this reduction may be justifiable. On the other hand, if only about five pages can be allotted to radio-telegraphy, we suggest it would be better to omit this subject altogether, particularly when the pages stand just as they were in the last edition some ten years ago. To find no reference to the modern triode valve, and to read that "in the Telefunken system an electrolytic cell is used for receiving by telephone and a coherer for recording or calling purposes," can only lead unnecessarily to adverse criticism. There are another two pages on radio-telephony later on, but it is questionable whether they serve any useful purpose. The section on ordinary telephony has been greatly modified to take into account the important progress that has been made in automatic telephony.

Vol. VI. concludes with sections on electricity in mining, by Mr. J. Martin, and electric cranes by Mr. A. Jack. The old section on electromedical appliances has (we think wisely) been omitted.

In the space at our disposal we can only deal in brief fashion with this work. The present edition contains much useful information, and is a distinct advance on its predecessor, and any criticisms we have made are merely with a view to further improvement when there is a call for another. In a large work of this kind it is very difficult to avoid unevenness in treatment, but this is not so apparent as it was. Lastly, we should like to express a word of praise for the printing and illustrations, which are of a high standard not usually found in books on engineering subjects.

Peebles Motor Converters.



VIEW OF 150 kW PEEBLES LA COUR CONVERTER. (A.C. Three-phase 6 600V 50 cycles, D.C. shunt-wound 230 V.)

In a recent issue we gave some details of modern rotary converter machines as employed in converting alternating into continuous current and *vice versa*. This function can, however, be performed in other ways, one of the most interesting of which is by employing the motor converter so long associated with the names of Peebles and La Cour. It may be recalled that this machine consists essentially of an ordinary induction motor and a rotary converter, the two being rigidly coupled together mechanically. In addition, the rotor winding of the alternating current end and the armature winding of the direct-current end are electrically connected. If the combined rotor and armature be assumed to be running with a slip of 50 per cent. it follows that the revolving field introduced into the rotor by the alternating current supply rotates relatively to the rotor at a speed corresponding to half the frequency of the supply circuit, thus introducing in the rotor windings a series of E.M.Fs. of the same frequency. The number of poles at the direct current end is so arranged that the frequency of the current induced in the armature winding at this standard speed is the same as the frequency of the rotor currents. It is therefore possible to connect the rotor and armature windings when their E.M.F.'s are equal and in phase. When this has been done the speed of the combined set remains constant, and operates as a single synchronous machine.

As the rotor revolves at a speed corresponding to half the frequency of the supply circuit it also follows that half the electrical energy supplied to the machine at the alternating current end is converted into mechanical energy, and this portion is transmitted by means of a shaft to the direct-current end. The other half of the energy supplied passes through the rotor winding to the direct-current armature in the form of electrical energy. The alternating-current end therefore operates half as a motor and half as a transformer, while the direct-current end operates half as a continuous-current generator and half as a rotary converter.

As the dimensions of the alternating current portion of the machine depend upon the speed of the revolving field and not on the speed of the rotor it is theoretically the same as a machine running at the synchronous speed corresponding to the supply frequency. The direct-current end is running at the same speed, which in its case is equal to half the frequency. This gives it advantages from the point of view of commutation, and it is generally of smaller proportions than an ordinary continuous current generator or rotary converter of the same output. Although the motor converter is started like an induction motor-generator, when running it operates synchronously with the main supply.

DETAILS OF THE MACHINE.

The accompanying illustration is of a 150 kW two-bearing Peebles converter motor, such as is manufactured by Messrs. Bruce, Peebles & Company, Ltd., the protagonists of the Peebles-La Cour system. It gives a general idea of the appearance of the machine. Similar machines are, of course, made in much larger sizes up to a maximum of 2 500 kW. The two machines are directly coupled together, and are mounted on a combination cast-iron bed plate. They are generally provided with three bearings. The rotor and armature are electrically connected by leads through the hollow portion of the shaft. The slip-rings are of small dimensions, as they are only used for starting or in three-wire installations for carrying the out of balance current. The direct-current end is fitted with commutating poles, and will carry 100 per cent. overload for short periods without injurious sparking at the commutator and without altering the brush position. Means are taken to allow for ample ventilation and to secure freedom from humming and vibration.

These machines may be started from either the alternating current or the direct-current end, and are, of course, receiving an ever-increasing application not only for traction but for lighting work and for balancing purposes on three-wire supply. They are usually employed for converting alternating to direct current, but are equally efficient when operating in the other direction. It is claimed for these machines that though a little less efficient at full load, equal at half load and better at quarter load than a rotary converter they are considerably better than motor generators. On the other hand, they allow simpler starting and synchronising, and give better regulation than either a rotary or motor-generator. They are not liable to reversing or hunting, while their upkeep is easy and costs little.

We should add that a very interesting pamphlet which Messrs. Bruce, Peebles & Company, Ltd., published some time ago with regard to this machine, has now been published in a French translation. This enterprising attempt to develop foreign trade is worthy of all praise and we hope will meet with considerable success.

Some Thermal Characteristics of Electric Ovens and Hot Plates.

We give below an account of the discussion which took place in Newcastle on Dr. E. Griffiths' and Mr. F. H. Schofield's Paper on "Some Thermal Characteristics of Electric Ovens and Hot Plates." An abstract of the Paper appeared in our issue of February 18th.

Mr. F. H. Downie considered that the results of bad thermal conductivity given in the Paper indicated the necessity of special utensils for use with hot plates, the aluminium utensils frequently employed being too liable to bend or bulge, and so impair the contact. Utensils with black finished surfaces would be better than oxidised, as the housewife would polish up any surface which appeared rusty or oxidised. In the case of ovens, light construction was preferable, because of the quicker heating, and for domestic use would prove more economical as the requirements were largely for short-time heating. Aluminium paint was found to reduce the heat transmission losses considerably.

Prof. H. Strond thought that the designers of electric ovens and hot plates had been too much tempted to copy other methods, instead of branching out and designing an article to suit their oven requirements. The results given in the Paper indicated that if the utensils used on hot plates were smaller than the hot plates themselves, there would be an enormous loss of heat. With radiant hot plates it was essential that the utensils should completely fill the whole aperture to prevent the escape of convective heat. In the case of ovens, what was required was an oven completely departing from the heavy gas-oven type, and having a small capacity for heat, giving quick heating, combined with a slow loss of heat. In order to avoid heat losses due to the frequent opening of the oven door, the dome type of oven had been put on the market. In this oven the base of the oven was covered by a dome, round the inside of which the heaters were fixed. When it was desired to see inside the oven, the dome was raised, the hot air remaining in it.

Mr. W. F. T. Pinkney stated the main requirement of the present time was quick heating and efficient hot plates and quick-heating ovens, but the most important feature of all apparatus was its reliability. With the majority of the present-day apparatus, the maintenance required was a great trouble and expense. Where a heat-absorbing surface was required, as for use with hot plates, cast iron could not be improved upon; but the sides of all pans, &c., should be polished, so as to prevent the radiation of heat. To retain this surface, the use of chrome or rustless steel might be advantageous. The chief drawback to the light type of ovens was usually their lack of mechanical strength, giving rise to leaky joints, &c.

Mr. H. B. Poynder suggested that ovens tightly packed with slag wool were bound to have a large heat capacity, which it might be possible to reduce by packing less densely. It was pointed out that unless the wool was packed to a density of 13 lb. per cubic foot there was a tendency for it to settle, so leaving an air space above, which was a greater disadvantage than the dense packing..

Mr. W. P. Ward considered that the experiments described would have been more valuable if they had been carried out by boiling water than by heating discs, as, although the evaporation losses might have been troublesome, the results would have been more comprehensible to the consumer. It was hoped that the radiant type of hot plate, in additon to removing the necessity for special pans, &c., of cast iron, would overcome the troubles due to the time required to heat up the heavy type. The difference in temperature of varying parts of the oven during the process of heating up was not of great importance, as no cooking would be done during that period. When actually cooking, the temperature distribution would be more even, particularly when using the low heat. The dome type of oven was found to be efficient, but the maintenance costs were heavy, due to the liability of breaking the element supports, &c., when lifting the dome.

Mr. H. Parry did not consider the experiments with thin discs could be taken as any criterion for the behaviour of a kettle-shaped vessel. Discs with turned-up flanges would have been a closer approximation, as there was appreciable heating obtained by conduction and radiation on the sides of the vessel.

Mr. J. R. Beard suggested the possibility of surrounding the oven by a vacuum chamber, which might be augmented by an additional chamber packed with slag wool.

Dr. E. Griffiths, in reply, emphasised that with a cast-iron hot plate it was essential to have good thermal contact between the plate and the utensil. To avoid heat losses in an oven due to the opening of the oven door, a thermometer should be used, and possibly a double glass window might be built into the oven, as was done in the case of laboratory ovens. The object of slag wool packing was to subdivide the air spaces and prevent circulation. If the wool was packed too lightly, this advantage was lost, whilst on the other hand, if it was packed too tightly, then the heat conductivity of the wool was increased. Immersion heaters, although having a 100 per cent. efficiency, at present gave trouble owing to mechanical defects. They had an enormous possibility, and would constitute the future means of water heating. Unfortunately, the vacuum chamber had not appeared to be a practical scheme from the trials that had been made, largely owing to the gases exuded by the metal walls, the conductivity being actually greater than when the insulating packing was used. The suggestion of providing an air space in addition to the insulating packing was good. The imitation of the gas cooker was the worst possible fault in present-day designs, as this type was far too heavy.

Lubricating Oils for Diesel Engine Air Compressors.

An interesting discussion took place at the last meeting of the Diesel Engine Users' Association on "Lubricating Oils suitable for Use in Diesel Engine Air Compressors." The question arose in connection with the revision of the recommendations made in October, 1916, by the Committee in a report on an explosion in the air compressor of a Diesel engine. In the light of further experience and information it was felt that the report of the Association, published under the title, "Air Compressor Explosions and Troubles," required some slight amendment in the section concerning lubricating oils suitable for air compressors.

The meeting was unanimous on the point that whatever quality of lubricating oil was used in the air compressor—whether a straight mineral oil or a compounded oil—the smallest practicable quantity should be introduced, and the following recommendations were finally adopted:—

Recommendations.

The lubricating oil used should be an oil of the highest grade obtainable and must be used only in the smallest practicable quantity. The following properties are necessary:—

(*a*) The oil should be entirely free from suspended particles of water; (*b*) It must be entirely free from sand or other inorganic material. No mechanical impurities must be visible in the oil when it is viewed by holding a sample in a glass vessel against a light; (*c*) the oil must be entirely free from inorganic acids; (*d*) oils should not be lower in viscosity than 300 seconds Redwood at 70°F. nor higher in viscocity than 3 000 seconds Redwood at 70°F.; (*e*) oils should in no case be lower in closed flash point then 350°F.; (*f*) if the oil is to be used on an enclosed crank case high-speed engine in which the same lubricant is used both for the compressor and in the crank case, it should have a closed flash point of not less than 400°F. (It should be borne in mind that "open" flash point tests give results 20° to 30°F. higher than the closed tests on these types of oils.)

From past experience it has been found that the oils which have met with most success in Diesel engine air compressor lubrication, besides complying with the foregoing stipulations, have generally possessed properties lying within the following limits: Specific gravity, 0·870 to 0·915 at 15°C.; viscosity (Redwood), 400 to 1 000 seconds at 70°F.; viscosity (Redwood), 75 to 125 seconds at 140°F.; closed flash point, not less than 400°F.; colour, red or yellow by transmitted light, but clear (not misty or smoky). Both pure mineral oils and compound oils containing small quantities of saponifiable oil have met with success on Diesel engine compressor service, but the majority of successful oils have been pure mineral oils.

The Glasgow Corporation Electricity Department Engineering Society has just concluded a most successful session. Formed three years ago with the object of encouraging the interchange of technical information, the progress of the society has been rapid, and there are now 390 members on the roll. The society meets once a month during the winter, the meetings being open to all employees of the department.

Overdoing It.

An Example of American Outletmania.

By "ELECTROCYNIC."

It might be supposed, from a perusal of American electrical papers, wherein every kind and size of current-using appliance is advertised as suitable for attachment to the ordinary lampholder, and is, indeed, equipped with the adapter necessary for this foolhardy purpose, that American electricians are, for some unaccountable reason, a little shy of wall-plugs. One visualises a modern American household as being entangled in a spider's web of wires, depending in frayed and helpless fashion from every lampholder, and feeding with the energising juice a heterogeneous array of washing machines, cookers, toasters, utility motors, &c.

I had certainly imagined that every American lampholder was at least a "*double*-duty socket," and that no self-respecting taxpayer on the other side of the Atlantic ever demeaned himself to the lowly wall-plug when, by stretching a little, he might hitch his heater to a ceiling outlet.

Two Dollars for One.

However, it appears that at least one contractor in the land of bluff believes in baseboard outlets, and is recommending them to prospective clients on the somewhat extraordinary ground that "every dollar's worth of electric wiring and outlets installed adds two dollars or more to the value of the building." This does not strike me as a very strong incentive. Anyway, the idea of making two dollars grow where only one grew before has evidently become an obsession with our San Franciscan friend. It seems so easy to make dollars this way; and in the circumstances one must admit that the number of points recommended by him in the wiring specification to which I am about to refer is not really excessive. He *might* have spaced his baseboard outlets much more closely; indeed, I don't see why they should not have been repeated as frequently as the pattern in the wall paper.

Multum in Parvo.

I have in front of me a cutting from the American journal "Electrical Merchandising," which contains the plan of a house, showing the suggested layout of the electrical installation. The house is quite a small one, on a single floor. There are only six rooms and a wash-house. For this tiny house the contractor has specified fifty-one outlets, apart from ceiling points—sixty-five altogether. It sounds incredible, and if I had not seen the plan I should not have believed it possible to get so many points into so small a house, notwithstanding that a point is rumoured to be entirely without magnitude. The house (assuming that the scheme has been translated into practice) must reek of electricity.

Before seeing this plan I would have said that one could not have too much of so good a thing as electric wiring. But, of course, I have been bred in the English tradition which allows one ceiling point and (perhaps) one wall-plug to each room. Even in my most fantastic dreams of electrical perfection I had never dared to imagine an average allowance of more than three wall-plugs and one ceiling light.

Ten Points per Room.

And now, in the semi-barbarous state of California, architects, builders and houseowners are being circularised by a contractor who desires to persuade them that it is necessary to install an average of ten points to a room. The figure would have been higher but for the fact that there are only a paltry four points on the "terrace," which from the plan appears to be a kind of verandah running the length of the house. Most people would consider one outlet in a place of this sort amply sufficient, if not excessive. The American terrace is, however, apparently a place of many purposes and occupations, requiring an extensive and variegated installation. It is equipped with the following outlets:—(1) Outlet for illuminated house number; (2) Outlet for portable lamp; (3) Outlet for toaster, percolater, &c.; (4) Outlet for sewing machine.

But why has no provision been made on the terrace for a washing machine wherewith the family linen might be publicly cleaned? This is an extraordinary omission. However, I suppose the washer could at a pinch be connected to the sewing machine plug.

The Chamber of Horrors.

There are nine points in the kitchen and a similar number in the wash-house. Readers who are able to specify the precise purpose of each outlet will be awarded—my respectful admiration. I couldn't possibly have guessed myself. In the living room are twelve points. In addition to one ceiling light and four wall brackets, this chamber of electrical horrors is starred with the following:—(1) Outlet for piano lamp or phonograph; (2) Outlet for stand lamp; (3) Outlet for lights on mantel; (4) Floor outlet for table lamp; (5) Outlet for heater; (6) Outlet for table lamp; (7) Outlet for vacuum cleaner.

In the long night watches I have dreamt of rooms like this, and have awakened shivering with dread. Such dreams are a natural and unpleasant consequence of an evening spent in sketching out the wiring plan for one's own sitting room. But I never expected to see my nightmare translated into the sober futility of actual fact.

Woe is Me!

The front bedroom, too, is pretty thoroughly equipped. Here we have a centre light, three brackets, a wardrobe light and baseboard outlets as follows:—(1) Heater or vacuum cleaner; (2) Curling iron; (3) Warming pad or milk warmer; (4) Reading lamp.

Presumably the bedroom is intended for a sleeping apartment, although the suggested electrical equipment might lead one to suppose that its purpose was as varied as the apparatus, and that it might be used as a hairdresser's shop, a kitchen or a study.

Nobody could be more exigent than I in the matter of electrical conveniences, and my own relations have at times remarked on what they are pleased to call the "stringiness" of my flat. ("Stringiness" may be defined as an excess of flexible cord.) But I have so far been satisfied with a maximum allowance of one ceiling point and three baseboard outlets per room. Why did I look at this beastly plan? It has unsettled me, and at night I shall dream of vacuum cleaners walking like men and clumsily inhaling the smoke of my superfine "Goldflakes," while I am held helpless in a clinging network of flexible cord and pelted with baseboard outlets by frenzied fuse boxes.

Better High than Low.

Of course, it is eminently desirable that every house should be adequately provided with outlets; and it is surely better to err on the high side rather than on the low when determining the number of points. Most contractors in this country seem to be woefully unimaginative, and are often diffident about recommending even a single wall-plug. While, judging from the infrequency with which one comes across two-way switches in ordinary houses, one might suppose that the average wireman was a little uncertain of the way to connect these useful contrivances. There are far too few points in most English houses, and I dare say in most American houses as well.

We may imagine, therefore, that the wire-loving San Franciscan, to whose specification I have adverted at some length, has been brooding for many years over the general inadequacy of outlets in Californian bungalows. And he has gone mad. He has (so to speak) taken the wire between his teeth and bolted. The result is—six rooms, sixty-five points.

The Golden Mean.

However it wouldn't be a bad scheme to let such a man run loose in England. He could not do any harm, and his extravagant ideas might at least assist in dispelling the characteristic lethargy of his British brethren.

Between the "outletmania" of San Francisco and the outlet meagreness of Surbiton we might achieve the golden mean, which is—but I will leave my pronunciamento on outlet location for a future occasion. My new house (now being wired) will enshrine in a casket of brick, mud or concrete—I am not sure which—my own opinions on the subject. It shall be a monument of electrical convenience and moderation, and over the door shall be written the words, "He loved Electra, but he did not lose his head."

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Office on receipt of published price, plus postage.]

"Dynamo and Motor Attendants, and Their Machines." By F. Broadbent, M.I.E.E. (London: S. Rentell & Company.) Pp. xvi.+213. 10th Ed. 4s. 6d. net.

"Elements of Illuminating Engineering." By A. P. Trotter. (London: Sir Isaac Pitman & Sons.) Pp. xi.+103.

"A Handbook of Laboratory Glass Blowing." By B. D. Bolas. (London: G. Routledge & Sons.) PP. vii.+106. 3s. 6d. net.

"Practical Testing of Electrical Machines." By L. Oulton and N. J. Wilson. (London: Sir Isaac Pitman & Sons.) Pp. 258. 6s. net

"Dynamo and Motor Erection and Management." By A. H. Avery. (London: Cassell & Company.) Pp. 152. 1s. 6d. net.

Reviews.

High-Tension Switchgear. By H. E. Poole. (London: Sir Isaac Pitman & Sons.) Pp. ix.+118. 2s. 6d. net.

Had the title of this book been "German (or even Continental) High-tension Switchgear" its most serious fault would have been removed.

It is difficult to visualise the market for such a book, written and published in England as it is, and treating a complicated subject in a necessarily elementary manner, when the author takes all his examples and illustrations from German practice and clearly considers the V.D.E. as the only possible authority on the subject. To a student or to a craftsman seeking to increase his knowledge of the apparatus he handles, the book can only be misleading. To an engineer who knows anything of switchgear the matter is too elementary, even as regards German practice, to be of value. In one respect the author is entitled to sympathy, since 15 000 words are far too few for so wide a subject. Considered as a book on German practice, criticisms become largely matters of detail. Much has been omitted, but little has been said which is incorrect.

The table on page 4 incorrectly states the V.D.E. current limits for Series I. and II. oil switches. It would have been better to reproduce the corresponding table from the V.D.E. rules, where the upper current limits are definitely set out. On page 7 the desirable speed of break in an oil switch is said to be a matter of debate, and the author considers a high speed as of little moment. In this country authorities all agree that, other things being equal, the higher the speed the better. On page 21 the maximum current density for brush contacts is given as 250 A per square inch; brushes may be worked at double this figure if the leaves are nearly normal to the contact face. The treatment of oil switch arcing contacts on pages 23 and 24 is unsatisfactory and the author is apparently not aware that the voltage drop across butt-type arcing contacts generally decreases with wear. Fig. 7 should be transferred from page 29 to page 47, where it is first mentioned.

The V.D.E. limit temperature rises on page 33, and elsewhere, are given in degrees Farenheit. Since both British and German standards state such figures in Centigrade, the conversion is a mistake. On pages 33-34 the discussion of switch oils is so worded as to cause confusion between "sludge" and free carbon. It is also stated that the breaking capacity of an oil switch can be considerably increased by using special-quality oils. It is very doubtful if this claim can be substantiated.

Three pages are devoted to a discussion of oil-switch charging resistances, an almost exclusively Continental device, and the data given regarding the value of these resistances is so vague as to be misleading. The limits of voltage variation for oil-switch closing and tripping coils given on page 51 are considerably less exacting than those customary in this country. The reference to paxolin on page 69 as a "form of compressed paper" falls short of the truth, and the position is not improved by the implication that for pressures over 6 600 V mica or glass is preferable where mechanical considerations are not of paramount importance. Outdoor horn break switches (pages 87-89) are considered by the author as a survival of bygone days, now limited to entirely unimportant service. As there is scarcely a high-voltage system in America which does not employ such apparatus largely and increasingly, the statement requires revision.

Under the heading of "Arrester Gear," page 92, a reference is made to "choke coils . . . also used in busbar layouts . . . to reduce the current rush on short-circuit." This casual reference to reactance coils is entirely out of place in this chapter and will give the uninitiated a wrong conception. On page 94 we are told that the Brazil resistance is the type most used in England in conjunction with lightning arresters. It is doubtful if even the makers of this device would care to advance this claim, as against carborundum or graphite paste rods, which are not mentioned.

Two pages are devoted to water-jet arresters, which are never used in this country or America, and are dying out on the Continent, and only six lines are given to the electrolytic arrester which is almost universal in really high-voltage work out of Europe. On pages 112-113 are given figures relating to pressure tests, including a table based on the ubiquitous V.D.E. rules. These figures are usually much lower than the British and American standard of $2\frac{1}{4}$ times normal voltage + 2 000.

The final paragraph in the chapter on "Testing" deserves to be reproduced *in extenso* :—

> Considerable brush discharge occurs with the higher pressures, but this is not dangerous in most instances. If the pressure seems likely to jump across a gap, a flame, such as that of a lighted match, thrown between the points will often cause a flash over. If the arc persists, the sparking distance is too small, but otherwise the factor of safety is sufficient when the difference between the test and working pressures is taken into consideration.

Imagine what might happen if the testing staff in a factory were to use a matchbox as an adjunct to a high-voltage transformer in this way!

Finally, it may be remarked that the author's phraseology is sometimes peculiar, "thoroughfare insulators" instead of through insulators; "crushed brush switches" (presumably arc-shaped as distinct from straight brushes); "fuse-shorted trips"; "commutator links" for multi-throw isolating switches; "detent" for catch; "mast switches" for outdoor horn switches; and "shed insulators" instead of pin insulators.

W. A. Coates.

Shorter Notices.

Mathematics for Engineers—Part II. By W. N. Rose. (London: Chapman & Hall.) Pp. xiv. + 419. 13s. 6d. net.

The Directly-Useful Technical Series is the outcome of an attempt to adopt a mean between practice and theory. In this volume, Mr. Rose has again adapted mathematics for engineers. The subject-matter deals chiefly with the differential and integral calculus and its applications together with short chapters on spherical trigonometry and mathematical probability. The examples are a very impressive feature of the book. The young engineer is naturally more interested in working out mathematical problems when they are clothed in engineering language. Each example in this volume has its bearing on some problem connected with engineering—those on maxima and minima being especially useful. Simple differential equations are treated concisely and completely in a few pages. The chapter on Harmonic Analysis is clear and practical. It is to be regretted that lack of space has apparently prevented the author from describing the harmonic analyser, such as was invented by the late Prof. Henrici. An account of Amsler's Integrator, too, would have been acceptable in the chapter on Graphic Integration.

Another pleasant feature of the book is the way the author has emphasised the importance of the graphical method, by giving graphical as well as algebraical proofs. To the individual with the non-mathematical mind, the graphical method is all-important. It is his only hope in understanding mathematical deductions. A good example is the author's treatment of root mean square values, first algebraically, and then graphically by Dr. Fleming's method.

The book will be very useful to engineering students and as a reference work for all engineers who are interested.

The How and Why of Radio Apparatus. By H. W. Secor. (New York: Experimenter Publishing Company, Inc.) Pp. 160. Price $1·75.

This little volume is intended for the use of amateur wireless operators and students. It is not intended as a complete text-book, but presents many phases of the subject in a clear and very attractive light which will appeal to experimenters on this side who are treated to text-books usually well above their heads or lacking in the human appeal which is so essential if the student's interest is to be held. The literature available to *amateur* wireless enthusiasts in this country is enough to make them lose all interest in their subject. There is an absence of snap, a lack of originality and imagination about much of the stuff served up to the British amateur. One pictures the authors as men who advise without any real knowledge or practical experience of their subjects. They learnedly explain but their explanations are guarded, hoary with age, common-place, almost priggish, if such an expression can be used. The man to teach must be an enthusiast and capable of instilling enthusiasm into his readers. He must have burnt out valves, got shocks from his induction coil, spent all night juggling with a detector. Then let him write about it tell his readers how to avoid these things. The enthusiastic amateur is the man to write for the amateur.

Interesting matter, a simple way of explaining things and an unbounded enthusiasm are essentials, but are not often found in articles for amateurs except in certain well-known cases.

The writer of this volume possesses these virtues. An intimate experience with his subject makes him interesting and convincing. His chapters cover induction coils, transformers, condensers, industances, receiving tuners, detectors, telephone receivers, amplifiers, wave-meters, aerials, and a final chapter on the measurement and calculation of inductance. Each chapter contains many novel features which will be entirely new to many readers. We cannot help feeling that the book supplies an element which our British publications for the most part lack—a human understanding of the amateur's needs.

Rudiments of Electrical Engineering. By Phillip Kemp, M.Sc., M.I.E.E. (London: Macmillan & Company, Ltd.) Pp. viii. + 255. 6s.

This book is presumably written for those responsible for the upkeep of small electrical installations and who desire to attain a certain degree of proficiency in the necessary details of such upkeep, rather than an understanding of cause and effect. For such the little book is suitable enough. The subject-matter has been dealt with non-mathematically, and the author admits quite frankly that the method of treatment is necessarily superficial in a number of ways. It is obvious that he recognises readily enough that the book is in no sense a text-book of electrical engineering, but merely a sort of introduction for that type of man who is scared away by the general run of text books. We wish, however, that he had boldly told his readers that there was no back-stair way of becoming a knowledgeable electrical engineer, and that they would have to face the fact and obtain some knowledge of mathematics and fundamental science as soon as they had finished reading his book. Perhaps he will add an after-word in future editions—showing that the solution of problems cannot often be accomplished "by covering the quantity which it is wished to determine when the remainder gives the combination required." We believe that this system of overcoming Ohm's law originated in America—but if that be untrue we apologise to America wholeheartedly.

Correspondence.

SYNCHRONOUS INDUCTION MOTORS AND POWER FACTORS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the correspondence on the above subject, it may be of interest to your readers to learn that the development of the single-field cascade synchronous motor has overcome all the inherent defects of the ordinary type cf machine. Not only does it start against $2\frac{1}{2}$ times full-load torque, but it will *synchronise* when carrying the same load and *without* any large rush of current. If required to start only against full-load torque, it takes only 10 per cent. to 15 per cent. more current than that required when running with a leading power factor of 0·7. Instead of the low starting power factor of the ordinary machine, the new motor starts with a power factor exceeding 0·9, and, finally, it is found that under the most adverse conditions no trace of hunting or phase-swinging is developed.

Machines of this type are in regular service and are being built in sizes from 100 to 700 B.H.P. with power factors varying from unity to 0.4 leading. The machine is entirely self-synchronising and is as easily started as an induction motor. The motor is also built to run synchronously at two or three speeds.—We are, &c.

For Sandycroft, Ltd.
John R. Murray,
Secretary.

London, April 27th.

THE ELECTRIC WASHER—A TOY OR A TRIUMPH.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Emerging from the cellar, where I have just been putting the family washing-machine through its weekly paces, I find your publication of March 18th, in which, I note, that "Electrocynic" suspects that I am no lady. I quite agree with him; I haven't felt like a lady since 1918, when the nurse went into a uniform factory and the cook eloped with a sailor. But as to his suggestion that my interest lies in the selling of washing-machines rather than in their personal application, there are moments when I feel like responding, "No such luck."

Whether, technically speaking, my washing-machine is really electric or not doesn't trouble my logical faculties at all, possibly owing to their lack in my composition. I admit that my electric washer is gas-heated, that it requires soap and water, as in the days of Pharaoh, and further horrible confession, it has to be oiled. However, as that well-known British matron, Mrs. Juliet, remarked a few years after her marriage to the equally celebrated Mr. Romeo, she didn't care by what name her machine was called, as long as it washed the clothes.

But as to the efficacy of our American power-wringer, I refuse to retreat an inch. What English hand-operated wringers may do, when driven by English hearts (or, should one rather say, backs) of oak, I cannot know. Possibly the American hand-wringer is defective; admittedly the American charlady is. But this I do know: in actual fact, clothes are wrung infinitely drier here by a power wringer than they ever are by hand. The masculine mind might attribute this result to the recently achieved aridity of our atmosphere, but feminine intuition points to the functioning of that electric motor behind the wringer. I suggest also that the proper moment for comparison is not as the first piece comes out of the tub, but, say, after the sixth sheet and the third tablecloth have been propelled through the wringer, *vi et armis*. And I still maintain that a regular family-wash, without a machine, is too heavy work for any woman, be she Jew or Gentile, bond or free.

As to population, we all know that the rich don't contribute to it very largely; as to the poor, apparently they can't be stopped from augmenting it with extreme rapidity. Thus the middle class is called upon to produce the teachers, doctors, dentists, nurses, judges, spiritual pastors and masters, &c., to remove the adenoids, fill the teeth, straighten the limbs, and improve the manners and morals of those children whose mothers can't or won't bring them up properly. And this raising of future citizens of light and leading, without benefit of cook, char, housemaid, nurse or governess (as is now generally the case in the United States), is no easy task. And the harder it is, the fewer are the number of children among the very people most capable of helping the quality of the population. So the question is not, would one rather have a charwoman or or a washing-machine, but would it not be better to have both, if possible, and thus to cut down the amount of time that the charwoman has to spend upon the washing, and to set her to wheeling the baby-carriage, figuratively speaking, in the time so saved.—I am, &c.

An American Housewife.

Underground Railway Training School.

On Tuesday the Press were invited to inspect the school which has been established at Lambeth North Station for the training of Underground Railway men, and to see the film which shows the men right and wrong ways of carrying out their work, with a view to enabling them to avoid or prevent accidents. There are at the school equipment for demonstrating the action of the brakes and a complete switchboard, upon which each man training to qualify for a motorman receives instruction. A brake valve, uncovered so as to give a sectional view, and a wall diagram, showing the whole lay-out of a motor car equipment, are particularly useful aids to instruction. There are on the school premises an office, lecture room, booking office school, motor equipment room, medical officer's room and cinema hall. New men are instructed in the duties of booking clerks and porters, which are the preliminary grades, and in the training is included the study of the geography of the railways, the avoidance of accidents and the absolute necessity for courtesy on all occasions. Before promotion to gatemen, collectors and liftmen, guards and signalmen, and motor men, men who have previously passed out of the school as proficient in the preliminary grades, return for instruction. Classes are also held twice a week which are open to all grades in the service. In addition to the theoretical training, the men are sent out on the line for practical training with a competent instructor.

In the first year, ended February, 1921, 257 men were engaged, whilst 433 men of various grades passed through the school.

An "All-British" Vacuum Cleaner.

The introduction of an "All British" electric vacuum cleaner is, it will be agreed, a step in the right direction, and the "Little Glutton" vacuum cleaner, which is being placed on the market by The Edison Swan Electric Co. qualifies for the proud title of "All British," as it is made throughout at the Ponders End Works of the Company.

A close inspection of the machine reveals the fact that it has not been designed in a hurry, but it is the result of careful forethought and experimental work. A comparison of the weight of the "Little Glutton," which is illustrated in Fig. 1, with that of other machines shows that it is designed on generous lines and constructed to last. The total weight is 23 lbs., but it is so well balanced and the four rubber-tyred wheels so easy running that it requires practically no effort to use it and a child can quite easily operate it. The finish is polished aluminium and many refinements and common-sense features are embodied in the design.

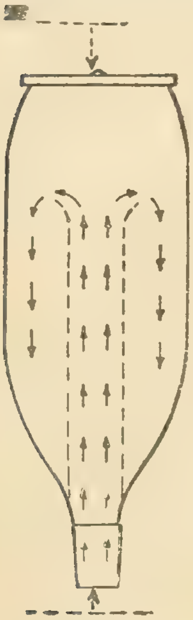


Fig. 3. Diagram of the Dust Bag.

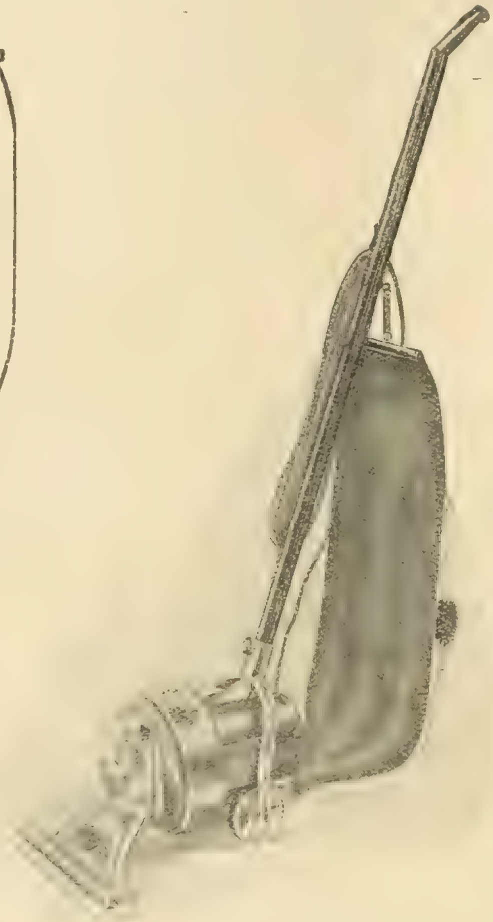


Fig. 1.—The "Little Glutton" Vacuum Cleaner.

An outstanding feature of this cleaner is the motor which is most rigidly built and is of a far heavier pattern than is usually found in cleaning machines. The carcase is built up from laminated field stampings of "Stalloy" with die cast aluminium end brackets. This carcase also carries the special automatic switch which will be referred to later. The armature is constructed on novel lines, in that two cores are mounted on the spindle leaving a central space one-third of its length, so that between the cores the armature windings, see Fig. 2, are directly open to the surrounding air thus providing a very effective self-cooling arrangement. The armature is wound with double silk-covered copper wire and is fitted with a commutator of twenty-four drawn copper bars. The spindle runs in ball bearings which are enclosed in machined housings of the same diameter as the core, and the armature can thus be entered from either end of the carcase. The brush gear and armature can be removed from the machine without disturbing any of the connections. This motor is quite "universal" as it runs equally well on direct or alternating current up to 50 periods. It is made for all circuits from 25 to 100 periods, and from 50 to 250 V. The normal loading is 200 W.

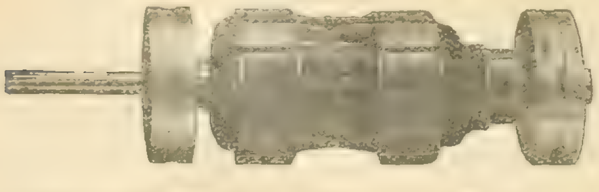


Fig. 2.—Armature of "Little Glutton" Motor, showing Cooling Arrangements.

The fan is six-bladed and is constructed from high tensile die-cast aluminium alloy. It is of exceptional strength and is designed to give the maximum air displacement.

Another interesting feature is the patented construction of the dust bag. In appearance this bag is similar to most others, but it is made in the form of a valve in which the dust is thrown up a central passage and is then thrown to right and left and is deposited in pockets. There is therefore no possibility of dust falling back into the machine and a clear passage is maintained when working the cleaner. The operation is shown in Fig. 3.

Switching Arrangements.

The automatic switch, which is patented, is specially designed to meet the wishes of those who are averse to operating a switch when a machine is in motion. The switch is operated by the main handle of the cleaner. The normal "at rest" position of this handle is a vertical one, and it is spring locked. To use the cleaner this handle is released and is brought into the most convenient position; this automatically starts the motor. Upon returning the handle to the vertical position the motor is automatically stopped.

Many other refinements in design have been introduced into this machine and its accessories, one noticeable feature being the connector for blowing or suction. In all other cleaners special adaptors are necessary and these are usually lost or mislaid when wanted. In the "Little Glutton" the device is sent out fixed to the hose as a unit, and no adaptor is required. The various brushes are also of novel design, differing from those usually supplied with cleaners, in that a suction zone is provided completely around the outer walls of the bristles in addition to the usual central aperture. In this manner, all dust raised by the action of the bristles is, it is claimed, thrown immediately into the suction zone, no matter in what direction the brush is used. The machines are provided with a very complete range of accessories including a hose length with steel extension tubes of ample diameter and a variety of nozzles for every class of cleaning.

Shop Lighting by Gasfilled Lamps.

The prime object of a shop-window lighting scheme is to provide adequate and pleasing illumination of the goods displayed. Among subsidiary aims may be mentioned attractive and artistic effect, due economy in current consumption, and, in some instances, distinctive design—as in the case of multiple shops. From the illuminating engineer's point of view, there are two principal types of window:—(1) those of large stores, which are usually spacious and dressed in an open style; and (2) the windows of smaller shops, which are generally cramped and often very crowded with goods. The same principles should be applied in designing the lighting of either type, but the equipment will vary in each case. The human eye instinctively and involuntarily seeks the brightest object in its field of vision, and, therefore, unless for very special reasons, it is not good practice to allow the actual source of light to be visible.

Fig. 1.

The intensity of illumination required for shop window displays varies from 15 to 25 foot-candles, according to the colour and nature of the goods exhibited, the lower figure being for light surroundings and open dressing. With modern reflectors and lamps these values can be obtained with a current consumption of from 1 to 3 W per cubic foot of window space. The 40, 60 and 100 W gasfilled lamps are particularly suited for shop window illumination. The type of reflectors used, and their arrangement, will depend largely on the size of the windows. A large window, such as those in the big department stores, should be treated for lighting purposes as a small theatre stage. For these, window trough reflectors give excellent results. A typical trough reflector, designed by the General Electric Company, is shown in Fig. 1. This consists of a steel shell lined with open mirror glass strips and provided at suitable intervals with B.C. holders to take 100-W gasfilled lamps. The design illustrated is intended for use in windows of average depth, and the lamps are spaced 18 in. apart. Other types are available for windows of various proportions and different spacings can be arranged.

Window Lighting Problems.

Where the window dressing is likely to vary in character from week to week, or where a very flexible system of lighting is desired, the G. E. C. F.B. 323 individual unit (shown in Fig. 2) is extremely useful. This unit consists of a concentrating type steel reflector lined with mirror glass, mounted on a knuckle-jointed brass down-rod and provided with a ceiling plate and B.C. holder. This fitting can be adopted as a pendant or bracket and is intended for use with 60 or 100 W gas-filled lamps, special ventilation being provided. With suitable switching arrangements, a variety of lighting effects can be obtained and the adjustable joint allows the light to be directed where it is most needed. Both the trough reflectors and the individual units are designed to screen the lamp filaments from direct view.

In lighting the windows of the smaller shops, several difficulties are met. In the first place, the small shop-keeper is usually averse from installing anything more than the old-fashioned drop pendant with (and often without) a conical shade. This is due partly to conservatism, partly to unwillingness to incur heavy expense and partly to an insufficient realisation of the advertising value of well-lighted windows. Moreover, until recently, there have been practically no simple, yet scientifically designed, units available at a reasonable price. The unit shown in Fig. 2 is admirable for the small shop, but where expense is a great consideration, the reflector, holder and gallery can be supplied with a short length of flux, and a B.C. adapter for attachment to existing pendant points. This unit can be equipped with one of the G.E.C. "Superlux" shades. "Superlux" which is a slate "cased" glass having an "egg-shell" finish, combines excellent diffusing and reflecting properties with a very low absorption factor. By the use of suitable curtains or friezes, the individual units can be completely hidden from public view and the wonderful, almost stereoscopic effects obtainable are a welcome contrast to the alternate sickly and glaring results seen in shops where no attempt at scientific illumination is made. The General Electric Company, Ltd., Magnet House, Kingsway, W.C. 2, have specialised in shop-window lighting, and, although they do not carry out installations, their illuminating department will willingly give the benefit of their experience to those interested in lighting problems.

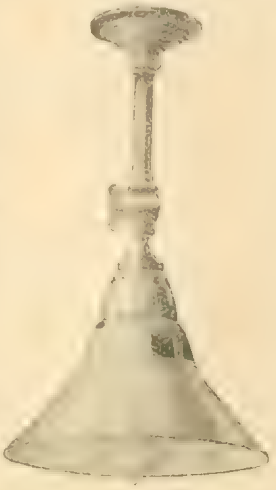


Fig. 2.

Elwell-Poulsen Arcs Aboard Ship.

There is no doubt that as the reliable range of wireless sets aboard ship is increased passengers will make a greater use of this means of communication. With this end in view the Cunard Company has installed Elwell Poulsen arc equipments on some of their larger liners, and some very satisfactory results are being obtained.

The first ship to be fitted was the "Caronia," and the results of several trips which she has made are now available. On the Atlantic route communication is maintained direct with shore stations throughout the passage. Very good ranges are also obtained with the "Polar" spark equipment, with which the "Caronia" is fitted in addition to the arc. At certain places on the route, however, spark jambing and atmospherics are particularly bad, and it was here that the arc was particularly valuable in getting messages through.

S.s. "Caronia" has recently completed a cruise in the Mediterranean, and the following extracts from the operator's report are interesting:—

The Elwell-Poulsen arc installation has worked very satisfactorily, and very good ranges have been obtained.

The greatest ranges obtained with the arc were with Bar Harbour on February 25th at 0612 position noon 35.00 N. 20.13 W. approx. distance 2 423 miles from which position continuous communication was maintained to New York.

Bar Harbour also advised that he copied our signals on 22nd February at 2 130 while working to Devizes, this distance being about 3 500 miles and while s.s. "Caronia" was still in the Mediterranean. At 0735 on 25th February communication was established with Norfolk, Va., at approximately 2 815 miles. Devizes was also communicated with on 19th January, at 0650 at approximately 2 000 miles.

During the Mediterranean cruise communication was kept practically throughout with Devizes, despite bad jambing from spark and arc stations in the vicinity. His signals would seem to carry to a greater distance south than west, and were usually very strong. No complaints were ever received regarding the clearness of s.s. "Caronia" arc note, and judging from the steadiness of the D.C. meter the arc is running most satisfactorily.

Although the main portions of s.s. "Caronia" arc equipment are those of a standard land station, there are several points of interest. A special method of keying is employed, so that no spacing wave is radiated, and the energy taken by the arc during the spacing period is considerably less than that during marking. Easy starting and a clear note are helped by the use of a separate alcohol vapouriser in the place of the usual drip-feed arrangement.

London Traffic Arrangements.

The Special Committee of Inquiry on Tramways appointed by the London County Council in March, 1920, has issued a report in which they state that they have considered several methods that have suggested themselves for dealing with the London traffic problem as a whole, and effecting such an improvement in the present arrangements as will enable the best use to be made of the existing facilities. It is pointed out that in the area there are some 122 road authorities exercising various powers of control. At present, except for the exercise of certain powers of control by the Ministry of Transport and the police, and the temporary powers conferred on local authorities by the Local Government (Emergency Provisions) Act, 1916, no very effective limitation exists as regards the number or character of road passenger transport services which may be introduced. As the result of this state of affairs there are now being operated in the area about 17 systems of separately operated tramways, and also a large number of motor omnibus undertakings.

While we recognise that in many respects the existing facilities require to be supplemented in order to meet the requirements of the public, we are satisfied that if the undertakings now operated were worked in co-ordination very great benefits could at once be secured for the public, while at the same time considerable financial advantages would accrue to individual undertakings. An essential condition is that any step taken must be accompanied by adequate provision for public control, so that the interests of the travelling public may be safeguarded. The only satisfactory and effective form which this control could take if arrangements were made for the operation of the existing undertakings on unified lines would be by means of a municipal body elected by the local authorities in Greater London, it being clearly understood that the setting up of such a body should be regarded as a temporary measure pending the re-organisation of local government in Greater London. The Committee state that they have examined the "service at cost" methods of operation in force in many American and Canadian cities. Under this arrangement the city authorities, or a specially constituted public authority, grant a franchise to private undertakings to operate the tramways systems in their area.

As the result of conferences between representatives of the Council and representatives of the London Underground group of companies the Committee feel that a point has been reached at which it would be well for the Council to outline its general policy as to the steps which should be taken to place the traffic arrangements of London on a satisfactory footing, bearing always in mind that the Council must necessarily look at the matter, not merely from the standpoint of its position as a tramway undertaker, but also as a local authority responsible for looking after the general interests of the public of London. The question of the relationship of existing undertakings and the establishment of a Traffic Control Authority for Greater London is of such obvious public importance, and one that affects so many interests, that no satisfactory settlement can, the Committee think, be hoped for unless the Government takes the matter in hand by arranging to bring together the various authorities concerned, and subsequently by formulating the legislative measures that will be necessary. There should be no delay in the Council defining generally its attitude in the matter and in approaching the Government. We recommend:—

That the Council earnestly desires the introduction by His Majesty's Government of legislation to make provision for the unified operation of local passenger transport undertakings in Greater London and for the setting up for such area of a municipal traffic control authority (to be appointed by the local authorities affected), it being understood that the establishment of such an authority shall be regarded as a temporary expedient pending the settlement of the question of the re-organisation of local government in Greater London, and that in the event of a new governing authority being set up for the area with the requisite powers such authority shall take the place of the municipal traffic authority herein referred to.

London and Home Counties Electricity District.

The Electricity Commissioners give notice that they will hold a local inquiry at the offices of the Institution of Electrical Engineers, Victoria Embankment, W.C., on the 14th June and following days with reference to the area to be included in the proposed district and the objections and representations which have been made on account of the inclusion in, or exclusion from, the said district of certain areas, and to consider schemes which have been submitted respectively by: (*a*) the London County Council, (*b*) the Conference of local authorities owning electricity undertakings in Greater London, and (*c*) the London Electricity Joint Committee, 1920, Ltd. In each case it is proposed to effect an improvement of the existing organisation for the supply of electricity in the district and to form a Joint Electricity Authority.

Schemes have also been submitted by (*d*) the Metropolitan Borough Council of Poplar, for effecting an improvement of the existing organisation for the supply of electricity in "East London and District," and for the formation of a Joint Electricity Authority for the district; and also (*e*) by the Great Eastern Railway Company, and (*f*) the London, Brighton & South Coast Railway Company, in both cases for effecting an improvement of the existing organisation for the supply of electricity in the district provisionally determined.

The Nash "Fish" Invention.

On Monday and Tuesday, the Royal Commission on Awards to Inventors, Mr. W. Temple Franks presiding, continued the hearing of the claim of Mr. G. H. Nash (of the Western Electric Company) and Messrs. Penny, Mack & Grace, for an award of £250 000 for the invention of hydrophone equipment, which was used in a structure called the Nash "fish" and operated through a cable from controlling apparatus on a surface vessel.

Mr. Hunter Gray, for the claimants, continuing his opening speech, said the Western Electric Company spent much money in evolving successful hydrophones, and Mr. Nash himself spent £3 000 for which he had received no pecuniary recompense. Mr. Nash and his colleagues had not been inspired by other inventions. He claimed that the device under consideration was the most important that had been investigated by the Commission.

Mr. G. H. Nash then gave evidence, in the course of which he said a naval captain had expressed the opinion that the "fish" idea was impossible, as it did not contain gyroscopes and other things which were used in torpedoes. When the hydrophone was not revolving about a perfectly vertical axis the back part of the microphone fell away from the front part, because they were coupled by a thin mica diaphragm, and that meant a change in sensitivity. Consequently, the body of the "fish" had to be made absolutely neutral—without either positive or negative buoyancy. To keep it horizontal he got an artificially submerged towing point. The weight used to keep the towing cable in the right position had a stream-lined tail and a little fin. After trying to tow the weight by the outer armour the towing was transferred to the central core, which was surrounded by 20 conductors. The pull was all on the core, and the conductors could, so to speak, go lazily past it. The protection for the cable was a specially devised spiral wire which was so constructed as to bend in a perfectly circular direction. In the silent cabin on the ship the sound of a submarine's engines could be heard even though a storm was raging. At the request of Captain Fisher, for the Admiralty, he also founded a listening school. In the experiments in July, 1917, it was considered that the winch was one thing they need not bother about. Captain Metcalfe (who) is also making a claim before the Commission) brought drawings of a winch. He (Mr. Nash) asked for 20 slip rings, but the winch Captain Metcalfe provided had 20 fixed and 20 moving studs. The first 60 winches were supplied by the Admiralty and gave a large amount of trouble, owing to the studs having been made with a sharp bevel. Subsequently to July, 1917, he proceeded to organise apparatus suitable for practical work. On October 17, 1917, when Admiralty officials witnessed the experiments, the whole thing worked beautifully.

Cross-examined by Sir Arthur Colefax, K.C., Mr. Nash said he knew the Admiralty had official reports on the sinking of submarines, and that the cases were subsequently investigated. It did not surprise him to hear that not one single submarine was "recorded" as having been sunk by the use of the Nash "fish." He was not surprised to hear there were cases of submarines sunk which were credited to some devices other than his. (Sir Arthur Colefax would not disclose the number, but said witness might take it they were very few.) His major work was after the Commission. Previous to that he had done a lot of work on small models. In reference to a letter he wrote in January, 1917, and which was intended to be laid before the Prime Minister, witness was not cognisant of what the Board of Inventions and Research had done. He went to America and obtained thermionic valves for Sir Richard Paget, and he made up a small hydrophone for Prof. Bragg. Sir Richard Paget, by reason of having met him at that time, knew he (witness) had an experimental research station, and he brought down non-directional hydrophones and experimented with them. In experiments he made in Poole Harbour the hydrophones he used were not of other designs than his own. He found out that the Admiralty had a bi-directional hydrophone—the Sykes-Morris—in 1919, but what he and his colleagues had got was not the same as the Sykes-Morris hydrophone. They invented theirs entirely independently. The idea of the baffle for the microphone did not originate with the Admiralty, because he had tried the beeswax baffle. The actual xylonite baffle used in the equipment was supplied by the Admiralty, but he and his colleagues had independently made another baffle. He did not learn as early as March, 1917, what the Admiralty hydrophones were. He simply learnt that they had directional hydrophones. He learnt that in May, 1917, when they sent him two models. The whole of his work was impromptu, backed by Captain Fisher. After trying the beeswax baffle he set about finding other materials that would not melt in the sun, and the result was a baffle of ebonite and rubber. That baffle was made, as far as he could tell, some time in June, 1917. He had never been to Hawkcraig. Mr. Mack went there in May, 1916. He did not know what Mr. Mack saw there until he saw his evidence prepared for this occasion.

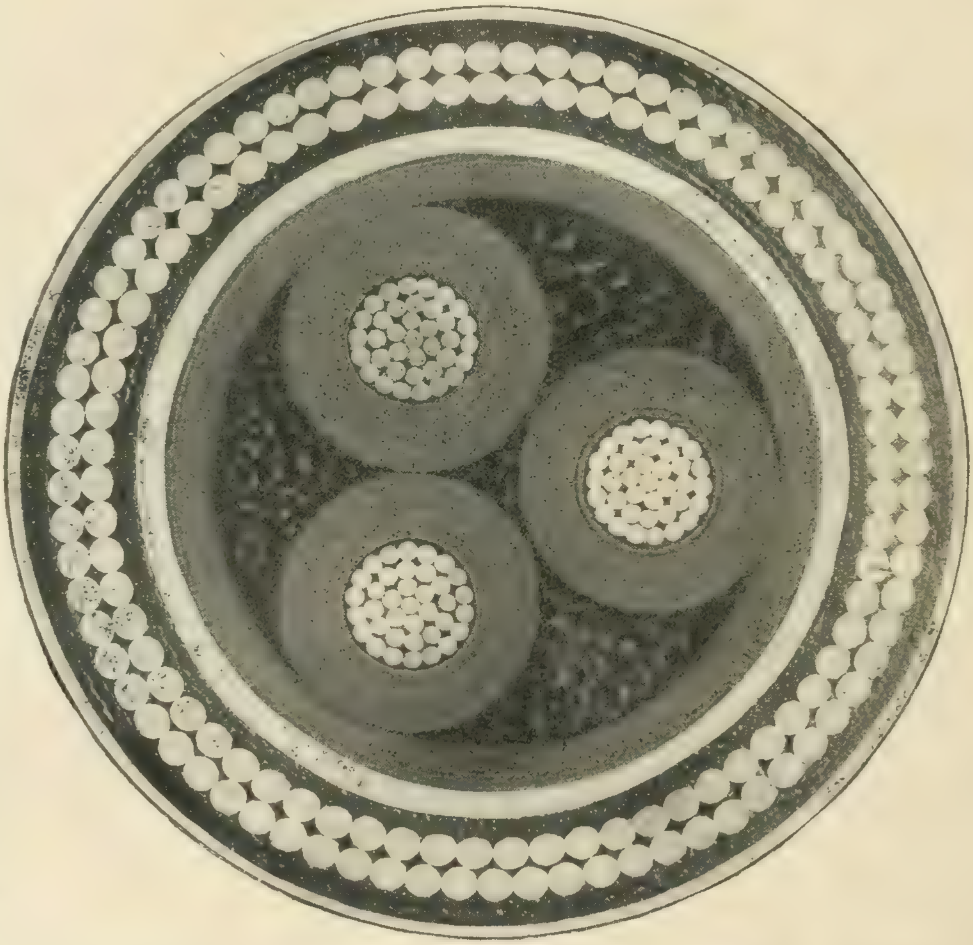
Sir Arthur Colefax said that submarines were undoubtedly hunted and harassed by means of the Nash "fish," but it had meant the sinking of none. The practical value of claimants' invention was small. In respect of other inventions of a similar character, substantial sums had been paid. It was admitted that Mr. Nash was the first to produce a hydrophone which was capable of being towed and giving directional indication provided the submarine was making sufficient noise. But the German submarines learned to go slow when hunted, and became much less noisy. The Admiralty had decided there should be no renewals of the Nash "fish" and no repairs to existing ones. Only three were actually in service at present.

Mr. Hunter Gray said that he would endeavour to establish that there was no combination as good as the Nash "fish." Claimants worked concurrently with the Admiralty on the problem, but quite independently, and they were entitled to considerable credit.

Further evidence was given by Mr. R. A. Mack, Capt. Yates Brown, Mr. J. F. Neill, Mr. B. E. Hammond, Commander W. N. Lapage, Mr. T. E. Eachus, Mr. F. T. Peters, Mr. R. Porter and Mr. Cross on behalf of the claimants, and Mr. L. C. Bernachi was the first witness called for the respondents.

The inquiry was then adjourned until Monday next, when further evidence for respondents will be given.

Another Super Cable.



Full Sized Section of 3-core Cable for 66,000 V Working Pressure Star Connections, now being built by the British Insulated and Helsby Cables, Ltd.

The Telephone Inquiry.

The Select Committee on the Telephone Service has continued to take evidence.

Last week, Mr. C. R. S. Kirkpatrick, M.I.C.E., chief engineer of the Port of London Authority, gave evidence and said the payments by the Authority to the National Telephone Company in 1911 (less contra account for wayleaves, &c.) were £1 719, and for the year ended March 31 last the total paid was £4 544. He strongly objected to the message rate system as most complicated and costly. What they were out for was a simple flat rate, but if that were not possible he thought that at least there should be one standard charge per call for the whole of the port. He could not make an accurate estimate, but he believed that under the proposed tariff the Authority would have to pay £15 000 a year. At present, owing to the competition of Continental ports, it was more than ever necessary that they should closely watch every possible increase in expenditure. The Authority desired to emphasise the fact that the prosperity of the port and the commerce of the Thames was dependent on the unremitting endeavour to preserve up-to-date means of communication at the lowest cost. The exclusion of Tilbury from the Port of London would produce delay, irritation and higher charges, and was considered a retrograde step. The Port Authority was going to build a floating stage at Tilbury to permit passengers to embark at any state of the tide, and a Bill would be promoted next Session for powers to do so. Other improvements were projected, and the effect of raising the charge to a message rate of 9d. a call was, therefore, diametrically opposed to the best interests of the port.

The witness was asked whether, assuming the Post Office proved there was a loss on every message sent by telephone, he thought the Port Authority should continue to enjoy the rate that caused that loss. The loss in such cases should be a national charge, as he considered it a matter of importance to the trade of the country. The Port was a national trust and the prosperity of London was bound up with the prosperity of the port. Having regard to the scattered nature of the docks and undertakings, every possible assistance that could be gained by co-ordination of working was most desirable. He had no complaint to make in regard to the telephone administration. His case was that, having regard to the geographical situation of the port, and the national interests involved, they should have special consideration.

Cost Basis of New Rates.

On the 27th ult. Sir Wm. Noble, Engineer-in-Chief of the G.P.O., said he thought from the engineering point of view the telephone administration was excellent. A section of the staff did nothing else but scientific research work, and the result of that work was very valuable. He said the new rates for the various classes of user represented the actual cost of providing the service as nearly as it could be ascertained. They did not include any addition for profit, but they covered all indirect costs, such as depreciation of plant, headquarters establishments and the leave and pensions of staff. The votes were based upon a careful and comprehensive study of the elements of capital and maintenance cost applying to each portion of the plant, and of the operating costs under all conditions met with in practice. The message fees were calculated to recoup to the Post Office the expense of operating calls, and also the cost of plant provided for handling the traffic of subscribers in common. The trunk charges and the subsidiary charges were arrived at by analagous methods. The calculations and capital cost were on pre-war basis, but current costs were taken for operating and maintenance. For extensions they had estimated on present costs up to 1924.

Wasteful Expenditure.

Major Purvis, in reply to the Chairman, said he would not object to the annual charge to private residents being less than to business men if the total number of calls were less than the basic number on which the present charge was fixed.

As to wasteful expenditure, the Chairman put this case which had been brought to his notice. A subscriber was leaving his flat and another his house. The incoming tenant in each case wanted a telephone and asked to be allowed to retain it. The Post Office refused to sanction that and took the instruments away, but installed new instruments in each case.

Major Purvis said he could not understand such a thing being done. He maintained that the charge made for the telephone service only just covered its cost. As to trunk calls, he thought it would be impossible to use wireless for that kind of service. He agreed that the effect of the high trunk rate would be to drive people more to the use of the telegraph.

Sir William Noble stated, in reply to questions, that no organisations dealing with telephone construction were conducted with greater efficiency and economy than was that of the research department of the Post Office. In New York the cost of their research department was enormously in excess of his. He expressed the opinion that the basic payment for youths was far too high, and their war bonus was on too high a scale; but that was an award by the Committee on Production.

In the opinion of Sir Wm. Noble local municipal management was outside the bounds of practical politics. There could be no reduction for at least three years in the charges, owing to the high cost of materials.

Answering questions as to trunk calls, Major Purvis said they were still working on the placing of trunk lines underground. When that system was complete, the cost of maintenance would be far less, and they would be able to do with less revenue. He understood the idea was to give a slight reduction on accounts when it was possible as an interim method of reduction until conditions permitted the issue of a new schedule. It was the same with local calls.

On Monday Sir Wm. Noble was further examined by members of the Committee. In regard to the provision for replacements he said that if the service had been owned by a private company it might have to be met by raising new capital. If they were going to raise capital for renewing old plant and prices ultimately came down, the capital value would be at a higher figure than the plant value. The moment the revenue exceeded the expenditure there would be a revision of the charges. The situation would be considered every year, and he could offer no reliable opinion as to how long the present rates would last. Some subscribers had been lost, but more were coming than were going out.

Legal Intelligence.

Trade Union on Electricity Supply.

At the North London Police Court on Tuesday, the Magistrate (Mr. Forbes Lankester) K.C.) delivered his reserved decision on the summons taken out by Mr. Arthur C. Dore against the Hackney Borough Council for making default in supplying electric current to his private house. Mr. Dore had entered into a contract for the supply of electricity by the Council, and employed a Mr. Cant, a master man, who employed no labour, to do the inside wiring; but the Council's workmen refused to make the connection, because the wiring was not done by trade union labour. The Council relied on a clause in their Provisional Order, which stated that they were not liable to a penalty if the default were caused by "inevitable accident or *force majeure*."

In the course of his judgment, Mr. Forbes Lankester said the Council were faced with a dilemma, in that they had either to yield to the threat of the trade union or run the risk of dislocating the business of the borough depending on them for electric light and power. The threat, if acted on, would deprive all men in the position of Mr. Cant of a legitimate livelihood, while it avowedly amounted to a claim on the part of the union to dictate to all their fellow-subjects the class of persons they should employ to do private electrical work on private premises. He found that the Council's default was not either inevitable accident or *force majeure*, and fined them 5s. per day for nien days (£2 5s.), with 20 guineas costs. we would assist any appeal to the High Court, as he thought that if the meaning of *force majeure* was to be extended it should be done by the High Court.

Parliamentary Intelligence.

COUNTY OF LONDON BILL.

The Select Committee of the House of Lords, which has been considering the Bill of the County of London Electric Supply Company for additional powers in regard to the use of land at Barking for a generating station and for raising capital, &c., has decided to allow the Bill to proceed subject to the power of purchase either by agreement or by compulsion on terms to be fixed hereafter being inserted in the Bill.

Mr. Craig Henderson, in his address on behalf of the London County Council, said since the Act of 1918 was passed the Company had purchased additional lands and now came before the Committee to ask for power to use those lands as a site for a generating station. The Public Act of 1919, by which the Electricity Commissioners were set up, put a stop order on the erection of stations on authorised sites which had not yet been used for that purpose. The 1919 Act provided that a new scheme of electricity supply throughout the country should be framed, and the Electricity Commissioners were authorised to split up the country into such districts as they chose, and, in order that they should not be hampered, Parliament said that existing companies or local authorities having statutory powers to erect stations, which they had not yet exercised, should no longer have those powers. The County of London Company asked for powers to erect a station in a fresh site. That was what Parliament said in the 1919 Act was not to be. It was for the Electricity Commissioners to select sites and formulate a scheme of supply. If this provision of the Bill were passed the company would go before the Commissioners as an authority which had received sanction from Parliament to use a particular site for a generating station. That was what the Act of 1919 was designed to stop. The Minister of Transport, when he made his report, understood that the company merely sought powers to use certain lands for the extension of the authorised generating station. The Romford Order of 1913 gave the company power to build upon certan lands such stations as might be necessary for the supply of electricity in the Romford district, but a station on the blue land, plus the pink land shown on the plans, would be suitable for the supply of London generally. And this was one of the two or three sites from which that could be done. This station of an ultimate capacity of 600 000 kW was destined as a station to supply London. Did that fall within the Ministry of Transport Report? Conditions had changed so much since 1918 that the company could not to-day borrow the money on the terms of compulsory purchase provided for in sect. 5 of their Act of 1918, and, therefore, they wished to repeal that section and put in the clause which was now Clause 11. The only cases in which the Commissioners should have to deal with approved sites were those in which the sites were approved before the Act of 1919. Under the Act of 1919 the company could link up with another authority, instead of asking for authority to use a site which the Commissioners might desire ultimately to be used.

The Marquis of Bristol said the Electricity Commissioners could define the terms when the London County Council wished to purchase.

Mr. Charteris (for the Company): Your Lordship is not suggesting that the County Council should have power to purchase this station outside their area on terms prescribed in the Public Act?

The Chairman: If the Electricity Commissioners, after consideration of your arguments, come to the conclusion that they have the power.

Mr. Charteris said he felt a very great difficulty about that, because they had not contemplated that the County Council should be given powers to go outside their area, as the existing law expressly prohibited them from doing that or from purchasing a station which was to be erected. What their Lordships were proposing would sterilise the undertaking in the sense that there was hanging over them an uncertain possibility of purchase by an unknown authority on undefined terms.

After discussion the clauses as amended by the promoters to carry out the decisions of the Committee were passed.

LOCHABER WATER POWER BILL.

During the week a Select Committee of the House of Commons, presided over by Sir Harry Samuel, has been considering this Bill, which seeks power to utilise the water power of the Spean watershed and the flood waters of the Spey river in order to generate electrical energy for the proposed works of the British Aluminium Company. Mr. Macmillan, K.C., for the promoters, said the Bill was promoted with a view to utilising for industrial purposes the great water resources of the Highlands. The promoters of the measure consisted of seven gentlemen, who were all connected with the British Aluminium Company. The real promotors were the British Aluminium Company, the main purpose of the Bill being to develop the water resources and make them available for the purposes of the Company. They were to have works at Fort-William, where the electrical energy might be used in the manufacture of aluminium. Having referred to the steps taken in other countries to develop their natural water power resources, he said the water resources of the Highlands, which had hitherto run to waste, provided them with an exceedingly important reservoir of energy whose utilisation for industrial purposes had important advantages.

Key of the Situation.

Referring to the works contemplated, Mr. Macmillan said the key of the situation really consisted in the utilisation of the two lochs known as Loch Laggan and Loch Treig. The first purpose of the Bill was to utilise two sources of water, the first of which was that of the Spean watershed. A dam would be built which would have the result of elongating Loch Laggan from a loch about seven miles long to one of about eleven miles long. It was also intended to construct a dam on Loch Treig, which would enable that loch to be used as a reservoir. Loch Treig would be the main reservoir, and its total capacity when the dam was completed would be 7 837 million cubic feet of water. The water from Loch Treig would be taken to the neighbourhood of the works at Fort-William by a tunnel. The first part of the scheme was designed to effect a complete utilisation of the water power of the district, and the second part involved the utilisation of the flood waters on the upper part of the River Spey. They proposed to construct a dam over the Spey, but it was not intended to impound the whole of the waters of the river. It was intended to trap only the flood waters caused by the excessive spates to which the district was subject. The summer flow of the Spey should remain untouched. Whenever, in consequence of heavy rainfall the water coming down the Spey increased in volume beyond the ordinary average summer flow they would impound it, and lead off that water into Loch Laggan, and make it available for their scheme by means of a conduit. They also proposed to intercept the waters of the River Mashie, a tributary of the Spey.

The Highland Host.

Counsel said he understood from the nature of the petitions that it was the anxiety of the Spey Fishery Board and certain proprietors on the Spey that had brought the Highland host once more into being before them. No doubt the Spey was an important fishing river, and the salmon fishing on it had an annual value of £18 000. The fishing had considerably improved owing to the laudable efforts of the proprietors, whose apprehensions were that by the dam across the upper reaches of the Spey they would prevent the fish going up that portion of the river to spawn. The Committee would have evidence to show what part the upper reaches of the Spey played in the fish life of the stream as a whole. They would submit in point of fact the river, from that aspect, would not be materially affected at all.

Scope and Cost of Scheme.

The County Council of Inverness and Local Authorities galore were interested in the welfare of the scheme. There was no opposition from the Spean Valley, where it was recognised that the scheme was of vital importance to the territory. The scheme would enable the Company to increase their output from 15 000 to 18 000 tons per annum. It would give employment to a large number of men. At Kinlochleven 94 per cent. of those employed were Scotsmen, and of these 80 per cent. came frm the Highlands and Islands. From 2 000 to 3 000 men would be employed by the scheme, and it would enable many of the crofting homes to continue their existence throughout the whole district, of which Fort-William was the centre. It was provided in the Bill that 2 500 h.p. should be made available to the Fort-William and the surrounding territory for the development of other industries. The total cost of the scheme itself was estimated at £3 000 000.

The Committee then adjourned.

Commercial Topics.

Catalogues for Chile.

The Commercial Secretary to H.M. Legation at Santiago (Mr. W. F. Vaughan Scott) has recently made some useful comments on the translation into Spanish of catalogues, pamphlets and other trade literature sent out by United Kingdom manufacturers and exporters to firms in Chile. Mr. Scott points out that the title or most conspicuous word should be in Spanish and not in English. Unless this is so, even when the subsequent matter is in Spanish, it is seldom read. As every firm of any standing in the country receives a mail bag full of advertising matter by each mail, it is obvious that with such a collection to choose from it is only the Spanish reading matter that will receive any attention. It is most important, therefore, that upon taking off the postal cover the most striking wording which reaches the eye should be in Spanish.

* *

The Canadian National Exhibition.

This Exhibition, which is held annually at Toronto, will be open this year from Aug. 27 until Sept. 10. The Exhibition presents a good opportunity for United Kingdom firms to secure wide publicity for their products in Canada. It is open to the general public, and combines the features of a trade fair and a pleasure ground. The more important Canadian and American firms are exhibitors, but the display by United Kingdom firms has hitherto been inconsiderable, at the 1920 Exhibition the number of these firms being less than 30. Last year the attendance exceeded one million, so that the Exhibition affords an excellent opportunity of bringing the products of British manufacturers before the Canadian public.

As in former years, a Bureau of Information in connection with the Trade Commissioner Service will be maintained, and Mr. F. W. Field, H.M. Trade Commissioner, will be glad to receive trade literature or catalogues for distribution from the Bureau. Small exhibits, typical of United Kingdom industries, and small attractive posters will also be welcome. Catalogues, &c., should be sent direct to H.M. Trade Commissioner not later than July 15 next, while applications for space should be sent to the Secretary, Canadian National Exhibition, 38, King-street, East Toronto.

* * * *

Finland's Industrial Condition.

In a recent Report on the Economic, Financial and Industrial Conditions of Finland, it is stated that the value of the national waterfalls is 400 000 000 Finnish marks, and in productive capacity the country can rank as one of the most prosperous of the smaller European States. The total expenditure for 1921 is 2 332 million marks, and the ordinary revenue is estimated at 2 203 million marks. The value of the output of the engineering works in 1919 is given as 236 349 600 marks, and of the lighting and power transmission undertakings 52 293 100 marks. During 1920 most industries did fairly well, though the metal industry suffered from the scarcity and high price of coal.

Both in imports and exports Great Britain stands first, followed by America, Germany and Sweden, Denmark, the Netherlands and France. The value of the imports of electrical machinery into Finland during the first nine months of 1920 was 15 470 680 marks; of insulated wires, cables, &c., 6 447 377, and of electric lamp bulbs 6 888,754. There were also large imports of wood-working and agricultural machinery, steam engines, water turbines, machine tools, motors, &c. Much of the machinery, instruments and metals came from Germany.

The Government have recently decided upon an extensive programme for the adoption of electric traction on the railways, and for the development of water power, &c.; and British engineers and exporters should, therefore, keep in touch with the Finnish market which possesses great possibilities. The demand for electrical and mechanical plant, electric motors, cables, &c., should be considerable for many years, though the exchange problem and German competition will have to be faced.

* * * *

Electric Manufacturing in 1920.

Several reports of electrical manufacturing companies have recently been issued and the results shown are very good, considering the adverse conditions prevailing. In all cases there is an increase in the gross and net profits, and dividends are either maintained at the old rate or increased. We refer to the report of the English Electric Company elsewhere, and of the others perhaps the most interesting is that of the Brush Electrical Engineering Company, which made a net profit of £191 096, against £148 685, and is again paying 15 per cent. on an increased capital, besides devoting the usual sum to pay off the 6 per cent. second prior lien debentures, adding £53 377 to the general reserve and increasing the balance forward from £85 568 to £143 268. Last year an additional 4 per cent. was paid on the participating second debenture stock for each of the last six years. In June, 1920, the ordinary stock was doubled by a bonus distribution and then converted into £1 shares, and in the following month 339 512 more shares were offered for subscription at par.

The Metropolitan-Vickers Electrical Company had an increase of £81 555 in the gross profit and of £83 231 in the net profit. After devoting £100 000 to reserve, £35 000 to special depreciation and increasing the carry-over, the directors are able to raise the dividend on the ordinary shares from 8 to 12½ per cent. The orders received during 1920 were in value about 80 per cent. greater than those received in 1919, while the orders completed were in value about 50 per cent. greater.

Messrs. Johnson & Phillips also announce an increase in the profits from £90 000 to £98 400, and the ordinary dividend is maintained at 12½ per cent., but on a larger capital.

Electricity Supply.

The BATH Electricity Supply Committee has applied for santion to borrow £30 000 for new mains and services.

RHYMNEY Urban Council has asked Mr. A. Ellis, of Cardiff, to report on the question of electricity supply for the town.

Mr. George Watson has been engaged as consulting engineer by ACCRINGTON Corporation in connection with extensions to the destructor works.

BARNSTAPLE Corporation has voted a gratuity of £100 to the electrical engineer (Mr. J. W. Hadfield) for extra work in connection with the scheme for the extension of the electricity works.

The ROCHDALE Corporation Electricity Works have made a record profit of £16 187 during the past year. It is proposed to transfer £5 000 to relief of rates, as last year, and to place the balance to reserve. The previous year's surplus was £14 000.

The WYE LIGHTING, HEATING AND POWER COMPANY, LTD., is applying to the Electricity Commissioners for a special order to authorise the provision and distribution of electrical energy in a specified area in the town of Wye and the rural district of Ashford.

Owing to trade depression, the BOLTON Electricity Committee has experienced a falling off in demand for electric current, and in order to reduce expenditure the extensions in progress at Back-o'-the-Bank Electricity Works are to be slowed down temporarily.

An instance of mutually beneficial pooling has been given by OSWALDTWISTLE, near Blackburn, where the gasworks are dependent upon electricity for motive power. The manager has, therefore, allotted 50 tons of coal to the Accrington Electricity Works, realising that if current is cut off the manufacture of gas will be seriously affected.

An interesting HYDRO-ELECTRIC STATION has been erected on the TWEED for the supply of electrical energy for power and lighting at the Tweed mills of Sir Henry Ballantyne & Sons. The electric drive is to be used throughout the mills, and it is computed that a saving of £10 000 a year will be effected in coal charges, &c. The cost of the plant and works was over £100 000.

The question of CONNECTING UP PREMISES WIRED BY NON-UNION ELECTRICIANS has been raised in DUNDEE, where the local Secretary of the E.T.U. has intimated that none of the jointers would be allowed to connect any work carried out by non-Union labour. The result is that this branch of the electricity department is at a complete standstill, as, owing to the strike there is no other work than that banned for the jointers.

As a result of the recent local inquiry held by Mr. H. R. Hooper on behalf of the Ministry of Health it is recommended that the boundaries of CARDIFF be extended so as to include Penarth urban district and part of the Llandaff and Dinas Powis rural district. If the Provisional Order be approved, the population of the city will be over 250 000 and its area about 18 000 acres. Provision will, no doubt, be made for the transfer of electric-supply powers relating to the added area.

The Electricity Commissioners have submitted to the Minister of Transport for confirmation a Special Order made by them for the supply of electricity in Panteg Urban District by the SOUTH WALES ELECTRICAL POWER DISTRIBUTION COMPANY and also the Special Order authorising the same company to supply electricity in certain parishes in ST. MELLONS (Mon.) Rural District, and similar orders made authorising RISCA (Mon.) and MYNYDDICLWYN (Mon.) Urban Council to supply electricity in their respective urban districts.

In an address to the GOSPORT ROTARY CLUB, Capt. W. H. Upton Marshall called attention to the fact that while large bulk supply schemes had already been prepared in many of the industrial areas in the north and in London under the authority of the Electricity Supply Act, nothing had yet been done in the SOUTH OF ENGLAND. The present was, therefore, a most opportune time for the whole question of electricity supply in the Portsmouth area to be carefully considered, as the subject was of vital importance not only to Gosport, but to other towns and villages in the neighbourhood. These towns would not be permitted by the Electricity Commissioners to erect stations of their own and would therefore be entirely dependent upon the action taken by Portsmouth. It was desirable that each borough and district council should take some combined action by forming an electricity supply committee with the object of going into the whole matter and with a view to ultimately becoming the joint authority for the area.

Considerable extensions of its municipal electricity undertaking are projected by LONDONDERRY Corporation, which has already obtained sanction to borrow £50 400 for carrying out certain of the extensions and improvements. The scheme has been prepared by the city electrical engineer (Mr. R. V. Macrory) and the Finance Committee is to report on its financial aspect. The capacity of the present plant is only 2 700 kW, but it is proposed to install an additional 3 000 kW turbo-alternator, two water tube boilers, a 1 000 kW rotary converter, with switchgear, &c. The complete scheme of Mr. Macrory is estimated to cost £69 000, but certain items have been postponed by the Electricity Commissioners. It is also proposed to lay an additional feeder cable some 3 000 yards and of supply cable to provide for 400 consumers' services with about 200 extra motors, &c. Mr. Macrory thinks that the new plant will increase the output by about 50 per cent., but the increased expenses will only be 20 per cent., as the new plant will be more economical, the net effect being an increase in the surplus from £3 594 to £16 558.

Electric Traction.

BRIGHTON Corporation is recommended to borrow £30 000 for the renewal of some of the tramway tracks.

By the employment of four electric vehicles for refuse collection the BATH Corporation expect to effect a saving of £1 500 a year, or the equivalent of a penny rate.

The SUNDERLAND Tramways Committee recently obtained the sanction of the Ministry of Transport to abolish cheap fares for workmen, and the order was put into force on Monday last. It is proposed to borrow money for doubling the track from Spelterworks-road to Grangetown terminus, &c.

The CHESTER Corporation is recommended by the Tramways Committee to take up the tramway between the Castle and Saltney, and to substitute a motor 'bus service; and Mr. A. R. Fearnley, general manager of Sheffield Corporation tramways, is to be engaged to advise on the organisation and working of the Municipal tramways undertaking.

An interesting experiment is being made by the BRADFORD tramways department in connection with parcels traffic between Bradford and Leeds. The vehicle employed is of the omnibus type, and is fitted with storage batteries, though it can also be operated on the trolley system. A speed of over 10 miles an hour is maintained, and it is stated that the cost is lower than that of the ordinary petrol lorry. The batteries are only in use when loads are being delivered at points off the tramway route or in proceeding to and from the parcels offices. When working on the batteries the capacity of the omnibus is stated to be 15 miles. The vehicle has been constructed at an almost nominal price, the materials used being mainly portions of worn out vehicles.

The Salvage and Stables department of the BIRMINGHAM Corporation are making increasing use of electric vehicles for refuse collection. They report that the deliveries under the contract with Edison Accumulators, Ltd., for 25 electric vehicles, at £1 280 each, had been completed, and three further vehicles had also been delivered, at £1 804 each, while a fourth is to be purchased. The refuse collection has been wonderfully speeded up by the use of electric vehicles. The committee has accepted the tender of the Brightside Foundry & Engineering Company for the supply and erection at the Montague-street depot of two kW Bumstead & Chandler engines direct coupled to B.T.-H. generators and switchboards, Worthington Simpson surface condenser, with steam piping, &c., complete with cables, for £7 300. The plant is required for driving the large number of motors at the works, and for the electric charging of the vehicles. Current for the lighting of the depot is supplied by an existing generator. The amount paid to the electric supply department for current is approximately £3 000 per annum, and it is estimated that the new arrangement will effect a saving of £2 000 per annum.

Bankruptcies and Liquidations.

Claims against JAS. WM. LAYTON, electrician, 5, Noble's Bank, Hendon, Sunderland, are to be sent by May 18, to Mr. W. A. Ellis.

SAMUEL BECKETT, jun., electrician, 50, Deane-road, Bolton, has been adjudicated bankrupt.

Alfred John Harrison, trading as the XTRA LIGHTING COMPANY, electrical and gas engineer, 4-6, Old Market, Sunderland, has been adjudicated bankrupt.

A meeting to receive an account of the winding up of the COWPER-COLES ENGINEERING COMPANY, LTD., will be held at 11, Ironmonger-lane, London, E.C. 2, on May 30.

An application for the discharge of Geo. Sutcliffe, trading as GEORGE SUTCLIFFE & COMPANY, electrical engineer, 22, George-street, Abertillery, will be heard on May 25, at the Town Hall, Tredegar.

Robt. Chas. Jones, trading as ELECT-MA ENGINEERING COMPANY, 59, Longridge-road, Earl's Court, London, S.W., and lately trading at Caledonia-street, King's Cross, London, N., has been adjudicated bankrupt.

Claims against Bernard Pordes, lately trading as the UNITED ELECTRICAL MANUFACTURERS' COMPANY, 18-22, Christopher-street, London, E.C., are to be sent by May 13, to Mr. E. H. Hawkins, 4, Charterhouse-street, E.C. 1.

The first meeting of creditors of WALTER HEDGECOX, electrical engineer, 121, Salop-street, Wolverhampton, will take place on May 7, at 30, Lichfield-street, Wolverhampton, and the public examination on May 25, at the County Court, Wolverhampton.

STOFFELS ELECTRIC SWITCH COMPANY, LTD., is being wound up voluntarily, and Mr. S. R. Rogers, 41, Eastcheap, London, E.C. 3, has been appointed liquidator. A meeting of creditors will be held at Mr. Roger's office on May 9.

A meeting to receive an account of the winding up of the ELECTROLYTIC COMPANY (SPAIN AND PORTUGAL), LTD., will be held at the office of the liquidator, Mr. R. I. Marsden, 5, Moorgate-street-buildings, London, E.C., on June 14.

The AMPERE ELECTRICAL ENGINEERING & PLATING COMPANY, LTD., is being wound up voluntarily. A meeting of creditors will be held at the offices of Messrs. Hannay & Hannay, N.E. Bank-chambers, Fowler-street, Southfields, on May 11. Claims to the liquidator, Mr. T. L. Hammond, at the same address.

The first meeting of creditors of Herbert Doyle, trading as the ACCESSORIES SUPPLY COMPANY, electrical accessories factor, 56, Hardman-street, Deansgate, Manchester, will take place on May 11 at the Official Receiver's office, Byrom-street, Manchester, and the public examination on June 17, at the Court House, Quay-street, Manchester.

Imperial and Foreign Notes.

Longreach (Queensland) Council is establishing an electricity supply undertaking.

Sandgate (Queensland) Council is applying for an Order-in-Council authorising it to establish electricity supply works.

Dunmunkle (Victoria) Shire Council is applying for an Order-in-Council to enable it to establish an electric supply service.

Electric supply was recently made available in Blackwood and Eden Park (S. Australia) by the Adelaide Electric Supply Company.

Maryborough (Victoria) Council has appointed Messrs. Wales and Wright to report on the subject of providing a supply of electricity for the town.

Nhill (Victoria) Shire Council has applied for an Order-in-Council authorising it to purchase the plant of the Nhill Electric Light Company. The price offered is £2 500.

Wagga (N.S.W.) Council is borrowing £55 000, at 7 per cent. interest from the Australian Temperance General Mutual Life Assurance Society for financing its electricity scheme.

Orange (N.S.W.) Council is contemplating the adoption of an electric supply scheme for the town and has applied for authority to borrow £40 000 to meet the cost of plant equipment.

The Central Illwarra (N.S.W.) Council has decided to take current from the Public Works Department's power house at Port Kembla, and has applied for sanction to a loan of £5 500.

Approval has been given by the Government Hydro-Electric Department to the scheme of electric supply proposed for Scottsdale (Tasmania). Mr. H. E. Lord is to prepare the specifications.

A syndicate has approached the Katoomba (N.S.W.) Council for the right to run railless electric vehicles to and from Leura Falls, Echo Point, Katoomba Falls, and other tourist sites on the Blue Mountains.

The Temora (N.S.W.) Council is about to establish electricity supply works; and Kyogle (N.S.W.) Shire Council is applying for permission to raise a loan for the purpose of providing a supply of electrical energy for the district.

Port Cygnet (Tasmania) Council recently asked the manager of the State Hydro-Electric Department to have the electric supply mains extended into the district. Other councils in the Huon district supported the application.

Bowral (N.S.W.) Council is considering a proposal of the Public Works Department to supply electricity from their power-house at Port Kembla at £8 per annum per kW of maximum demand, plus 1d. per unit. The cost of the distribution system is estimated at £6 900.

An Order in Council has been issued authorising the Kaponga (N.Z.) Town Board to borrow £6 000 for extensions of the electric lighting undertaking, and the ratepayers have authorised the Waimairi (N.Z.) County Council to raise a loan of £7 000 for electric supply mains and other public works.

Picton (N.S.W.) Council having obtained the sanction of the ratepayers to borrow money for the erection of an electric power house, has asked the Government for permission to raise the necessary loan. The estimate of the consulting engineer, Mr. Franki (Warburton & Franki), is £6 550.

Windsor (Queensland) Council is seeking an Order-in-Council to permit it to deal with the City Electric Lighting Company in regard to a supply of electricity to consumers in the town or to borrow £20 000 for plant and equipment to enable the Council to distribute electricity purchased in bulk from the company.

Mr. J. H. Butters, general manager and engineer of the Tasmanian Government hydro-electric department, has returned, after his visit to England in order to arrange with British electrical manufacturers for the supply of h.t. plant required for increasing the capacity of the works at Waddamana from 17 000 h.p. to 57 000 h.p.

In our issue of the 8th ult. we referred to proposals for the erection of Hydro-electric Works and for the Electrification of the Jamaican Railways, and to the estimates submitted by the consulting engineers, Messrs. Preece, Cardew & Rider. It is now announced that another report has been submitted by an engineer of the American Westinghouse Company, who estimates the cost of converting the Government line at £1 000 000. As this figure is much below that of the British engineers, there is considerable risk of the contract going to the United States if electrification should be decided upon.

The Australian Commonwealth Postmaster-General (Mr. G. H. Wise) has recently had figures compiled showing the cost of telephone facilities in Australia compared with other parts of the world. The cost of a three-minutes' conversation varies in Australia from 4d. for 12 miles to 1s. 10d. for 150, while in New Zealand the figures are respectively, 6d. and 2s. 3d., ; in the United Kingdom 4½d. and 3s. 6d., and in the United States 5d. and 4s. 2d. Mr. Wise states that the service is much cheaper in Australia than in America in spite of greater increases in cost of material.

The Portuguese Government is waking up to the necessity of organising electricity supply on modern lines, for it has appointed a Commission to consider the question from the national standpoint.

The U.S.A. Senate has passed the Bill authorising the President to regulate the landings of submarine cables, and the measure will now go before the House of Representatives.

Miscellaneous.

An application has been made by Jules Carpentier for the restoration of Patent No. 19102 of 1910 for an "Improved transmitter for transmitting telegrams composed in perforations on a band by the Baudot system," which expired on Oct. 29, 1919, owing to non-payment of renewal fee.

Electrical machinery, including two dynamos, were destroyed in a fire, which gutted the main saw-mills department of Messrs. Charles Jenkins & Sons' timber yard at Porth (Glam.) last week. The large carpentry shop, which is driven electrically, was saved. The damage, estimated at £4 000, is covered by insurance.

The Swedish General Electric, Limited, are exhibiting examples of their standard variable speed direct-current, single phase and three-phase motors, direct-current and alternating-current dynamos at the Printing and Allied Trades' Exhibition which opened at the Agricultural Hall (Islington) on the 30th inst. The Company's Stand (No. 78) attracted a number of visitors.

The Governing Body of the Finsbury Technical College announce that the entrance examination for the Session 1921-22 will be held on Tuesday, Sept. 20th next. Applications for admission should be forwarded to the College not later than Sept. 15th on forms to be obtained from the Registrar, Leonard-street, City-road, E.C. The programme of the College is under revision and will be issued in due course.

The death took place on the 27th inst. of Mr. William E. Bull, senior London representative of Messrs. Falk, Stadelmann & Company, Ltd. Mr. Bull was connected with the illuminating trade since his boyhood, having entered the business of Prince & Symmons, one of the pioneer firms in oil lighting in 1874. He joined Messrs. Falk, Stadelmann & Company in 1901, and his undoubted ability and genial personality soon secured him a vast circle of friends, who will miss his periodic calls. Mr. Bull, who was an ardent swimmer was well-known in Masonic circles being for the past 21 years secretary of the Shepherds Bush Lodge.

In the course of the past 12 months, foremen in practically every industry have been experiencing trying and difficult times, and the fact that they, as a body, are not recognised even as an industrial unit by the Whitley Councils has rather enhanced than ameliorated the difficulties of their position. They have felt the full force of the bumps as industrial buffers, being compelled to suffer as a consequence of upheavals, and while precluded from giving industrial conferences the benefit of their practical knowledge, are nevertheless the intermediary factor relied upon to give practical effect to decisions arrived at. The Industrial League and Council has had its attention directed to the incongruity of the situation, and they readily acceded to the request of the foremen to take the initiative in bringing about a National Conference.

Foremen's and Supervisors' Associations in all parts of the United Kingdom were communicated with, and a most successful conference was held in the League's offices in Victoria-street, S.W. 20 500 foremen and supervisors were represented by the delegates attending, who were received by the Right Hon. J. H. Whitley, M.P. The full report of the conference, together with the names of the delegates and organisations represented, appears in this month's issue of the "Industrial League Journal," and makes very interesting reading. From it we note that several resolutions of far-reaching importance to managers, foremen and supervisors were agreed upon, and obviously the formation of a National Federation is a step in the right direction if foremen are going to play the part in National reconstruction that the importance of their positions demand.

Institution Notes.

We regret that an announcement under the heading of "Arrangements for the Week," which appeared in our last issue, was misleading. The dinner referred to was that of the Iron and Steel Institute, and not of the Institution of Electrical Engineers.

We are asked to announce that the Electrical Power Engineers Association is recommending its members to support the following candidates for election as ordinary members of the Council of the Institution of Electrical Engineers: Lt.-Col. F. A. Cortez-Leigh, Mr. A. Page, Mr. T. Roles and Mr. W. C. P. Tapper.

The following awards have been made by the Institution of Civil Engineers for Papers read during the past session: Mr. George Ellison, Telford Gold Medal and Telford Premium; Sir Murdoch McDonald and Mr. T. E. Stanton, Telford Gold Medals; Mr. R. G. C. Batson, George Stephenson Gold Medal; Mr. S. A. Main, Watt Gold Medal; Mr. Algernon Peake, Mr. L. H. Larmuth, Mr. H. E. Hurst, Prof. T. B. Abell and Mr. P. Allan, Telford Premiums. Appreciation was also expressed of the Paper contributed jointly by Sir Robert A. Hadfield, F.R.S., and Mr. Main.

At the annual meeting of the Royal Institution held recently the following officers were unanimously elected for the ensuing year: *President*, The Duke of Northumberland; *Treasurer*, Sir James Crichton Browne; *Secretary*, Colonel E. H. Grove-Hills; *Managers*, The Rt. Hon. Lord Blyth, Horace T. Brown, J. H. Balfour Browne, J. M. Bruce, Sir James J. Dobbie, P. F. Frankland, A. H. Goschen, The Rt. Hon. Earl Iveagh, H. R. Kempe, Sir Ernest Moon, A. W. Porter, Sir James Reid, Bart., Sir David Salomons, Bart., Sir Alfred Yarrow, Bart., The Rt. Hon. Sir Robert Younger. *Visitors*, J. H. Batty, A. Carpmael, F. Clowes, E. Dent, Lieut.-Col. H. E. Gaulter, G. H. Griffin, W. E. Lawson Johnston, J. R. Leeson, F. K. McClean, E. M. Micholls, H. M. Ross, J. Shaw, S. Skinner, T. H. Sowerby, W. Stone.

Business Items, &c.

Mr. A. B. Cartland, A.M.I.E.E., 3, Creechurch-lane, Leadenhall-street, London, E.C. 3, has been appointed sole representative for London and the Southern Counties for Messrs. William Whittaker (Burnley), Ltd., boiler furnace manufacturers, and the Premier Appliances Company, Ltd., manufacturers of boiler expansion joints.

The Jackson Electric Stove Company, Ltd., have appointed Mr. W. Blogg, of the Sterling Telephone Company, of 8, Park place, Cardiff, as their agent for the whole of Wales, to represent them in their well-known electric cooking and heating apparatus. Mr. Blogg will carry a consignment stock at Cardiff, where samples can be seen and inspected.

The Sun Electrical Company, Ltd., notify that, owing to the growth of their business in Ireland, they have moved to larger premises, and new showrooms have been opened at Gibson's-buildings, Mill-street, Belfast, where a large and comprehensive stock of electric light fittings and material are available for the trade. The branch remains under the management of Mr. E. P. Prior.

The following firms have been recently elected members of the British Electrical and Allied Manufacturers' Association :—Babcock & Wilcox, Bonella Bros., Robt. Ingram, Clark & Co., Thos. De La Rue & Co., General Accessories Co., Power Plant Co. (West Drayton), Sutcliffe (of Crumpsall), Ltd. (Manchester), Venner Time Switches, Ltd., Widdop Engine Co. (Keighley) and Wilson Hartnell & Co. (Leeds). Except where stated the firms mentioned have their offices in London.

Catalogues, Price Lists, &c.

A list containing an illustrated description and prices of the Midget "Masta" and "Misaloc" Fuse Switches has been issued by Berry's Electric, Ltd., 85, Newman-street, W.1. The switches are totally enclosed, interlocked and foolproof, and they comply with Home Office requirements. The fuse bridge in the "Masta" switch consists of an asbestos tube, through which new fuse wire may be threaded when required, and no live metal parts can be touched by the hand. The switch is designed for use on circuits of a capacity up to 10 A, 250 V.

The Cambridge & Paul Instrument Company, Ltd., 45, Grosvenor-place, London, S.W. 1, have recently issued two sectional lists relating to "Cambridge" unipivot instruments for direct current and to "Cambridge" testing sets respectively. Both are well illustrated, and the list (No. 160) on the unipivot instruments gives details of the construction of various types of instruments, with particulars of shunts, accessories, multi-range instruments, &c. In the other pamphlet (No. 160) particulars are given of the insulation and continuity detector, the self-contained rotary and portable decade patterns of Wheatstone bridge, Omega and universal portable testing sets, the direct reading and induction fault localisers, rail bonding testing set, cable testing outfits, teries, &c.

The latest publication of the General Electric Co. is less a catalogue than a text book. It deals with the important question of protection of electrical circuits by means of Moscicki condensers and Giles valves. The causes of voltage surges and lightning effects on high tension transmission lines are discussed together with the nature of such surges, the resonance dangers of the oscillatory circuits, the reduction of surge pressure by resistance, the defects of the spark gap, the requirements of surge proeective gear and the condenser as a protective agent. Various advantages of the condenser for this purpose are summed up and a detailed description of the apparatus used on this system is given. Protection of direct current circuits by means of electrolytic condensers and details of condenser protection gear on typical circuits are also described. Appendixes deal with certain points in the theory of the apparatus suggested for use, and the whole bulletin is one worthy of serious study.

Three sections of their revised catalogue lists have been issued by Messrs. George Ellison, Perry Bar, Birmingham, dealing respectively with oil-cooled starters for slip ring induction motors up to 1 500 h.p., with brake solenoids or power magnets, and with cable fittings for iron-clad switchgear, including the "Ellison" patent cone gland. The first list (No. 76) contains much useful technical information on an important subject; and gives details of the design and construction of the various types of starter manufactured by the firm with curves of the capacity, temperature rise and operating times, tables of weight, dimensions and other data. In list No. 431 particulars are given of cable fittings, pipe flanges, sealing and dividing boxes, armour clamps and glands for iron-clad switchgear, and List 327 contains details of the various sizes of series and shunt-wound brake solenoids. Copies of the three lists, which are fully illustrated and eyeleted for filing, can be obtained by those interested.

The use of electric vehicles for various classes of industrial transport work for refuse collection and other purposes is being rapidly extended in urban areas, owing to their economy and other advantages. In a well illustrated pamphlet, recently issued by Messrs. Mossay & Co., Ltd., 7, Princes-street, Westminster, S.W. 1, selling agents for the "Orwell" Electric Vehicles, some particulars are given of the variety of trade services in which these vehicles are already employed. They are used by railway companies, by meat and fish merchants, breweries, dairies, flour mills, bakeries, co-operative stores, &c., for the transport of goods and parcels, and by a number of local authorities for refuse collection and other municipal work. The "Orwell" electric truck is also extensively employed for moving goods and luggage at railway stations, works and factories. The pamphlet contains some good illustrations of typical electric vehicles and lorries, with views of the works of Messrs. Ransomes, Sims & Jefferies, at Ipswich, where the "Orwell" vehicle is manufactured.

Tenders Invited and Accepted.

Manchester Electricity Committee require tenders by May 10 for the supply of weldless steel lamp columns. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Manchester Tramways Committee requires tenders by May 10 for electrolytic copper and bronze trolley wire. Specifications, &c., from the General Manager, 55, Piccadilly, Manchester.

Kilmarnock Tramways Committee require tenders by May 15 for the supply of stores, including cable, lamps, insulating tapes, overhead material, varnishes, paints, oils, &c. Forms of tender from the Manager

Mexborough & Swinton Urban District Council invite tenders for the supply and erection of a 750-kW rotary converter with transformer. Specifications, &c., from the engineer and manager, Mr. J. B. Feltham, and tenders to Mr. J. W. Hattersley, clerk to the Council, Hope-street, Mexborough, by noon, May 21.

Glasgow Corporation invites tenders for the supply of cables and meters for 12 months from May 31. Specifications, with forms of tender, from the engineer, Mr. R. B. Mitchell, 75, Waterloo-street, and tenders to the town clerk, Mr. J. Lindsay, City Chambers, Glasgow, by May 20.

It is notified that the date on which all tenders for the supply of plant and material for the electrification of the Cape Town-Simonstown & Durban-Pietermaritzburg Railway lines has been extended to noon, July 5. Tenders to the High Commissioner for the Union of South Africa, Trafalgar-square, London, W.C.

The Australian Commonwealth Postmaster-General's Department invites tenders by May 25 for ironwork, including couplings, piping, bolts, rings, &c. (schedule 704), and by May 31 for porous cells (schedule 1685), and of ammonium chloride (schedule 1683). Specifications can be seen at 35, Old Queen-street, Westminster, S.W.1.

The directors of the Great Western Railway Company invite tenders for various stores, including telegraph instruments, telegraph ironwork and tools and telegraph drysalteries, electric wires and cables, india-rubber goods, oils, acids, alkalis, &c., metals, hardware goods, &c. Samples may be seen at Swindon from May 9 to 11. Specifications, with forms of tender, from the office of the Stores Superintendent, Swindon, and tenders to the Secretary, Mr. A. E. Bolter, Paddington Station, London, W., by May 12.

The Electricity Commissioners of Victoria invite tenders for the supply and delivery at the Morwell Power House of street poles and copper cable. Copies of tender forms from the Agent-General for Victoria, Victoria House, Melbourne-place, Strand, London, W.C.2, and specifications may be inspected at the offices of the consulting engineers, Messrs. John Coates & Company, Ltd., also at Victoria House. Tenders to the Secretary of the Commissioners, 673, Bourke-street West, Melbourne, Australia, by May 31.

London County Council Stores Committee has accepted tenders of the following firms for electric traction lamps: British Union Lamp Works, Ltd., estimated value £366; English Electric and Siemens Supplies, Ltd., £8 505; Stella Lamp Company, Ltd., £432.

Leicester Corporation has accepted the tender of the English Electric Company for the supply and erection of a 10 000-kW turbo-generator set (with Allen condenser) at £91 304. Tenders were received from 10 English and three foreign firms and the tender accepted was the lowest of the English tenders, the highest being £102 169. The English Electric Company guaranteed delivery within seven months. Although the foreign tenders were lower than the English, they made stipulations the Committee could not accept. They required 12 months for delivery, with no penalty for non-delivery, and in case of any breakdown there would be serious delay in sending abroad for replacements. It is estimated that the saving to be effected by the new plant, assuming the average coal consumption of the existing stations at 4 lb. and at the new station 2½ lb., with coal at 35s. per ton, would be £18 700 for the first six months. The demand for electricity has been growing at an average rate of 1 000 kW per annum for several years past. During 1920 manufacturers installed motors taking 2 200 h.p., and in spite of the present depression 700 h.p. had been installed in the first three months of 1921.

Personal and Appointments.

Mr. J. E. Sears, Jun., C.B.E., M.A., A.M.Inst.C.E., F.Inst.P., has been appointed Deputy Warden of the Standards in succession to Major P. A. MacMahon, F.R.S., who has retired. Mr. Sears is Superintendent of the Meteorology Department of the National Physical Laboratory, and will continue to hold that post in addition to that at the Standards Department of the Board of Trade.

Mr. W. J. Talbot, who acted as vice-president last year, was last week appointed President of the Walsall Chamber of Commerce. He was for two years lecturer to the electrical engineering classes at Walsall Technical Institute. About 18 years ago he became engineer and manager of Messrs. John Russell & Company's tube works, and later, with Dr. G. Stead, established the Talbot-Stead Tube Company, Ltd. He is chairman of the Electricity Committee of the Walsall Town Council.

Mr. J. A. Crowther, borough electrical engineer of Wallasey, has tendered his resignation, to take effect on July 31 next. The Electricity Committee has accepted the resignation and has expressed its appreciation of the long and faithful services rendered by Mr. Crowther. The terms upon which Mr. Crowther retires include the payment to him of his full salary to Sept. 30, and thereafter a superannuation allowance of £475 per annum, and a retaining fee of 100 guineas a year for two years from Oct. 1 next.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

16 364/15 Planiawerke Akt.-Ges. fur Kohlenfabrikation. Arc-lamp electrodes. (31/12/14.)
140 054 Knudsen. Electric safety fuses. (6/12/19 Convention date not granted.)
140 367 Automatic Telephone Manufacturing Co., Ltd. Automatic or semi-automatic telephone systems. (31/3/19.)
140 807 Western Electric Co. Electric signalling system. (14/11/14.)
142 074 Alexanderson. Directional wireless receiving systems. (18/4/19.)

Separate currents derived from a receiving antenna of loop form are impressed upon a receiving circuit, one current being due to the magnetic exposure and one to the electrostatic exposure, and means are provided for adjusting as desired the phase of the currents thus impressed upon the receiving circuit.

142 495 Gallo & Villarboito. Electric switches. (29/4/19.)
144 252 Automatic Telephone Manufacturing Co., Ltd. Automatic telephone systems. (31/5/19.)
146 328 Krupp Akt.-Ges. Arrangement for testing an electrical gyroscopic-firing-apparatus also intended for practice purposes, and provided with means for automatically indicating the result of the testing operation. (2/1/19.)
147 437 Ges. fur Drahtlose Telegraphie. Electric condensers. (24/3/19.)
148 265 Wilson Welder & Metals Co., Inc. Arc-welding electrodes. (21/7/19.)
148 277 Frauenfelder. Electric lamp for cycles. (23/7/19.)
149 342 Soc. Anon. des Etablissements L. Bleriot. Electro-magnets. (31/7/19.)
151 928 Western Electric Co., Ltd. High-frequency electric signalling. (29/9/19. Addition to 102 503.)
151 990 Schweitzer. Apparatus for separating or sorting fragmentary materials by electric conductivity. (3/10/19.)
155 237 Metropolitan-Vickers Electrical Co., Ltd. Electrical transformers. (10/12/19.)
159 111 Igranic Electric Co., Ltd. (Cutler Hammer Mfg. Co.) Electro-magnetic switches. (18/5/20.)
159 112 Lofts. Improvements in electrically heated articles to avoid damage through overheating. (19/5/20.)
159 122 Western Electric Co., Ltd. (Western Electric Co., Inc.) Telephone and like circuits. (27/11/19.) Divided application on 155 698. Addition to 155 698.
159 228 Colson. Devices for locking incandescent electric lamps in their holders. (26/6/18.)
159 229 Percival. (Lacey). Electric fixture support couplers. (6/2/19.)
159 260 Goold. (National Safety Appliance Co.) Means for controlling the operative field of magnets. (14/11/19.)
159 267 British-Thomson-Houston Co., Ltd. (General Electric Co.) X-ray apparatus. (18/11/19.)
159 282 Smillie & Metropolitan-Vickers Electrical Co., Ltd. Ventilation and cooling of electrical or other machines. (20/11/19.)
159 288 Fairburn. Controllers for electric motors. (20/11/19.)
159 306 Anderson. Method of controlling electric motors operating fluid-pressure pumps or the like. (24/11/19.)
159 316 Heurtley & Muirhead & Co., Ltd. Telegraphy. (25/11/19.)
159 317 Turner. Electric-ignition collecting, distributing and timing devices and systems. (25/11/19.)
159 322 British Thomson-Houston Co., Ltd. (General Electric Co.) Electric thermionic amplifiers. (25/11/19.)

Comprises a system for amplifying electric current having a number of electron discharge amplifiers connected in parallel in which a small inductance is included in the grid circuit of one of the amplifiers for preventing the generation of high-frequency oscillations by the amplifiers.

159 343 Siemens Bros. Dynamo Works, Ltd. & Wilson. Dynamo electric machines. (4/12/19.)
159 345 Highfield & Calverley. Electric converting apparatus. (5/12/19.)
159 358 Clark. Electrical static machines and apparatus for electro-therapeutic work and for like purposes. (9/12/19.)
159 374 British Thomson-Houston Co., Ltd. (General Electric Co.) Dynamo-electric machines. (16/12/19.)

APPLICATIONS FOR PATENTS.

October 1, 1921.

27 909 Cutter Electrical & Mfg. Co. Switching mechanism. (2/10/19, U.S.)
27 912 Provincial Cinematograph Theatres, Ltd., & Harrison. Kinematograph lanterns, &c.
27 913 Provincial Cinematograph Theatres, Ltd., & Harrison. Carbon-operating devices for kinematograph lanterns, &c.
27 932 Lindenburg, A. G., Heraeus Ges. & Rohn. Induction furnaces. (19/5/20, Germany.

October 2, 1920.

27 956 Hanff. Sheet metal clips for earthing cable conduits.
27 964 Meagher. Alloy for electrical make-and-break contacts.
27 984 Boudon. Electric hair-waving apparatus. (26/3/20, France.)
27 991 Henley's Telegraph Works Co. & Dunsheath. Testing electric cables.

October 4, 1920.

28 055 Welsh. Electrically heating contents of utensils.
28 065 Bradley. Switches and circuit regulating devices.
28 069 Holly & Norris. Electric radiators.
28 077 Ramoneda. Frames for polyphase machinery. (10/2/20., France.)
28 081 Schweitzer. Apparatus for sorting or separating by electric conductivity. (3/10/19, France.)
28 085 Metropolitan-Vickers Electric Co. Electrical speed regulator systems. (2/10/19, U.S.)
28 090 B. T.-H. Co. (G. E. Co.) Inductance apparatus.
28 092 Coolidge. X-ray apparatus. (9/7/20, U.S.)
28 094 Herrmann. Insulators. (4/6/20, France.)
28 101 Cusins & Whittaker-Swinton. Thermionic or vacuum tubes, &c.
28 110 Creed & Carpenter. Electro-magnetic switching apparatus.
28 116 Johnson & Rahbek. Electroscopic apparatus. (15/2/19, Denmark.)

October 5, 1920.

28 143 Automatic Telephone Mfg. Co. (Mercer & Gillings). Telephone systems.
28 198 B. T.-H. Co. X-ray apparatus. (29/10/13, U.S.)
28 199 B. T.-H. Co. (G. E. Co.). Operating mechanisms for searchlights.
28 203 Bond & Marpole. Electric lamp, &c., brackets.
28 207 Frei. Electric heating device for plunging.
28 208 Marks (National Carbon Co.). Deferred action dry battery.
28 212 Ashdown. Electric air diffuser.
28 213 Watkinson. Electric resistance switches.
28 214 Watkinson. Electric switches.
28 250 Soc. de l'Accumulateur Tudor. Accumulators. (5/11/19, Belgium.)

October 6 1920.

28 252 John. Incandescent lamps.
28 264 Connor & Puckette. Speed regulation of electric motors
28 278 Crabtree. Switches.
28 317 Sidat. Electric apparatus for filtering air, &c.
28 318 Whittaker-Swinton. Production of h.t. currents.
28 327 B. T.-H. Co. (G. E. Co.). Induction apparatus.
28 328 Neashell. Current interrupter for electric irons.

Companies' Reports, &c.

INDO-EUROPEAN TELEGRAPH COMPANY, LTD.

Mr. J. Herbert Tritton presided over the 54th ordinary general meeting of this Company last week, and stated that the directors' report was for the past year, but the accounts were only for the year 1918, the latest they could furnish for the moment, though they hoped before the end of the summer to present these for 1919. With regard to the Russian assets, the main position remained as outlined at the last meeting, except that normal accretions of interest, &c., had slightly increased the item of Russian Government debts to £97 223. The directors regarded it as an imperative duty to deal with the question of those doubtful assets and they hoped at the next general meeting to inform the shareholders of the method they proposed to adopt. They had satisfied themselves that, apart from the Russian items, the entry under sundry debtors contained nothing that was not worth its face value. Under the Peace Treaty they had recently been paid by the German Government the full value, together with dividends and accrued interest, of the Marks 200 000 Prussian 4 per cent. Treasury Bonds (matured in 1917) standing under unappropriated investments. As the equalisation of dividends fund was exhausted with the exception of about £3 000, a larger dividend than 7 per cent. for 1921 could not reasonably be expected.

Near East Troubles.

The past year had been one of disappointment. Trouble after trouble had supervened in Eastern Europe and in the Near East, and they had found it impossible to maintain their existing position in many sections of the line, their officials and staff having, in many instances, to be withdrawn. Complications in the Near East also extended to Persia, culminating in the threatened withdrawal of the British troops from that country and the enforced evacuation of the families of all telegraph and other officials in Persia. Their sympathy and thanks were due to their staff, and particularly to Mr. Watt, one of their representatives abroad, who faced with great courage the possibility of serious personal danger whilst carrying out his missions from the company. Their representative in Teheran remained at his post. The Persian Government having surmounted their difficulties will be in a position doubtless to further the re-establishment of the company's telegraph system transiting their country. Meanwhile, it was in a state of suspended animation, though the international importance of the route seemed greater than ever.

Hopes of Restoring Main Route.

Their arrangements with Germany presented in theory no difficulty, although for reasons of which they were fully aware they were not at the moment able to reach a definite conclusion of the negotiations. The negotiations with Poland reached the final stage after a visit which their colleague, Mr. Axel W. Berg, made to Warsaw, and their reconstruction and repair work on that section might begin in the early summer; owing to its having been in parts the battlefield of contending armies, that portion of the route naturally required a considerable amount of work. As to the important section of the route controlled by the Soviet Government, they had learned from the Moscow Government that, in principle, there was no objecton to the conclusion of an arrangement by which their line would transit that territory on its old ground. The directors had also reason to hope that where the influence of the Soviet Government might be needed in territory which may be described as more or less debatable ground, it would be exercised in favour of the company. They were, therefore, once more encouraged to hope that all might, within a measurable space of time, be again well with them, and that reconstruction and consolidation might everywhere be begun along their route. It was only in the Polish section that reconstruction over a considerable distance might have to be faced, and even there they were confident that by the utilisation of temporary links pending permanent reconstruction they should very quickly supply a workable line. The greater part of the material was ready at convenient points waiting to be handled.

Radio Patents.

During the enforced inactivity of the company the directors had devoted a certain amount of time to the development of radio-telegraphy. Experiments on the Galletti system had to be abandoned owing to the war, and it had not been found possible to resume them. Whilst the company had, therefore, ceased to interest itself in any one system, certain radio patents and assets held by them had, together with the experience of the directors, been placed at the disposal of a new company, the Radio Communication Company, Ltd., against a substantial holding of shares. That company, having standardised various sets of apparatus, was doing very considerable business, particularly in the supply and working sets of on ships belonging to some of the foremost shipping companies, and the directors considered that the investment should prove to be in every way a profiytable one. The directors considered that the item in the 1918 accounts—advances (then £11 000, since increased to £13 000) made to the Galletti Company—were fully secured by the fact that the company had a controlling interest in the assets of the Galletti Company, which included not only an important number of shares also held by that company in the Radio Communication Company, but also a good claim against the French Government for compensation for requisition and appropriation during the war of the plant of the Galletti station in France.

The accounts for 1918 were adopted, and a final dividend was declared for the year 1920, of £1 2s. 6d. per share (tax free), making with the interim dividend, 7 per cent. for the year; and a distribution out of equalisation of dividends fund was made of 15s. per share.

NORTH METROPOLITAN ELECTRIC POWER COMPANY.

Mr. E. Garcke, who presided over the annual meeting of the North Metropolitan Electric Power Supply Company last week, was able to give a good account of the Company's progress. He said the net revenue for the past year has been a record, and the result would have been even better had it not been for the depression in trade in the latter part of the year. The net revenue, including interest and dividends received was £101 351, compared with £65 868 for 1919. After meeting prior charges, placing £16 000 to reserve and paying dividend on the 6 per cent. preference shares, the directors were able to recommend a dividend on the ordinary shares of 7½ per cent., compared with 4½ per cent. for the preceding year, leaving £4 433 to be carried forward. The result was satisfactory, especially in view of the fact that the expenses —particularly for coal—had increased considerably. The improvement was in a measure due to the revised rates of charges introduced as from April 1 last year. Under the Statutory Undertakings (Increase of Charges) Act, 1918, orders were obtained by this company and its associated company (the North Metropolitan Electrical Power Distribution Company) authorising an increase in the rates of supply for private purposes. A judgment had also been obtained by the company for the annulment of a pre-war contract for the supply of electricity in bulk to Stoke Newington Council, and in future it would be given on their standard terms. The decision of the Court had, moreover, enabled them successfully to negotiate with the Middlesex County Council for a revision of the rates of supply to the Metropolitan Electric Tramways. The latter company operated 56 route miles of tramways and light railways and the traction demand formed a very appreciable portion of their total output. Arrangements had been made for a revision of the price.

Power and Bulk Supply.

A large number of new contracts had been made with consumers who required a supply for power purposes, and important bulk supply contracts had been entered into with the Harrow Electric Light and Power Company and the Welwyn Garden City for distribution in their respective areas. Arrangements had had to be made for providing additional plant and cables to enable the company to supply the increased demand for electricity and £87 000 had been expended on capital account during the year. Further capital expenditure would be necessary during the current year to meet the increasing demand for supplies throughout the whole of the Company's area. The authorised share capital had been increased by £500 000 to £1 500 000 under the powers contained in the North Metropolitan Power Supply Act, 1920. The Company was authorised to issue debenture capital up to one-third of the share capital issued, provided one-half thereof was paid up; but the consent of the Minister of Transport had been obtained which would enable the company to issue debentures or debenture stock up to one-half its issued and paid-up share capital. In regard to "The London and Home Counties Electricity District," and proposals for the formation of a joint electricity authority for the area, the directors were opposing the proposal to the extent that the North Metropolitan Company should be left out of the scheme. The position of the Company was very different from that of an ordinary supply company. Their powers to supply had been granted to them in perpetuity, and they were not subject to compulsory purchase at any time. The area of the Company's supply was an exceptionally favourable one, and was rapidly developing for industrial purposes, and the demand was steadily increasing. He had no doubt that the development during the next few years would be as rapid as in the previous years. So far as the present year was concerned, the results of the first quarter were very satisfactory.

The revenue of the Submarine Cables' Trust for the year ended April 15th amounted to £26 987, and the expenses to £1 935, leaving a balance of £35 052, to which is added the sum of £67 brought forward, making an available balance of £35 119. After providing £9 195 to meet payment of the coupons, the sum of £25 905 has been transferred to the redemption fund, leaving a balance of £18. 16s. 1d. to be carried forward. Since the last report 216 certificates have been redeemed (exclusive of the coupons of reversion), 20 by purchase on the market, 9 by tender, and 187 were drawn by lot on 2nd inst.

The chairman of the British Electric Transformer Company, Ltd. (Mr. A. F. Berry), who presided over the annual meeting on the 29th ult., said that out of the available balance of £80 789 they were making a distribution on the ordinary shares at the same rate as for 1919, utilising £4 250 of the amount brought in and carrying forward £6 178. They started the current year with 50 per cent. more work in hand (money value), or 30 per cent. more in horse-power, than at the beginning of 1920. The future was always difficult to foretell, but, given support, the board could look forward to full-tide employment and a continued improvement in trading results. It was only by strong and united action that the board had been able to keep the works so fully employed, and he had confidence that, now they were having to reduce prices to secure work, they might rely on the necessary increased effort from their shops, even though they had, as would be the case, to pay wages more in accord with the reduced cost of living. The next few years would test the capacity of even the best captains of industry, and their business would be by reducing costs of production to see their order sheet kept well filled well ahead. He was disinclined to support any attack either upon the Government or the trade unions, but there were matters which those responsible for the creation and development of an industry would be glad to see handled differently, or not handled at all, by Governments and trade unions, who were not in any way naturally fitted to control industry. Their interference in the past had produced grievous results. Foreign competition could only be met by unity and co-operation between employers and employees.

The directors of the Brush Electrical Engineering Company, Ltd., report that for the year 1920 the profit and loss account shows, after providing for general charges, maintenance of plant and buildings, and interest on the debenture stocks and loans, a balance of £191 097, making, with £74 726 brought forward, a total balance of £265 823, subject to taxation demands and directors' additional remuneration. It is recommended that £12 400 be placed to depreciation of buildings and plant and £600 to depreciation of patents and goodwill; that £15 576 be written off new share issue expenses; that £2 044 10s. 6d. be devoted to paying a further 4 per cent. interest on the prior lien participating second debenture stock, £53 377 be placed to general reserve and that a dividend at the rate of 15 per cent. per annum be paid on the shares for the year (£38 557), leaving to be carried forward £143 268. The sum of £91 227 was expended on capital account during the year. The general reserve account has been increased during the year by £3 866 profit on purchases of the Company's debenture stocks for sinking fund purposes, and the further sum of £53 377, now appropriated to this account, raises the general reserve fund to £75 000. The business continues to develop satisfactorily. The new shop in course of erection for the extended manufacture of Brush-Ljungstrom turbo generators has been delayed owing to difficulties in obtaining delivery of the steel-work, but progress has been more rapid of late, and work on the buildings is now active. The demand for these highly efficient machines has largely increased.

Presiding over the meeting of the British L. M. Ericsson Mfg. Company, Ltd., last week the Chairman, Mr. W. M. Crowe, stated that the general depression which had taken hold of the world at large was not affecting telephone manufacturing as greatly as most other industries. The increased telephone rates were certain to give a check to the advance of telephony in this country, but it would only be temporary. There was an enormous amount of leeway to make up both in this country and throughout the world, and he was optimistic as to the future of the company. The Telephone Department was now getting into its stride and, given a bit of fair play, should make headway as never before. Part of its troubles were owing to the difficulties manufacturers had had in getting the material turned out.

The automatic telephone was, without a doubt, the thing of the future, and their Stockholm friends had now fully developed an automatic system which they claimed was second to no other, and they had received many orders, among others for Stockholm City. They had the rights to manufacture the system at their Beeston factory and the Post Office were sending two of their automatic experts to Stockholm to examine into and have demonstrated the system to them. They were therefore hopeful that before long they should be asked to make and install an automatic exchange in England. They had a young engineer at Beeston who had patented an automatic system which was distinct from anything else on the market, and they hoped that it might develop into something worth putting into practical use.

Owing to the state of the market they had deferred the proposed issue of preference shares. Now that they were rid of the Excess Profits Duty perhaps matters would improve, and it would be the duty of the directors to seize the opportunity of making an issue when that happened.

New Companies.

The following list is compiled from information supplied by Messrs. Jordan & Sons, Ltd., company registration agents, Chancery-lane, London, W.C. 2:—

JOHN COLLIER & COMPANY (ELECTRICAL ENGINEERS), LTD. (174.260). Reg. April 16, capital £20 000 in £1 shares, to acquire and carry on business of electrical engineers. Directors: J. Collier, J. Ratcliffe and W. T. Reynolds. Reg. office: 29, King-street West, Manchester. Private company.

J. H. HUMPHREY, LTD. (174,271).—Reg. April 18, capital £1 000 in £1 shares, to carry on business of electrical engineer, electricians and mechanical engineers and manufacturers. Directors: J. H. Humphrey, F. J. Cowie, and S. Barraclough. Reg. office: Downham-street, Bradford. Private company.

NATHAN & ALLEN, LTD. (174 343).—Reg. April 21, capital £10 000 in £1 shares, to acquire and carry on business of electrical engineers. Directors: B. Nathan, J. H. Wild, F. S. Allen and E. P. Lucking. Reg. office: 25, Victoria-street, S.W. 1. Private company.

OLIVERS, ELECTRO-PLATERS, LTD. (174 314).—Reg. April 20, capital £2 000 in £1 shares, to carry on business of electrical and mechanical engineers, electro-platers, &c. Directors: H. D. Oliver G. Richardson, S. R. Woodger and H. Williment. Reg. office: 42, South Market-road, Great Yarmouth. Private company.

Companies Incorporated Outside U.K.

ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA PROPRIETARY LTD. (1 957F).—Reg. April 13, capital £3 000 000 in £1 shares, to acquire, refine, amalgamate, manipulate electrolytically or otherwise treat and prepare for market ores, metals, fluxes and mineral substances. Reg office: Pinners' Hall, Austin Friars, London, E.C. Company incorporated in Victoria.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics": "German Al-metal Commercial Machines," by Dr. A. Gradenwitz; "Screw Propellers," by M. A. S. Riach; and "Flying Boat Construction," by D. Nicholson.

"The Cabinet Maker": "Furniture at the Royal Academy"; Annual Report of the Furniture Warehousemen and Removers' Association; and "Practical Polishing."

"Chemical Age"; "The Case for Chemical Warfare," by Sir William Pope, President of the Society of Chemical Industry; "British Manufacturers and New Acid Processes"; and "The Interests of British Chemical Merchants."

"Farm and Home": "How to Regain the Sheep we have lost," by Professor Jas. Long; "Stockbreeding and Rearing"; and "Men and Affairs in Agriculture."

"The Fruit-Grower": National Food Production Number. "Autograph Message from Lord Bledisloe"; "Tractors for Market Gardening and Orchard Work," by H. Scott Hall; and "Pest Control by Spraying," by J. H. May, M.I.E.E., F.C.S., and G. S. Woodcock.

"Gardening Illustrated": "Fruit Trees in Rural Districts"; "Banksian Roses" (illustrated); and "Dwarf Shrubs for the Rock Garden."

"Hardware Trade Journal": Special I.F.A. Conference Number. "The Wholesaler Hardware Association Meeting"; and "Some Incidents in the Life of the Southport Association."

Forty Years Ago.

(The Electrician, May 7, 1881.)

Royal Society.—On Thrusday evening, the 5th May, a Paper was presented by Lord Rayleigh, F.R.S., and Dr. Schuster, F.R.S., "On the Determination of the Ohm in Absolute Measures."

Quite So!

Like lightning rods, sweet girls should be,
Cool, pointed, straight, exacting;
Drawing the sparks—yet not too free,
Nor harmed by their attracting.

A New Telephonic Experiment.—The Paris correspondent of the "Daily Telegraph" reports that an interesting experiment has just been made between Calais and Dover with a new kind of telephone, patented under the name of "Electrophone." The articulation is said to have been perfect, and there was no perceptible interference through the companion wires in the same cable which were working hard all the tiem.

The Noises Made by the Voltaic Arc.—M. A. Niaudet finds that the noises made by the voltaic arc occur when there is a diminution in the potential of the two carbons. This variation in potential corresponds in inverse manner to the intensity of the current. The results, as obtained by M. Niaudet with a Duprez galvanometer for measuring the intensities and E.M.F.s, are given below:—

Intensity of current in Weber's.	Difference of Potential.	
34	54.3	Silence.
36	43	Noise.
34	49	Silence.
43	41,4	Noise.
38.1	49	Silence.

Prices of Metals, Chemicals, &c.

Tuesday, May 3.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£71 10 0	—	£1 0 0
Electro Wirebars	,,	£73 0 0	—	—
H.C. wire, basis	per lb.	0s. 11$\frac{5}{16}$d.	—	$\frac{3}{16}$d.
Sheet	,,	1s. 0½d.	—	—
Phosphor Bronze Wire (*Telephone*)—				
Phosphor-bronze wire, basis	,,	1s. 3$\frac{5}{16}$d.	—	$\frac{3}{16}$d.
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1d.	—	—
Wire, basis	,,	1s. 1d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£6 10 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£27 0 0	—	—
Lead Pig—				
English	,,	£22 15 0	£0 10 0	—
Foreign or Colonial	,,	£21 10 0	£0 15 0	—
Tin—				
Ingot	,,	£170 0 0	—	£4 5 0
Wire, basis	per lb.	2s. 4¼d.	—	½d.

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £13 10s.

,, (Roll-Brimstone).—Per ton £12 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £30.

Boric Acid (Crystals).—Per ton £69.

Sodium Bichromate.—Per lb. 7½d.

Sodium Chlorate.—Per lb. 4½d.

Rubber.—Para fine, 10¼d.; plantation 1st latex, 10½d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co.

Arrangements for the Week.

FRIDAY, May 6th (to-day).

Iron and Steel Institute.

10 a.m. At the Institution of Civil Engineers, Great George-street, London, S.W. Papers to be read: "The Prevention of Hardening Cracks and the Effect of Controlling the Recalescence of a Tungsten Tool Steel," by Mr. S. N. Brayshaw; "On the Cause of Quenching Cracks," by Messrs. K. Honda, T. Matsushita and S. Idei; "Slip-lines and Twinning in Electro-deposited Iron," by Mr. W. E. Hughes; "Cupric Etching Effects Produced by Phosphorus and Oxygen in Iron," by Mr. J. H. Whiteley and "Röntgen Spectrographic Investigations of Iron and Steel," by Mr. A. Westgren.

Junior Institution of Engineers.

8 p.m. At Caxton Hall, London, S.W. Lecturette on "Fire Resistance of Aggregates for Reinforced Concrete," by Mr. D. W. Wood.

Röntgen Society.

8 p.m. At the University, Manchester. Paper by Prof. W. L. Bragg and a Demonstration of Some Electro-physiological Experiments, by Prof. A. V. Hill.

MONDAY, May 9th.

Batti-Wallah's Society.

1 p.m. At the Holborn Restaurant, London, W.C. Lunch. Speaker will be Canon H. Bickersteth Ottley.

Institution of Mechanical Engineers, Graduates Section.

7 p.m. At Storey's Gate, London, S.W. Paper on "The Engineering Aspect of Modern Iron-Foundry Practice," by Mr. W. H. Sawyer.

Institution of Electrical Engineers.—North-Eastern Centre.

7.15 p.m. At Armstrong College, Newcastle. Annual General Meeting.

Faraday Society.

8 p.m. At the Chemical Society, Burlington House, Piccadilly, London, W. Papers to be read: "The Problem of the Fuel Cell," by Messrs. E. K. Rideal and U. R. Evans; "The Solubility of Small Particles and the Stability of Colloids," by Mr. L. F. Knapp; "Note on a Formula Expressing the Variation of Surface Tension with Temperature," by Prof. F. G. Donnan. Continuation of Discussion held at Manchester on Studies in Capillarity.

TUESDAY, May 10th.

National Association of Supervising Electricians.

7 p.m. At St. Bride's Institute, Bride Lane, London, E.C. Paper on "Electric Light Wiring Systems," by Mr. F. T. Alldread.

Institution of Electrical Engineers.—S. Midland Centre.
Students Section.

7.30 p.m. At The University, Edmund-street, Birmingham. Annual General Meeting followed by an address by the Chairman, Mr. F. Forrest.

WEDNESDAY, May 11th.

University of London.

5 p.m. At University College, Gower-street, London, W.C. Lecture on "Wireless Telegraphy and Telephony by Continuous Waves," by Prof. J. A. Fleming, F.R.S. (Lecture III.)

Institution of Railway Signal Engineers.

6 p.m. At the Midland Grand Hotel, St. Pancras, London, N.W. Discussion on the Reports of the Sub-Committees on "Track Circuit Nomenclature," and "Track Circuit Record Forms."

North-East Coast Institution of Engineers and Shipbuilders.

7.30 p.m. At the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. Paper on "The Causes of Detonation in Internal Combustion Engines," by Mr. H. T. Tizard.

THURSDAY, May 12th.

Royal Society.

4.30 p.m. At Burlington House, Piccadilly, W. Discussion on "The Quantum Theory of Line-Spectra," opened by Sir Ernest Rutherford, followed by Dr. N. Bohr.

FRIDAY, May 13th.

Physical Society of London.

5 p.m. At the Imperial College of Science, London, S.W. Papers on "Notes on Vacuum Tubes used as Detectors on Electrical Oscillations," by Mr. L. Hartshorn and Mr. E. S. Keeping; "The Coefficient of Diffusion of Certain Saturated Solutions," by Mr. B. W. Clack; and "Experiments on Thermal Transpiration Currents," by Dr. G. D. West.

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Notes.

The Jubilee of the Institution.

ON May 17, 1871, a small body of scientists, military officers and telegraphists met in London to found the Society of Telegraph Engineers, an association which after fifty years of not entirely unchequered progress, including two changes of title, is now known the world over as the Institution of Electrical Engineers. From a tiny collection of some 100 individuals its membership roll now numbers nearly 10 000 names, and, what is more important, the rate of accession to its ranks is increasing. And the quality of its membership is not less than its quantity. The reason for this is, we think, not far to seek. As Mr. LLEWELYN ATKINSON and Mr. J. E. KINGSBURY point out in articles which we publish on another page of this issue (and the same point is made in the communications we have been fortunate to receive from the two surviving original members, Col. E. D. MALCOLM and Sir HERBERT JEKYLL), the Institution has developed from a society with a purely scientific, and therefore necessarily somewhat narrow, objective into a body whose usefulness to its members and whose influence on the proper development of human endeavour is likely to be increasingly profound.

The Future.

BUT this increasing usefulness carries with it increased responsibilities. With the wider ground that its activities must cover the Institution is drawn more and more into the dusty high road of industrial and political life and can linger less and less in the quiet groves of Science. As the representative body of a great industry anxious to put forward its opinions on, and be consulted about, everything which affects electrical interests, the Institution must spend an ever-increasing time in council and compromise, so that the varied interests of its members may be duly represented. Such work as this requires wise guidance and constant endeavour on the part of the ruling body, a guidance and endeavour which we are glad to think it is receiving. For as the hour brings the man, so responsibilities bring the Council. But it must not be forgotten that such a governing body as that of the Council of the Institution of Electrical Engineers gathers its strength and guidance, not by inspiration from above, but from assistance from below, and that upon the general body of members ultimately rests the real responsibility of directing the Institution's affairs, not only for their own good and for the benefit of the industry, but, in the most general sense, "for the use and convenience of man." As during the past fifty years the whilom Society of Telegraph Engineers has, as Col. MALCOLM says, "exceeded my fondest dreams," so the next fifty years should see an even greater development.

The Kelvin Medal.

ANOTHER milestone in engineering, as distinct from purely electrical, history was erected last week when the Kelvin Medal was presented to Dr. WILLIAM CAWTHORNE UNWIN, F.R.S., by Mr. A. J. BALFOUR, in the Hall of the Institution of Civil Engineers. The ceremony was distinguished by that national shyness which is so usual on such occasions and by that other national characteristic of regarding great men and great achievements, except of course in the sphere of athletics, as so much a matter of course as to require no special attention. We have no doubt that Dr. UNWIN, with his natural modesty, would not have arranged matters differently. But we take leave to doubt that if the occasion had been the presentation of a medal to, say, Mr. CHAPLIN something a little more ceremonial would have been arranged. And we really wonder whether an occasion which, for the first time in history, was a joint tribute to our great dead and to our honoured living could not have been carried out with a little more pomp and a spirit of more definite conviction that this was truly an event in engineering history.

The Conjunction of Theory and Practice.

MR. BALFOUR in making the presentation first paid a tribute to the honoured name of KELVIN, who, he said, had in a manner perhaps never equalled before, except by ARCHIMEDES, the power of theorising on the most obscure secrets of nature and at the same time of carrying out effectively some engineering feat. To this combination of theory and practice, which was so evident in Kelvin, we must look, he said, for the progress of practical invention and discovery. That was our real hope, almost our only hope, of gradually bettering the material conditions of mankind. Turning to the recipient of the medal, he said that he did not suppose that to the general public Dr. Unwin's name was a household word. He had noticed that men who did the pioneer's work were very often not known by the large masses of their contemporaries. He thought the only kind of fame that was worth having was the fame that came from the persons in a position to know. That species of fame Dr. Unwin had in ample measure, for his name was honoured wherever engineering was known and there was no branch of modern engineering to which he had not made some personal contribution. But if there is to be that conjunction of theory and practice, of which Mr. Balfour rightly emphasised the importance, more care must be taken, as Dr. Unwin in his reply pointed out, to provide adequate preliminary scientific training for young engineers. Indeed, no better tribute could be paid to and no better use made of the knowledge which has been rendered possible by the work of great scientists like Kelvin than to employ it as a basis of increasing the knowledge of students of science and of engineers in general.

Railway Electrification.

The slow development of electric traction on main lines in this country has enabled British engineers to adopt both an impartial and critical attitude towards what has been done in America and on the Continent. At the same time, such an attitude has the disadvantage that engineers in those countries are gaining the experience and we are not. For that difficulties in locomotive construction have been encountered is not to be wondered at, as there is no reason to expect that such equipment will be immune from the birth-throes which accompany the advent of most things, certainly most things engineering, into this world. And as will be seen from the abstract which we publish on another page of this issue, these difficulties are equally present in both the United States and European countries. At the same time, the different principles which have governed the design of American and European locomotives afford an interesting study. While, on the one hand, in America praiseworthy attempts are being made to preserve wherever possible purely rotary motion, on the Continent the demand for a high centre of gravity has led to the use of reciprocating motion. This, however, is a general statement, to which there are exceptions, for we illustrate one American locomotive with reciprocating motion and locomotives with purely rotary motion have been working successfully for the past two or three years in Switzerland. But interesting though this study may be to us as engineers, its interest must be to a large extent neutralised by the remembrance that this country was the birthplace of railways. Does this development to which we have drawn attention indicate that in electric traction we are to follow instead of lead? We sincerely hope not.

Criticism of the Electricity Supply Bill.

No one, certainly no electrical engineer, wishes to take up the attitude that the Electricity Supply Bill is perfect—such measures seldom are. But it is distinctly unfortunate that because some of its provisions do not meet with general approval a massed attack should have been launched upon the whole measure. The result might have been foreseen. Hostile criticism from certain quarters of the suggestion to form Joint Electricity Authorities has provoked a counter-attack in support of the Bill and ranks seem to be forming up for a contest on the old battle ground of private versus public ownership. Apart from the essential unwisdom of such a discussion at the present time we are afraid that the result of this agitation can only be that a useful measure will be further postponed or defeated. When, however, a communication from the Secretary of the Provincial Electric Supply Committee urges ratepayers' Associations, Chambers of Commerce and others to throw their weight against "a proposal to finance Joint Electricity Authorities on the security of the rates" and to protest against "an irregular semi-nationalising of the industry," it was only to be expected that local authorities would take up the challenge and would pass resolutions and otherwise act in support of the Bill.

Urgent Need for Reorganisation.

The most definite of these actions up till now was the meeting on Tuesday last of the Executive Committee of the Conference of Local Authorities Owning Electricity Undertakings in Greater London when the Honorary Secretary, Mr. Leslie Gordon, the Town Clerk of Hammersmith, submitted a memorandum containing a temperate and closely reasoned reply to the statement of the Provincial Committee. As Mr. Gordon rightly points out, there is urgent need for the re-organisation and the scientific development of electricity supply, as has been fully acknowledged by the Reconstruction Committee, by the Electric Power Committee of the Board of Trade and by a committee of chairmen of the Ministry of Reconstruction. But as the policy advocated in these reports was only partially carried out in the Electric (Supply) Act of 1919, the Government gave an undertaking that a supplementary measure would be introduced to confer financial powers upon Joint Electricity Authorities. The present Bill, which is similar to last year's belated measure, is, of course, not only a redemption of that promise, but is necessary to complete the original legislative scheme. From this point of view it should, therefore, receive general support as the present indefinite position is good for no one and can only be improved by a combination of interests for the general good. It is to be regretted that no progress has been made with the Bill this session, for in our opinion failure to place it on the statute book is a serious set-back to the proper development of the electricity supply industry.

The London Schemes.

In none of the six schemes that have been put forward for the Greater London Area is there anything which will prejudice existing concerns. They are conceived upon a basis of assisting each undertaking by complete co-operation and unity of control, particularly on questions of generation and bulk supply. The practical effect of a suitable scheme, provided the powers of the present Bill were available, would be to stop the wasteful system of producing an inefficient and costly supply in many parts of the area by excessive capital expenditure on existing unsuitable generating stations. The capital cost incurred in carrying out the Conference or Municipal scheme would be considerably less than the capital expenditure which would have to be undertaken upon existing stations under the present system, while the saving in working costs would be enormous, and the risk of any charge falling upon the rates in any part of the area a very remote contingency. The proposed Joint Authority instead of being a charge on the rates, should do much to assist in keeping them down while it would help materially to develop and cheapen electricity supply, thus aiding in the industrial progress and prosperity of the area and of the country as a whole. It is a pity that this is not more generally realised, and that personal views cannot be sunk in a whole hearted attempt to get an Authority into being.

Details of the Schemes.

Of the six schemes that have been submitted to the Electricity Commissioners for the improvement of the electric supply organisation in the Greater London district four of them, including one emanating from the London Electricity Joint Committee (1920), Ltd., contemplate the formation of a Joint Electricity Authority, but the other two, which are put forward by the Great Eastern, and the London, Brighton & South Coast Railway Companies, are not more than skeletons, if indeed they comply with the conditions laid down by the Commissioners. No engineering or other details are given and it is therefore difficult to express an opinion upon them. For instance, the scheme of the Great Eastern Company which has no electric service of its own, states that "it is essential that an adequate scheme should exist for ensuring a regular supply of electricity for traction purposes at the lowest possible cost." This seems to contemplate the erection of a generating station of an initial capacity of 120 000 kW with room for expanding to 225 000 kW. The system of supply will be three-phase at 50 cycles per second; the main transmission pressure 33 000 V, and the local transmission pressure 6 600 V or 11 000 V. A site for a generating station at West Ham was acquired by the Company under powers conferred by its 1915 Act, and this station would be equipped and operated by the Company, but surplus energy would be supplied to other railway companies, to a Joint Electricity Authority or authorised undertakers. But the Great Eastern have been flirting with electric traction for many years and, to the naked eye, are about in the same position as when they started.

The London, Brighton and South Coast Proposals.

The position of the London, Brighton & South Coast Railway Company is somewhat peculiar, as parts of its London and suburban lines are already operated electrically, and considerable progress has been made with the work of converting the remainder of the system to electric traction. Electrical energy is taken from the London Electric Supply Corporation (over 16 million units per annum are supplied by the Company at present), but when the electrification of the line is completed it is estimated that about 125 000 000 units will be required. Consequently, the Railway Company proposes, either by itself or in co-operation with the Supply Corporation to erect and equip on a suitable site, a large generating station, with units of 25 000 kW, each generating at a frequency of 25 periods. The ultimate capacity of the station would be 125 000 kW, but arrangements would be made for co-operating with others in the supply of electricity and the use of any spare plant.

The I.M.E.A. Convention.

The preliminary programme of the twenty-sixth Annual Convention of the Incorporated Municipal Electrical Association, which is to be held at Dundee from June 13th to 17th, is the result of a careful balance between work and pleasure. Besides the Presidential Address, Papers are to be read on subjects which will be equally attractive to the commercially and technically-minded among those attending, while due regard is to be paid to visual instruction by visits to works and to that maintenance of the healthy body in the healthy mind which is as necessary to electrical engineers as to the rest of mankind We have always viewed the proceedings of this Convention with more than usual interest, as we see in it the germ of what should be a much greater gathering of electrical engineers, and we even have hopes that before long it will blossom out from what is admittedly a sectional gathering into a Convention, representative of the entire electrical industry. At the present time the I.M.E.A. meeting is of great value from the electrical, commercial and psychological points of view, but its utility is necessarily limited by the fact that it is organised by one section of the industry—and a section too whose interests are naturally sectional. This being so it has done well to have attracted so wide an interest, but could it be altered in the way we have suggested its appeal would be wider and its usefulness would be correspondingly increased. The one thing which seems to be likely to detract from the success of the gathering this year is industrial troubles, but we hope that by the beginning of next month a happy issue will have been found out of all afflictions of that kind.

Trade Union Ban on Non-Union Wiring.

A further step has been taken towards the determination of how far Trade Unions can by direct or indirect means impose restrictions on work performed by non-Union labour. This has arisen out of a case at Hackney, where the employees of the Electricity Department refused to connect up premises which had been wired by a master-man. As we anticipated, the North London police court magistrate, Mr. Forbes Lankester, has decided that the Hackney Borough Council has made default in the supply of electricity, *i.e.*, has committed a breach of the Electric Lighting Acts. The facts are similar to those in several other cases that have recently occurred in London and the provinces and seem to indicate that the Electrical Trades Union has definitely decided to prevent anyone who has had his house wired by non-Union labour from getting a supply of electricity. The Hackney case is the first that has come before a court and, as it raises questions of far-reaching importance, it will be of general interest to examine the facts and the defence put forward by the Council.

The Facts.

The intending consumer, a Mr. Dove, had entered into an agreement with the Council as required by the Electric Lighting Act, 1882, for a supply of electricity, a service had been laid to his premises, the internal wiring had been executed to the satisfaction of the borough electrical engineer and everything was in readiness for the connection to be made when it was discovered that the internal work had not been carried out by union labour. Thereupon the Council's workmen refused to connect the premises and the default continued from April 10th to 16th. At the hearing the Council admitted all the facts, but pleaded that they were protected by Sub-section 3 of Clause 26 of the Hackney Provisional Electric Lighting Order of 1893. This subsection is substantially the same as Paragraph 4 of Clause 30 of the Electric Lighting (Clauses) Act, 1899, and provides "that in no case shall any penalty be inflicted in respect of any default if the Court are of opinion that the default was caused by inevitable accident or *force majeure*. . ."

The Scope of "Force Majeure."

The magistrate, who took time to consider his decision, found that the default was not due to inevitable accident, and that though *force majeure* had been held to apply to strikes actually proceeding, to war, breakdowns of machinery and to other causes, it had never been held to apply to fear, however reasonable, of the consequences of threatened action. We believe this decision to be good law, as well as sound common sense. For while in previous similar cases the breakdown of the generating plant and defects suddenly developing in the supply cables have been held to be a good defence to a claim for penalties for default in supplying energy, the only obstacle in the present case was the refusal of the employees to do the work they were paid to do. That is a human, not an engineering, matter—two very different things.

The Restraint of Trade.

APART from the immediate consequences of the refusal by the Council's workmen to carry out instructions it would be disastrous not only to the supply industry, but to the whole community if the defence pleaded were successful. While we are in full sympathy with the E.T.U. in its legitimate efforts to advance the interests and the status of its members, this action is a very high-handed one, for it would deprive small master men and all non-unionists of their means of livelihood. Furthermore, it is not really to the advantage of trade unionism to adopt such a policy in restraint of trade as this is, while it is also contrary to the fundamental principles of English law and to natural justice and equity. The public supply of electricity is now a necessity and not a luxury; hence the need for making it clear to all electricity undertakers that a supply must be given to every intending consumer who has complied with the necessary preliminaries laid down in the Electricity Supply Acts. Undertakers cannot compel a consumer to make use of any particular type of lamp or apparatus, neither should they, directly or indirectly, have a voice in saying who is to carry out his wiring work, providing it is properly done in accordance with certain technical rules. Meantime the unfortunate Mr. DOVE is without his electricity supply.

The Lochaber Water Power Bill.

WE are pleased to see that after an exhaustive investigation a Select Committee of the House of Commons, presided over by Sir HARRY SAMUEL, has found the preamble of the Lochaber Water Power Bill proved, subject to certain provisions for the protection of the Spey River salmon fisheries. Practically the whole of the opposition to the Bill, which was promoted by the directors of the British Aluminium Company and which embodies a large scheme for utilising the available water power of the Highlands in generating electrical energy for the manufacture of aluminium and for other industrial purposes, came from the salmon-fishing interests. Sport we know is important, but it need not be pre-eminent and, in any event, we think that the decision of the Committee will not prejudice salmon fishing, because it is provided that the natural flow of the Upper Spey above the intake at Loch Laggan is not to be abstracted unless the flow exceeds 30 000 000 gallons. in 24 hours. The Spey Fishery Board have, moreover, the right to demand on 12 days in the year that water shall not be abstracted until the flow of the river reaches 100 million gallons. In addition, the conduit at the intake at Loch Laggan is to be made 75 per cent. larger than was suggested by the promoters. We understand that the Bill will now proceed as an unopposed measure as the parties have come to terms. The estimated cost of the proposed works is £3 000 000 and as some 2 000 to 3 000 men will be given employment, while the Company's manufacturing resources will be greatly increased, the scheme should materially aid in the development of the Highlands.

The Scientific Worker and Patent Law.

ONE of the most difficult questions which the organised scientific worker has to deal with, and one which is giving rise to the greatest sense of injustice among this class of organised workers is the question of payment and recognition for patentable work done during the employers' time, and often, we may add, for similar work done in the employees' own time. We are therefore glad to see that an elucidation of some of the more complicated points in this question was recently given by Mr. H. E. POTTS in a lecture to the National Union of Scientific Workers. Mr. POTTS began by pointing out that the legal position was that, in the absence of a special contract, the invention of the employee, even although made in the time, with the materials, and at the expense of the employer, does not become the property of the employer to such an extent as to prevent the employee from taking out a patent. Unfortunately to this basic principle there are many exceptions among which four are particularly important. If the work is done under specific instructions, the management may claim to be at least its part inventor. They have a claim to its advantages if the work could be considered as a condition of the inventor's employment, or if the worker was in a position of special confidence, and had access to special information without which his invention could not have been made. The position was also often modified by agreements which were in force between firms and their staffs with regard to the assigning of patents and the collection of royalties. Mr. POTTS made the very wise suggestion that one of the principal duties of the union should be to decide upon a fair agreement in these matters, and that, before formulating any policy, conditions prevailing in America and on the Continent should be investigated and some representative body of employers communicated with. In our opinion such discussion cannot fail to be of value. There is a tendency among inventors, as in other circles, to consider that without their work nothing could be done and to expect to be rewarded accordingly. On the other hand, many employers look upon all such work as being their own property since it is done in their time and take up a very arbitary attitude with regard to its remuneration. There is no doubt that the real position lies somewhere between these two extremes.

Assisting the Skilled Employee.

THERE is no doubt that a good deal of the present industrial unrest would be overcome if more interest in the details of their work could be inculcated in the general bulk of employees, or, in other words, if these employees had been in a position from the start to appreciate the value of self-education. Such lack of self-education is due more often than not to the indifference and ignorance of the parents than the children themselves, and the work which the Skilled Employment and Apprenticeship Association is doing to remove these defects is, therefore, of the greatest importance. By means of voluntary personal service this Association carries out a steady propaganda in favour of apprenticeship, and of giving boys and girls every opportunity to become skilled workers. It uses its powers of persuasion to get the child's employment regarded not as an end, but as a means to development, and not doing this without carefully considering the tastes and inclinations of each child and the influence of such questions as home conditions, recreations and social position before giving any advice as to the trade which should be adopted. The work of this Association which seems for the moment to be mainly confined to London is in our opinion worthy of the highest praise and support.

Tariffs and Other Things.

It is presumably the object of every electricity supply engineer to frame a tariff which shall not only increase the revenue of his undertaking to a commerical figure, but provide him with sufficient capital for its development, or, in other words, encourage the greater use of energy for a number of varying purposes. But there is considerable difficulty in averaging the solutions of all the various problems which affect this question and in keeping strictly before us what is fundamental and what is merely secondary in the matter. From both these points of view we fear that the joint discussion on Mr. J. W. BEAUCHAMP's and Mr. J. R. BLAIKIE's recent Papers on tariffs which concluded at the Institution of Electrical Engineers on Thursday of last week will not be of much assistance to those who hoped to find some light and leading from it. It is true that it ranged over a wide field and raised some interesting points, which were none the less interesting because they were remote from the subject of the two Papers. But, on the whole, we have not advanced much.

CHEAP AND INTELLIGIBLE.

Summarising the general trend of the remarks of the various speakers it may be said that those who took the trouble to deal with the matter in its simplest commercial aspect were generally agreed that a tariff which is to encourage consumers must be cheap and intelligible and, though Mr. COWAN's "value-for-service" idea by no means obtained general acceptance, it is nevertheless obvious that he has gained numerous converts since he first propounded his views. So much so that, though the time has not yet come when we may expect to see tariffs admittedly based on his ideas, there is no doubt that their influence will be more and more felt in the framing of charges, especially for domestic loads. We were not surprised on the other hand, to hear the station engineer criticised (though sometimes the criticism came from unexpected quarters) for his lack of enterprise in dealing with new developments. We agree that all station engineers are not so enterprising as they might be in developing their domestic loads or in framing tariffs for the encouragement of domestic consumers. But it is not always realised by their critics that the problem is not so simple as it seems, and that in a number of undertakings there are local difficulties which prevent any great branching out into new work. We believe in most cases every effort is being made to secure the greatest possible progress, as it certainly should be.

CONSTANT CURRENT SUPPLY.

It was interesting to note that more than one speaker flirted with the advantages of constant current compared with the constant voltage supply for the domestic load, while another, not unexpected, excursion were the hard knocks which manufacturers both gave and received on the suitability and general reliability of their apparatus. It is a question which has been widely and rightly discussed and it is one to which as much attention will have to be given in the future as has been given to it in the past if domestic electricity is to be worth the name. But it is a little difficult to see the advisability of dragging it into a discussion on a Paper on tariffs, a subject upon which there is so much of interest to be said and upon which so much of interest remained unsaid.

The essential accuracy and soundness of Mr. BLAIKIE's ideas were also subjected to some criticism, but in general it may be said that, except in one particular, the discussion was disappointing just because the meeting failed to realise that this is above all a commercial question.

Doubtless this was not altogether the fault of the speakers, for Mr. BLAIKIE's Paper, with its more or less theoretical costing argument, was hardly the foundation for a discussion of this character. On the other hand, Mr. BEAUCHAMP's Paper, though not pretending to be more than a text whose lessons station engineers could work out for themselves, gave an excellent opportunity, which the meeting might well have seized and unfortunately did not, for a really broad consideration of the multi-part tariff question.

THE MILLSTONE OF THE SMALL CONSUMER.

One point was, however, rightly stressed. Its importance can hardly be over emphasised. That is, the unsound financial position into which many of the small undertakings have been forced by the increasing cost of producing electricity. Mr. W. L. MADGEN, Col. W. A. VIGNOLES, Mr. P. D. TUCKETT and Mr A. N. RYE were all in agreement on this point and were equally in agreement as to the reason for the position. The reason is that the small consumer paying on a flat rate basis does not contribute such an annual sum as to compensate for the expenditure necessary to connect him and keep him connected to the mains. Or, in plain figures, any consumer whose bill is less than £5 per annum is a loss to the undertaking and a very large proportion of the consumers of small undertakings fall into this category. This situation has arisen for many reasons, among them the general use of the metal filament lamp, shorter working hours and the Daylight Savings Bill, resulting in a reduced consumption of energy compared with five years ago. While, if Mr. MADGEN is to be believed and a quarter watt lamp is iminent, the consumption will soon be less, unless either the tariff can be altered or the consumption increased in some other way. As Mr. RYE pointed out the solution of both these difficulties can be obtained by persuading the consumer to adopt a two-part tariff, an arrangement which is mutually beneficial both to himself and to the undertaking. Since, however, would-be consumers cannot be refused connection and the best paying ones already take a supply, persuasion hardly goes far enough, especially as the maximum flat rate has not been increased in proportion to the increased costs, and it is, therefore, uneconomic to quote so attractive a two-part tariff as it was before the war. The time has therefore come when the use of such a two-part tariff should be made compulsory or the maximum flat rate raised to such a figure as to restore the old balance between the two. This is not profiteering open or disguised, for such an arrangement would be as beneficial to the consumer as to the supply undertaking.

THE JOINT COMMITTEE ON TARIFFS.

We are glad to see that these conclusions have been also reached by a Joint Committee on Tariffs of the British Electrical Development Association. This Committee has for some time been considering in all their phases the various problems connected with tariffs, especially in their relation to small consumers. As a result of their researches and of the deputation which waited on the Electricity Commissioners to point out the views of the Association on the subject, a memorandum reviewing the whole question was recently prepared of which an account will be found on another page of this issue. The arguments and evidence therein produced leave hardly any loophole for doubt that the flat rate system of charging is both inequitable and uncommercial; and we hope that every means will be taken to secure its removal. Unfortunately there is more than a suspicion that political influences, as usual, are unfavourable. We hope that this is not the case and that if it is it will be overcome, for, otherwise, the chief reason for the retention of the flat rate seems to be sentimental. Now, sentiment, we are told, is a bad thing in business, and so generally, we feel sure, will this be recognised, that even those who have the greatest respect for the methods of our forebears will view the departure of the old flat rate with hardly a trace of regret.

The Jubilee of the Institution of Electrical Engineers.

The Genesis and Development of a Great Society.

From the small body of military officers, scientists and electricians who held a meeting at No. 2, Westminster-chambers, Victoria-street, London, S.W., to that great and living association, the Institution of Electrical Engineers, with its membership of nearly ten thousand, is almost exactly fifty years to-day. The inaugural meeting in fact took place on May 18, 1871, and it is perhaps a little unfortunate that circumstances prevent an adequate celebration of this event on the due date. We understand that this omission will be rectified later, but the occasion is one to which we may justly draw attention. For history is not, or need not be, the dry bones of forgotten things but is, or should be, the living inspiration of the work of the past vitalising the deeds of the future. Unfortunately, the founders of the Society did not realise that they were making history and the early records of the Institution's activities and doings are exceptionally meagre.

We have, however, been fortunate to obtain some reminiscences, from the only two original members of the Society of Telegraph Engineers, as the Institution was first called, who are now living. Of these Colonel (then Captain) E. D. Malcolm was a member of the Provisional Committee appointed to form the Society and Sir Herbert Jekyll, K.C.M.G., was one of the 66 original members. Of other early members who are still with us we may mention Sir John Gavey and Mr. Alexander Siemens, both of whom are Past-Presidents, and Messrs. A. W. Heaviside, J. Rymer-Jones, H. R. Kempe and P. V. Luke.

Besides the communications of two early members we have been fortunate enough to receive pronouncements from the President, Mr. Llewelyn B. Atkinson and from Mr. J. E. Kingsbury. The former deals with the lessons the occasion has to offer and the latter with historical details not only of our own Institution but of some of the earlier scientific Societies of this country. The lessons and morals of the past of the Institution in relation to its future are not difficult to draw.

The Foundation of the Institution.

By Col. E. D. MALCOLM, C.B.
(Of Poltalloch).

I was in a manner, almost inexplicable, put into the position of instructor of telegraphy to the Royal Engineers at Chatham. It had happened that I had come home from building forts in Canada and had returned to Chatham the headquarters of the Corps of Royal Engineers with nothing to do for the moment.

While in Canada a somewhat blusterous Yankee presented himself where I and my R.E.'s were stationed, and he informed me that he wanted to teach the Canadians how to blow up the ice-bridge which was formed every year between the two banks of the St. Lawrence. Of course I received him with every courtesy, but determined to show him in the terms of the Yankee Poet that—

"Joshua P. Robinson 'E
Didn't know everything
Down to Judee."

Part of the equipment of my force being a small dynamo and electric fuses, &c., I determined to give my would be instructor a good show and took him down the St. Lawrence some distance below the icebridge—cut three holes in the ice, one up the river and two down forming a pretty handsome triangle of possibly 150 yds. side. At a signal my man, who had the electric machine, let it off and the ice cracked up with what he called an almighty smash. My friend remarked that he thought twice as much of gunpowder as he ever had before and to himself he concluded he hadn't much to teach the British.

Soon after this I was ordered to England and to Chatham, finding nothing particular to do there, I went through a course of electricity, as it was called, formed my own opinions and almost immediately after, the term of office of the Chief Instructor being finished, I found myself, without any question of offer or acceptance, suddenly put into that office. Well, I had formed my opinions, and the first was that in telegraphy at the present time, speed was of the utmost importance. When I entered upon my work two men worked at a table, one sending and the other receiving. My opinion was that each kept the other back. I got permission to put a big clock in the practising room and then I told my young sappers to race the clock as I looked upon speed as most important, and with speed they would get accuracy also.

An Early Irish Trouble.

Not very long after there was a strike of telegraphists in Ireland, and every single man was emptied out of the school, but luckily one fellow, who had worked for speed, as I was trying to get them to, was sent to take over a particular office. Directly he entered, the occupant dashed off at his utmost speed an announcement to a chum somewhere else that the man who was to turn him out of his office had arrived—with a few uncomplimentary remarks. My representative calmly remarked "Well, I don't think you need have used that language." Result—immediate collapse and most courteous subsequent treatment, but for me, personally, only a sneer from headquarters that I had not got more men to send. *N.B.*—It was their business not mine to send them.

This very early experience confirmed me in my views as to the necessity of introducing a course of systematic instruction to which end I gradually compiled a short pamphlet. This one day I showed to Mr. Preece, who was the head of the Government Telegraph Department, who, having run through it hastily said: "Goodness, Malcolm, I wish I had something like this in London!"

The Wreck of the "Royal George."

The earliest application of electricity to the rough and tumble work of the world was in the destruction of the "Royal George" at Portsmouth. The story of her wreck is well known. She had become a nuisance and it was necessary to remove her if possible, but that was the question—was it possible? All sorts of impossible jobs are passed on to the Royal Engineers (I have had one of them myself), so a R.E. had to blow up the ship of war. He knew that somehow or another that fire went from an electrical machine to a distance, down a copper wire. He also knew that water put out fire and he would not get a spark at the end of the length of bare copper wire. So to prevent the water from getting at the copper and extinguishing the fire he procured a long strip of linen which he soaked in beeswax and lapped round the copper wire and thus prevented the water from putting out the fire while passing down to the charge. He was successful and I believe the real inventor of the insulation of electric wire which now carries the spark thousands of miles. A rather interesting example of correct results from incorrect data.

The Genesis of the Society.

A cousin of mine, Capt. Webber, R.E., was in command of a company of Royal Engineers' Telegraphers stationed in London, and the idea occurred to him that there was a tremendous future for electric telegraphy if it could be in some way consolidated, so he talked the question over with the late Dr. Siemens who had a considerable business both in London and, I think, in Berlin, or somewhere in Germany. They talked the matter over and one day Capt. Webber came down to Chatham and saw me, who, to a certain indefinite extent, seemed to him to represent a Government Department and asked me to join in the project to form a Society, to which I consented to his great joy, he exclaiming "That's the third and that constitutes a company," or something of the kind. Of course, the earliest meetings of the Society were very modest and, as far as I remember, the talk was mostly about old forms of instruments and tales of the then recent wonders of telegraphy. But they gradually got more and more scientific, and, with that, it extended first to the continent of Europe and now, I believe, its members can be found in the remotest parts of the world, and at the present time receives scientific communication from Japan. A most glorious growth from a very modest beginning! As far as I know there has only been one serious struggle and that was between Capt. Webber and myself. He, for counting noses and collecting immediate pence, proposed that female telegraphers should be eligible for election. This I opposed tooth and nail, and after a short struggle, succeeded and now the Society exceeds my fondest dreams.

An Early Member's Experiences.

By Sir HERBERT JEKYLL, K.C.M.G.

There is very little that I am able to tell you about the formation of the Society of Telegraph Engineers 50 years ago, and for what little there is I have to rely upon my memory, as I have no records bearing on the subject.

At the time of the acquisition of the telegraphs by the Post Office in 1870, it was decided to employ a company of the Royal Engineers in the reconstruction and maintenance of the telegraph system which was in very bad repair at the time. The 22nd Company, then stationed at Chatham, was detailed for this duty, and of the three officers I was one, the other two being Capt. Webber and Lieut. Ramsay. The work assigned to us was the rebuilding of the trunk line from Uxbridge to Oxford, and we were engaged upon it for about six months in the course of the year. I remember receiving the news of the fall of Sedan while inspecting the progress of the work on horseback in the Chiltern Hills. It was about this time, so far as my memory serves me, that the Society was formed. It began in quite a small way, and the original members were mostly officials of the G.P.O. who had been taken over from the telegraph companies, among whom were Mr. Culley, the engineer-in-chief, Mr., afterwards Sir William, Preece, Mr. Shaw and others. Meetings were held from time to time, and Papers on technical subjects were read. I believe I contributed one myself.

At that time the Society was concerned exclusively with telegraph work, as the application of electricity to power and lighting had either not begun or was in the experimental stage.

I continued in the service of the G.P.O. until 1876, with an interval in 1873 when I was in charge of telegraph work on the West Coast of Africa in the Ashantee War. I think I left the Society in 1876. I had very little to do with it apart from attending occasional meetings.

The Development of the Institution.

By LLEWELYN B. ATKINSON.

Jubilees are useful periods for retrospect and stocktaking, whether that retrospect and stocktaking be concerned with the reigns of kings, married life, or the proceedings of Institutions, and I am, therefore, gladly taking this opportunity of saying something in The Electrician about the history and development of the Institution of Electrical Engineers, whose formal birthday occurred on May 18, 1871, almost exactly 50 years ago. From such a review electrical engineers may not only derive information of great interest, but learn some useful lessons for future conduct.

The Electrical Society of London.

The idea of founding an electrical society in London was even as long ago as 1871 not a new one. As early as 1837 a society called the Electrical Society of London was already in existence. The object of this Society, like the Society of Telegraph Engineers, the forerunner of the Institution, was the reading and discussion of Papers on electrical matters, but the Society did not last long, for on April 22, 1843, it was resolved to wind it up primarily owing to financial difficulties arising from the cost of printing the proceedings, and secondly, from the apathy of the members who neither attended the meetings nor invited fresh members to join. The minutes of this Society are in the possession of the I.E.E. and contain some very interesting notes on the discussions which took place. After the disappearance of this early body, electrical societies in London seem to have been in abeyance until about 1870 when telegraphists, especially those connected with military work, discussed the desirability of founding a society of telegraph enginers with Sir William Thomson, afterwards Lord Kelvin, as the first president.

Things advanced so far that a small committee was eventually formed for this purpose, and a meeting was held on May 17, 1871, at No. 2, Westminster Chambers, Victoria-street, London, S.W., in the office of Major Frank Bolton, when the following gentlemen agreed to form a society and appointed themselves as a provisional committee: Mr. E. W. Wildman Whitehouse, Captain P. H. Colomb, R.N., Major R. H. Stotherd, R.E., Mr. Louis Lœffler, Capt. C. E. Webber, R.E., Capt. E. D. Malcolm, R.E., Mr. Robert Sabine, and Major Frank Bolton.

At the same meeting formal resolutions of constitution were passed, 66 names were submitted and duly elected as members. Of these only two are now living, namely, Col. E. D. Malcolm, R.E., of Poltalloch, Argyllshire, who was an original member of the committee, and Sir Herbert Jekyll, K.C.M.G., who was for many years connected with the Board of Trade and who is now living at Godalming in Surrey.

The First General Meeting.

The first general meeting of the Society of Telegraph Engineers was held on February 28, 1872. It had been desired pretty generally that Sir William Thomson should be the first President, but, as a matter of fact, this honour fell on Dr. (afterwards Sir) William Siemens, who, on that date, delivered an address dealing principally with the objects of the Society, making it clear that he at that time regarded the Society as a specialist society and the Institution of Civil Engineers as the institution which would cover all activities of engineers. This point of view remained with the Institution for the first 35 years of its existence and in its early stages the Society was necessarily chiefly concerned with telegraphic matters, though as the applications of electricity and magnetism developed and the Society expanded its scope a change became necessary and the broader outlook was indicated in the change of its name, first, to the Society of Telegraph Engineers and Electricians in 1881, and in 1883 to the Institution of Electrical Engineers. That it would develop in this way was foreseen at the time the original society was founded and was clearly foreshadowed by C. F. Varley in a speech at the opening meeting when he said:—

> "This Society, I assume, will gradually, by natural selection, develop more into an electrical society than into a society of telegraphy proper: and the moment it is understood that all Papers on electricity or bearing directly upon the development of electrical science are admitted, it at once takes the science out of the narrow groove into which it seemed to be drifting, into the most extensive of all grooves, because it will be found ultimately to embrace every operation in nature."

The Second Phase.

It is common knowledge that, within recent years, the Institution has been definitely jolted out of the groove or series of grooves in which it had been running for some time and which formed the second phase of its career. This change is widely accepted as a change for the better. Like all rapid changes, it has brought difficulties and anxieties in its train, but there seems no doubt it has definitely improved and added to the popularity and power of this Institute.

It is only natural with the wide expansion of electrical engineering that the growth of the membership of the Institution has been almost phenomenal, until now it is the largest British technical society. The seven or eight original founders who I have mentioned above were joined by 60 others to form the original body and at the end of the first year the membership numbered 110. At present the membership totals 9 571, of whom 1 705 are full members, 4 618 associate members, 828 graduates, 1 962 students and 449 associates, together with 9 honorary members. This increase has been progressive, so that in contemplating the outcome of their action taken nearly half a century ago the two surviving original members have the satisfaction of knowing that practically every man of prominence in the electrical world in this country has been numbered among its members and that the Institution as it now stands is a powerful influence, actively and successfully promoting the objects for which it exists and thus conferring great benefits on the community at large.

An Increase in Influence.

This increase in the Institution's influence has only been made possible by the widening of its efforts. As mentioned above, for the first 35 years of its existence the Institution was purely a body for the reading and discussing of Papers, but recently it has taken up the attitude that, whilst certifying by its membership to a standard of engineering skill, it must also endeavour by its activities to promote the interests of all its members in directions which do not necessarily depend only on their particular status or skill. This function of its activities has been brought about to a considerable extent by the fact that electrical engineering is largely concerned with public services and hence the entrance into its affairs of Governmental and municipal regulations in a degree quite unapproached in civil or mechanical engineering. The increasing and broadening sympathy existing between the Institution of Electrical Engineers and all classes in the industry may be traced to the time when definitely or implicitly this great difference between it and the older institutions was recognised and the work of the Institution adapted to the needs of the industry.

The Future of the Institution.

So much for the past, but it is more difficult to speak of the future. One thing is certain, the founders of the Society of Telegraph Engineers could not have foreseen its present scope or envisaged its future development. No one will more heartily agree with this statement than the two surviving original members, Sir Herbert Jekyll and Col. Malcolm. It was hardly to be expected that they should. In those days industrial electricity meant telegraphy, nowadays its industrial applications can hardly be numbered, but while electrical engineers have spread out into numerous fields all those fields are not equally tilled. There is still a great deal to do, much work for the Institution, more work for its members. It is gratifying to see that the great assistance the Institution and its members can mutually give each other is being more generally recognised, and, that being so, although there are many difficulties to be overcome, there is no reason why its progress in the future should be less than it has been in the past, indeed, I am confident it will be greater.

Some Early Electrical Societies.

We think it is of interest to reproduce the following from the address delivered by Mr. J. E. Kingsbury in 1915 to the students of the Institution.

In celebrating the jubilee of the Institution, which was formed in 1871 under the title of the Society of Telegraph Engineers for the general advancement of electrical and telegraphic science and more particularly for facilitating the exchange of opinions and ideas among its members, we must not forget that it was by no means the first society promoted to advance science and thereby the good of the world. For in the direct line of succession we can go back to about 1645 when a number of people formed a small club which consisted "of divers worthy persons inquistive of natural philosophy" and particularly of what was then called the new or experimental philosophy. That club later developed into the Royal Society which was formed in 1660 and received its charter of incorporation in 1662. One of the most important achievements of the Royal Society was the development of the taste of the gathering together of kindred spirits to thrash out problems of mutual interest. That tendency grew in the succeeding century to such an extent that in 1754 a Society for the Encouragement of Arts, Manufactures and Commerce was founded. Numerous other societies followed and the interest extended from what may be called general questions to those which were more distinct and the interest of society in engineering developed greatly until in 1818 the Institution of Civil Engineers was founded and received its charter 10 years later. Numerous other societies were also founded, but the tendency of them all was to become specialised. That is, the original Society founded for dealing with pure science realised that it was impossible to follow the details of all science and consequently various departmental societies were formed for the specific object of dealing with particular branches.

An Institution with a Meagre History.

It is surprising to find that very meagre details have been preserved of the formation and development of the Institution of Electrical Engineers, for there is really nothing excepting a brief and hastily compiled account which was prepared in 1903, when a telegraph conference took place, and an article in "Scientific London," a book published in 1874. The author of the latter work very definitely indicates that the Society was formed through and from the Civil Engineers. He says :—

> "At the commencement of the present decade [1870 1880] it was felt that by many eminent electricians and members of the Institution of Civil Engineers that the department to which they had devoted themselves had at length assumed such imposing proportions as to demand a separate and special organisation. Far from opposing the development of that new body the parent society in Great George-street at once extended a helping hand to the scheme, and offered free use of its handsome room for the meetings of the new Society. To Major Frank Bolton and to Major Webber, R.E., is due the inception of the idea of a Society of Telegraph Engineers, and these gentlemen were warmly supported by Messrs. Robert Sabine, Latimer Clark and Dr. C. W. Siemens."

It must be pointed out that the telegraph industry was already of some importance at that period. For the total amount of capital invested in submarine telegraph companies, exclusive of the Government Indo-European line, amounted to £10 230 370, and the total length of the cables was 37 795 miles. This does not take into account the investment in inland telegraphs which amounted to something like £7 500 000.

Subsequent Developments.

In connection with the subsequent development of the Institution the following from Dr. C. W., later Sir William, Siemens, presidential address gives much food for thought. He says :—

> "Regarding the formation of the Society our future prosperity will be influenced in a great measure by the direction in which we shall start upon our pilgrimage. Let us hope therefore that our joint efforts may lead us in the direction of true scientific practical advancement. But before we set out upon our labours it behoves us fairly to consider whether there is need or scope for a Society of Telegraph Engineers. . . . Is it desirable indeed, it may be urged, to take a branch from the parent stem and to cultivate it separately. Shall we not degenerate thereby into 'specialists' or what may be called 'fractional quantities of scientific men,' and this in face of the patent fact that the further we advance in scientific knowledge (whether pure or applied), the more clearly we perceive the intimate connection between its different branches and the impossibility of cultivating one without constantly reverting to the others. In answer to such allegations we may fairly assert that we do not intend to become specialists in a narrow sense of wishing to confine the range of our knowledge to the phenomena and appliances which have an immediate application to our professional objects. We are on the contrary sensible to the fact that in order to master those *special* branches of knowledge thoroughly we shall have to travel into adjacent fields and build our practice upon the widest possible scientific foundation, but our time is limited, and although the great principles of nature may be understood generally by one person, their applications are unbounded, and all we may hope to do is to attain to a general scientific basis, and with it to devote our energies vigorously to the details of one or two branches of applied science."

In another part of the same address Dr. C. W. Siemens said :—

> "Problems of pure electrical science meet the telegraph engineer at every turn. . . . There is hardly a problem in electrical science that is not of practical interest to the telegraph engineer, and considering that electricity is not represented at the present day by a separate learned society, I am of opinion that we should not exclude from our subjects questions of purely electrical science."

Broadening Interests.

The broadening interests of the early Society are sufficiently indicated in its changes of name. In December, 1880, the title was amended by the addition of the words "and of electricians." An example of the interest which members had always taken in the details of the Society's work is to be found in the discussion which arose at the meeting as to the necessity of the word "of." On behalf of the Council it was explained that the points had already been canvassed in all its bearings, and the word was retained. In the Council's report of December 15, 1881, it was stated that "the proportion of scientific names to be found among the list of members collected this year seems to afford evidence that this alteration of the title has certainly assisted in making the better known a fact which appears to have been previously only partially recognised, that is, that the Society is established to promote electrical science in all its branches." The electrical developments of the eighties showed a further change in the title to be advisable, and in 1889 the present title was adopted. The membership of the Society in its first years was 110. "The members including Ronalds, Wheatstone, Cooke, Bayne and a host of others who must for ever be associated with the history of telegraphy of this country many of whom are still amongst us, and I think it is a fortunate thing and an honour to have so many of them as members of our Society." These words were spoken by Mr. Latimer Clark and his own name was equally honoured by us as the others.

The past in the records of the Institution is indeed largely made up of individual work or individual inventions. The future is more and more becoming the work of a number, and while the suppression of the inventive faculty would be undesirable the time has come when the joint stock principle which originated and has largely been adopted in England for investment should be more developed than it has been in engineering work. Broadly speaking, however, the future of the Institution, as its past has done, will depend on its members, and I am quite sure that the varied developments and applications which have arisen during its life will be eclipsed by the infinitely greater and more important ones which will come into being in the future.

The Regulation of Synchronous Generators.

By A. G. WARREN, B.Sc., M.I.E.E.

INTRODUCTION.

It is seldom that it is possible to determine the regulation of a large alternator, under varying load, by direct measurement. Such determinations involve considerable expense and call for larger quantities of power than can be conveniently provided, or dissipated, in the average works. Recourse, therefore, has to be made to tests involving but a small expenditure of power, from the results of which the regulation can be calculated. Such tests, if carried out scientifically, are capable of giving results of considerable accuracy. Some of them, and the methods of analysing them, have fallen into disrepute. These are critically examined by the writer and modifications are suggested. Apart from ohmic drop, the reduction in the terminal P.D. of an alternator when loaded is due in part to a leakage reactive drop in the machine, and in part to a true drop in generated voltage, brought about by the reaction of the armature current upon the field in the gap.

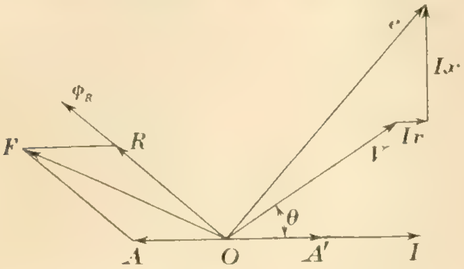

FIG. 1.

The vector diagram for the conditions assumed is shown in Fig. 1. Here V represents the terminal P.D., leading the current I by an angle, θ. Ir and Ix are the resistance and leakage reactance drops respectively, giving us e as the generated voltage in the machine. This generated voltage e is brought about by a flux, φ_R, which may be conveniently represented as a time vector 90 deg. ahead of e. To produce the flux φ_R requires a magnetomotive force, R (determined from the no-load characteristic of the machine). Towards this an amount, F, is contributed by the field winding and an amount, A, by the armature winding. The determination of F is seen in the diagram. F, A and R are here treated as time vectors; considered with respect to the field system, they are, of course, space vectors.

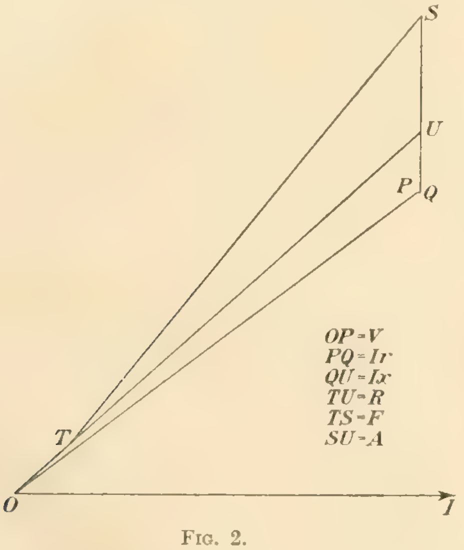

FIG. 2.

The application of such a diagram to the determination of the voltage drop on load assumes the constancy of the leakage reactance under all conditions of loading, and also the equality of the reluctances of the magnetic circuit to the magnetomotive forces F, A and R. The former assumption is open to a certain amount of objection; the latter is essentially correct for a machine with non-salient poles. It is desirable, in making practical tests for the determination of the reactance and reaction, to work under conditions approximating as closely as possible to normal working.

DETERMINATION OF REGULATION WHEN CONSTANTS ARE KNOWN.

It is convenient in making use of the diagram to turn the triangle ORF through a right angle, giving us Fig. 2 (re-lettered). If the magnetomotive force scale be altered so that R is represented by the same length as e, the voltage it produces, we obtain the well-known diagram Fig. 3, to which reference will be made later.

If the open circuit characteristic be available, and the leakage reactance and the armature reaction coefficient be known, the regulation for any load can be readily found. To take an actual case for which the open circuit characteristic is given in Fig. 4, let us determine the regulation for a load of 300 amps per phase at a power factor of 0·8, assuming the phase resistance to be 0·12 ohm, the leakage reactance 2 ohms and the armature reaction coefficient 0·15 (*i.e.*, armature current to be multiplied by 0·15 to obtain the equivalent field current).

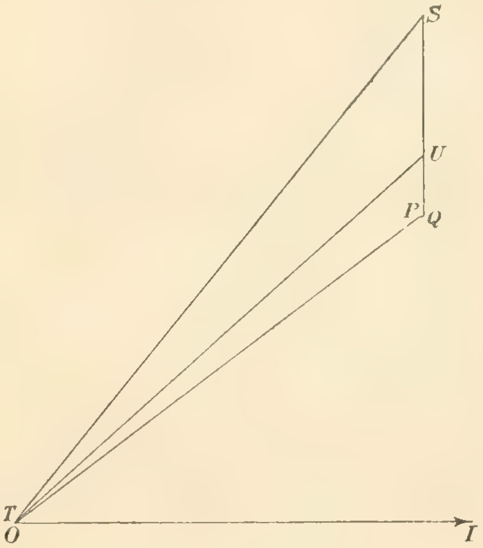

FIG. 3.

As continual reference will be made to this machine, the general particulars and data obtained upon tests are tabulated here.

Three-phase star-connected generator; phase voltage 5 000, current 300 A; phase resistance 0·12 Ω; field current 60·7 A when armature short-circuit current is 300 A; field current 60·7 A when wattless armature current of 100 A is delivered at 1 500 V; field current 245 A when wattless armature current of 300 A is delivered at 4 950 V.

OP (Fig. 2) is set out at the correct angle and equal to 5 000 V, $PQ=36$ V, $QU=600$ V, whence OU, the generated voltage, is found by measurement to be 5 410; this would be produced by a field current, TU, of 185 A, SU is 45 A, whence ST is found by measurement to be 217·5 A, which from the open circuit characteristic is seen to correspond to 5 700 V.

To solve the problem the other way round is not so simple, but the diagram can be drawn with the aid of a simple scale prepared in the following manner: On a strip of paper mark a voltage scale, as employed for OP, PQ, &c. For the particular case, all that is required is a zero mark and divisions from 4 800 to 5 200. Next mark another voltage scale from the same zero and between the same limits. The method of marking this scale is easiest described with the aid of the actual example : 5 000 V corresponds to 157 A in the fields ; measure off 157 A to the same scale as *TU*, *SU*, &c., and mark it 5 000 V, and so continue. The completed scale obtained is shown in Fig. 5.

Suppose that we are given that the open circuit voltage is 5 500, to find the voltage when a current of 300 A is taken at a power factor of 0·8. From the open-circuit characteristic we see that the field current is 194 A. *PQ*, *QU* and *US* of Fig. 6 are set out, also the line *O'P* upon which *O* must be. With *S* as a centre, an arc of radius 194 A is struck. *T* must be upon this arc. The scale is placed with its zero at *U*, and is moved until the intercept of the arc upon the scale *II* is the same as the intercept of *O'P* upon scale *I*. This can be performed readily with great accuracy. A slight movement of the scale hardly changes the intercept upon *II*, but causes a big change in the intercept upon *I*. The voltage is read upon *II*. It is found to be 5 070, which, on being marked upon *O'P*, gives *OP* as 4 660.

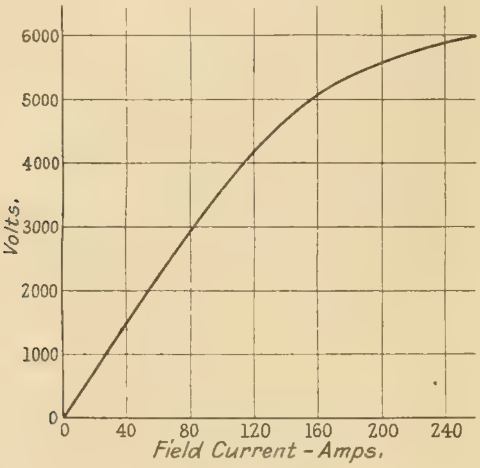

Fig. 4.

Methods of Determining Regulation from Experimental Data.

Standard methods of determining the regulation experimentally may be summarised as (*a*) synchronous impedance methods, either by short-circuit or with zero power factor load ; (*b*) magnetomotive force methods (either by short-circuit or with zero power factor load) ; (*c*) Potier's method, with its various modifications (actually general methods on the principles enunciated above) ; (*d*) the two reaction method, due to Blondel, in which the armature reaction is split into demagnetising and cross-magnetising components. Undoubtedly (*d*) is the most scientific when dealing with salient pole generators. Its advantage over the general method properly applied, however, is small, and it is doubtful whether its increased accuracy is sufficiently pronounced to compensate for the increase in complication. It is with a certain modification of Potier's method that the writer intends to deal particularly, and little further reference will be made to the two-reaction method.

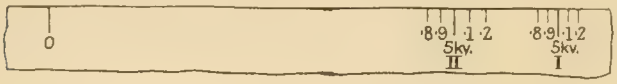

Fig. 5.

All methods would give identical results for an air-core machine ; the differences between the methods lie in the means adopted to take account of the variation of the quantities involved with the magnitude and nature of the load.

Synchronous Impedance Methods.

These methods assume that the reluctance of the magnetic circuit is constant and that the effects of the magnetomotive forces of the impressed field and of armature reaction are the same as if each acted alone. For the magnetomotive force of armature reaction the voltage that it would produce is substituted. It is assumed to have the same value under all conditions. We thus arrive at a fictitious reactance for the armature, constant under all conditions of load. The drop on this reactance is *QS* of Fig. 3. Actually the reactance of an alternator is far from constant. The true leakage reactance for a machine with open slots varies but little, but the fictitious reactance substituted for the armature reaction is much less at saturation than when the magnetic circuit is unsaturated, since its value is proportional to the flux produced by the armature current. For a machine with salient poles this flux will vary, not only with the degree of saturation, but also with the power-factor of the load.

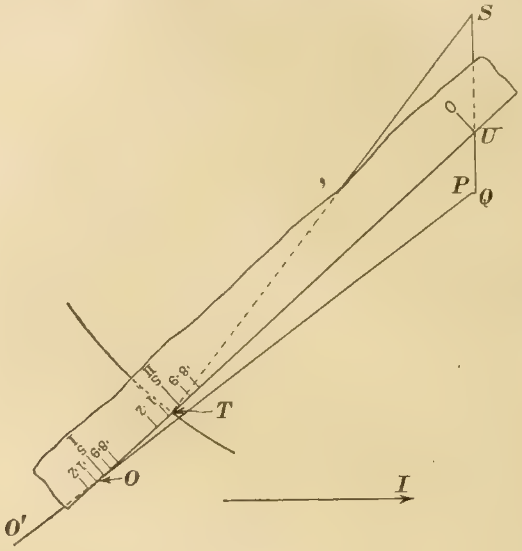

Fig. 6.

The oldest method of determining the synchronous impedance is from the short-circuit test. The field is excited until full-load current is obtained on short circuit. If we assume that the synchronous reactance is *X*, Fig. 3 reduces to Fig. 7, where *E* is the voltage read off the no-load characteristic corresponding to the field current employed. The resistance drop is always small compared with the fictitious reactive drop and *E* may be assumed equal to *IX*, giving $X=E/I$. For the particular alternator considered, a short-circuit current of 300 A was obtained with a field current of 60·7 A, corresponding to 2 250 V, whence the synchronous reactance is 7·50 O. This value is far too high and if employed in calculation the regulation appears far worse than it actually is. It is the reactance with the field far from saturated, which is much higher than the reactance under normal working conditions.

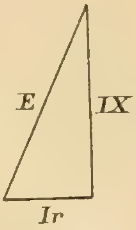

Fig. 7.

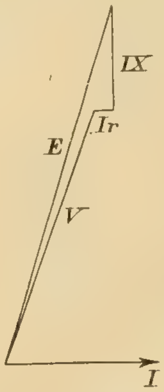

Fig. 8.

The American Institute of Electrical Engineers now recommend the measurement of the synchronous impedance under full excitation and full current at zero power factor.

The vector diagram (drawn for a small power factor) is given in Fig. 8. Under these conditions the field is fully saturated and a more reasonable value of X is obtained: we have $X=(E-V)/I$. (From the diagram it can be seen that the assumption that the power factor is zero when it is made reasonably small introduces but negligible errors). In the particular alternator under consideration the voltages obtained at an excitation of 245 A were 5 890 at no-load and 4 950 at 300 A wattless, whence X under these conditions is 3·13 O, less than one-half of its value as determined from the short circuit test.

Magnetomotive Force Methods.

These methods also assume to a certain degree the constancy of the reluctance of the magnetic circuit, but not to such a definite extent as the foregoing methods. In the magnetomotive force methods it is assumed that all drop, apart from that due to resistance is brought about by armature reaction, there being no armature leakage reactance. Fig. 3 then becomes Fig. 9. Here OS represents the impressed magnetomotive force, SQ the armature reaction, and OQ the resultant magnetomotive force and, to a different scale, the generated E.M.F. If the armature reaction coefficient be determined from the short-circuit test, a too optimistic coefficient is obtained for application at normal saturation, since it is implicitly assumed that the true leakage reactance decreases in just the same proportion as the effect of armature reaction, instead of its remaining nearly constant. Taking the value from the short-circuit test we get for the armature reaction constant $60·7/300=0·202$. If, however, we take the full wattless current test a pessimistic value of the coefficient is obtained. From the open circuit curve we find that 4 950 V is obtained with a field current of 154 A. This taken in conjunction with the wattless current test at 300 A and 4 950 V at 245 A excitation gives us as the armature reaction coefficient $91/300=0·303$.

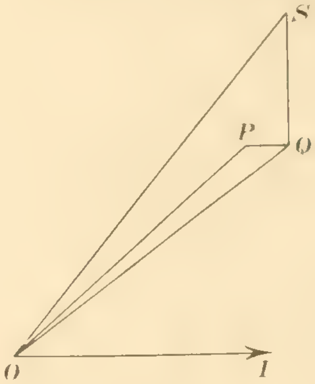

Fig. 9.

(*To be concluded.*)

Recent Work on Nickel Plating.

By W. E. HUGHES, B.A. (Cantab.)

Two important papers on the electro-deposition of nickel have recently been read before the American Electro-chemical Society. The one, presented by Mr. C. P. Madsen, contains the general conclusions drawn from the results of five years' work on nickel deposition, and is entitled "Ductile Electrolytic Nickel"; the other, of which Dr. W. Blum, electro-chemist at the Bureau of Standards, Washington, D.C., is the author, is concerned with "The Use of Fluorides in Solutions for Nickel Deposition." It will be convenient to consider each paper separately, though some cross references will perhaps be necessary.

Ductile Electrolytic Nickel.

Mr. Madsen's original aim was to manufacture, by electro-deposition, "a better type of resistance alloys and armors for (electrical) heating units." This involved the production of thick deposits of nickel, and, consequently, required the study of the published methods of nickel deposition—and, especially, of solutions used for that purpose. The general conclusions drawn were: (1) The usefulness of any nickel electrolyte can be determined only after its entire metal content has been replaced from the anode; (2) No conclusion can be drawn from deposits less than 0·01 in. thick; and (3) Reports of results with any electrolyte are of no value, without knowing the exact analysis of the anode used. These conclusions led the author to concentrate attention on the anode side of the plating tank, and, in doing so, he has certainly done a very important piece of work.

The results of the investigation confirmed the conclusions of others, namely, that cast anodes give a higher efficiency than either hot-rolled or electrolytic nickel. As regards this last, it was found that annealing always improved its efficiency; and this is an important matter, since it shows that, as one would expect *a priori*, the physical constitution of an anode is of importance. In general, it was found that "the domestic so-called cold-rolled malleable nickel performed the best of any nickel tried, particularly with the proper amount of chloride present in the bath. They dissolved with an efficiency of about 97 per cent. when free from passive portions. This type of anode was therefore used exclusively in the subsequent three years of this investigation. The average percentage analysis of this material is as follows: $Mn=0·33$, $C=0·30$, $Si=0·23$, $Cu=0·25$, $Fe=2·13$, $Ni=95·30$." Mr. Madsen considers that a modified form of Dr. Watts' solution* is the best to use, but no details of the modification made are given, except that "addition agents" are introduced. The double sulphate bath is ruled out, and justly so; and baths containing magnesium sulphate are stated to be unstable and unreliable, though the reasons for this view are not given.

Mr. Madsen states that he had one particularly curious experience during the course of his work. He found that a cathode that was removed from the bath, and re-inserted every few minutes during a time of deposition lasting twenty-four hours, was by far the most perfect deposit hitherto produced by him; and he further found that, if the time of removal did not exceed fifteen seconds in duration, the deposit was not laminated. Moreover, a connection between the frequency of removal, necessary for producing the best results, and the factors of deposition influencing the formation of hydrogen, such as anode efficiency, temperature, acidity, and current density, was disclosed. As the hydrogen evolution was diminished, so the frequency of removal necessary became less, and since hydrogen evolution (and, consequently, pitting of the deposit) depended upon the type of anode employed, the frequency of removal depended upon the anode. An anode was finally made which lessened the frequency of removal to once every ten to fifteen minutes, while pitless metal up to $\frac{1}{32}$ in. thick was being deposited.

The Importance of the Anode Problem.

The importance of Mr. Madsen's work consists, largely, in the results obtained in tackling anew the anode problem in connection with the nickel-plating bath. It is, indeed, high time that serious attention was directed to this subject, for it is of the greatest importance in the economical working of nickel solutions. It is suggested by the present writer that the removal of the cathode (that formed part of the practice of Mr. Madsen) is only effective in that, thereby, adherent hydrogen bubbles are dislocated. Mr. Madsen himself shows that removal of the cathode becomes the less necessary the more efficient the anode employed is; and the introduction of such an operation as part of the regular practice of deposition would, in the writer's opinion, certainly result in piles of stripped work. It is the solution of the anode that is of importance. For, if that dissolves well, and gives an, approximately, 100 per cent. efficiency, then metal removed by deposition at the cathode will be replaced in the only proper way. The liquid round the cathode will then be replenished with metal, and hydrogen evolution will be made more difficult. Means must, it need hardly be said, be taken to distribute the metal-laden anolyte throughout the solution, though, strangely enough, Mr. Madsen does not refer to this matter, which is one of agitation. The further details promised by the author will be awaited with interest by all who are concerned with nickel-plating. In addition to information as to composition, one would like to learn something more as to the physical condition of the anode chosen by the author, for it is well known that, as pointed out by Dr. J. E. Stead some years ago, metal in one physical state dissolves more readily than in another. And since the physical state of an anode will depend upon its metallurgical treatment and the conditions of its manufacture, these factors must be taken into account. Further, it would be interesting to know whether the anode of Mr. Madsen's choice is equally efficient in other types of solution than the modified form of Dr. Watts' bath to which he refers.

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*Dr. Watts' solution contained: Nickel sulphate, 32 ozs. to gall.; nickel chloride, 3 ozs. to gall.; and boric acid, 3 ozs. to gall. See "Rapid Nickel Plating," Trans. Am. Electro-Chem. Soc., 1916, Vol. 29, p. 396.

Comparative Merits of Fluoride and Chloride Solutions.

Dr. Blum's Paper is concerned with—especially—the comparative merits of solutions containing fluorides and those containing chlorides. The chloride bath used for purposes of comparison was a slightly modified Watts' solution (*v. sup.*) of the composition: nickel sulphate=34 oz. per gall., nickel chloride=3·2 oz. per gall., and boric acid=4·2 oz. per gall. His general conclusions are:—"(1) When nickel or sodium fluoride is added to nickel baths containing boric acid, fluoborates more complex than those corresponding to the formula HBF_4 are probably produced. . . . . (5) Nickel deposits produced in solutions containing fluorides have a finer structure and a higher tensile strength than those produced in corresponding chloride solutions. When prepared with anodes containing about 97 per cent. of nickel, there is slightly more iron and copper in the fluoride deposits than in the chloride. (6) The anode corrosion in solutions containing fluorides is good, and the solutions produce less sludge than do corresponding chloride solutions. Attempts to use electrolytic anodes in such solutions at reasonably high current densities have not yet been successful, but the results with hot-rolled anodes are promising. (7) The use of fluorides in nickel solutions for electro-typing will probably increase the wearing quality of the printing surface. In electroplating, good deposits can be secured in the presence of fluorides at somewhat higher current densities than are ordinarily employed, and these deposits, while slightly harder to buff, show greater resistance to abrasion." A solution of the following composition is recommended: nickel sulphate = 37·5 oz. per gall., sodium fluoride = 1·1 oz. per gall., boric acid = 4·2 oz. per gall. The current densities recommended are: 28 to 37 A per square foot for producing adherent deposits in nickel-plating, and 14 to 19 A per square foot for making reproductions, as in electro-typing.

Difficulty of Practical Reproduction.

It is, no doubt, true that, as the author claims, investigation of fluoride solutions throws light on the behaviour of nickel baths more commonly used, and may lead to their improved operation. All the same, it is doubtful whether the improvement indicated will be immediate. Dr. Blum's work is that of the electro-chemist, and can be made much use of by such an one only; and, moreover, it is by no means certain that the results will be reproducible (without more) in continuous works practice. Supposing they could be, it is not easy to see sufficient advantages in the deposits from the fluoride bath to justify the substitution for sodium chloride (common salt) of the more expensive fluoride. Further, if, as is likely and as Dr. Blum states, complex fluoborates are present in his bath, workshop control will be difficult, for no one could know what reactions proceeded at the electrodes—certainly those at the anode would be unknown. And, therefore, though a bath might work well for a time, complex substances, formed in the course of electrolysis, might be quite capable of affecting the deposits formed subsequently, and the depositor, faced with a bad deposit, would be totally unable "to put things right." These remarks are not intended to disparage Dr. Blum's work. This is of great interest and importance—to an electro-chemist; but a works manager who emptied one of his 300 gallon tanks of its present electrolyte, and substituted for it a fluoride solution, would, in the present stage of experience with such solutions, be very unwise. At the same time, there is no reason why "trial baths" on a smaller scale should not be used for particular purposes, as, for instance, securing hard printing surfaces. A plant for this purpose has actually been set up and successfully worked at the Bureau of Engraving and Printing (Washington) under the supervision of—be it noted—the Bureau of Standards.

Chemists, engineers, and the like will find much useful information of a purely scientific nature in Dr. Blum's excellent Paper. Those interested in the structure of deposited metal will find that he has not forgotten this important aspect of the matter. Micrographs are given to show, side by side, the structures of nickel deposited in the chloride and the fluoride baths. Much more information might, however, have been given about structure, and one might justly have looked for more exact details in regard to it. Since Dr. Blum is an enthusiast on this subject, perhaps more is to come later.

A Review of Recent Large Electric Locomotives.*

By **A. LATERNSER.**

Recent American Locomotives.

Since the original continuous-current locomotive in Fig. 1, with partly spring-borne motors of the tram-suspension type, supplied by the **General Electric Company**, did not prove satisfactory for express service with speeds up to 100 km. per hour on the Chicago, Milwaukee and St. Paul Railway, this firm has recently returned to its earlier construction used on the New York Central Railroad, and has produced a type with slow-speed motors mounted on the axles, as shown in Fig. 2. The competing Westinghouse firm has supplied for the same service locomotives of the type represented in Fig. 3, having high-speed, double motors, and their well-known quill drive. The locomotive in Fig. 1 had to be withdrawn from express service on account of the harmful effect on the rails. This is not remarkable when it is borne in mind that with such a low centre of gravity and rails of 42·5 to 45 kg. per mile on sleepers 600 mm. apart, the weight per driving axle is about 25 tons, of which 7·4 tons (or 30 per cent.) is non-spring-borne. In the new G.E.C. type, Fig. 2, the weight per driving axle is reduced to 17·3 tons, and of this only 4·35 tons (or 25 per cent.) is not carried by springs. For this locomotive it is also claimed that the efficiency retains its normally high value at top speed, in contrast to the geared locomotive where the efficiency falls off appreciably at high speeds. The low position of the centre of gravity—a point which European designers seek to avoid—remains in the new type, and for this reason the adopted name "speed king" would appear irrelevant. The author is informed that this type, too, has been withdrawn from express service, because of the destructive effects on the rails, despite automatic devices for reducing side knocks on curves. The **Westinghouse** locomotive in Fig. 3, with its centre of gravity raised by using larger wheels and mounting the motors higher, is more in accord with European views. Here the non-spring-borne weight per driving axle is 3·3 tons, or 13 per cent. of the driving-axle load of 25 tons. Though the non-spring-borne load is smaller than in the new G.E.C. type (Fig. 2), the total axle load is greater, partly owing to the increased power.

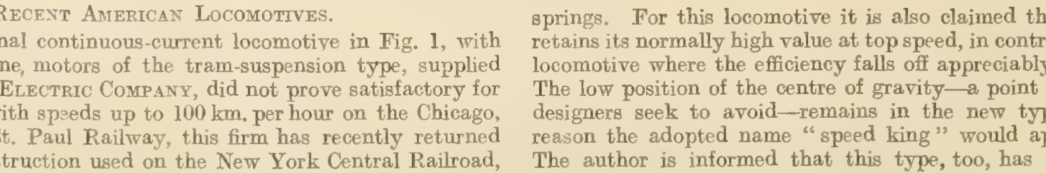

Fig. 1.—Goods Locomotive, Type 2B+B+B+B2, of the General Electric Company, for the Chicago, Milwaukee & St. Paul Railway.

The comparison of these two recent American locomotives, which comprise numerous compromises, show that the best solution can be spoken of only in connection with given conditions. On the one hand, the gearless type of the General Electric Company, built for the New York Central Railroad, has been undoubtedly successful;

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* Abstract of an article in the "Schweizerische Bauzeitung," Vol. LXXVII., p. 19.

on the other hand, the Westinghouse geared type with many years service on the New York, New Haven and Hartford Railroad has also proved satisfactory.

Around the most desirable type of goods locomotive, there also centres much active discussion in America. In this connection, the Westinghouse geared, coupling-rod type, in Fig. 4, has proved a successful competitor against the geared type of the G.E.C. in Fig. 1. The Westinghouse locomotive was built for the Pennsylvania Railroad, electrified with single-phase current at 11,000 V and 25 cycles, and is more powerful than any of the three foregoing types. The locomotive carries a phase converter which changes the single-phase supply current into three-phase current for the motors. This split-phase locomotive also has its successful predecessors on the Norfolk and Western Railway.

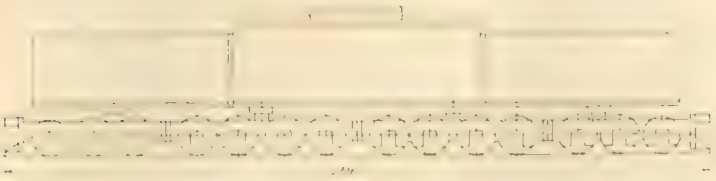


Fig. 2.—Express Locomotive, Type 1B+D+D+B1, of the General Electric Company, for the Chicago, Milwaukee & St. Paul Railway.

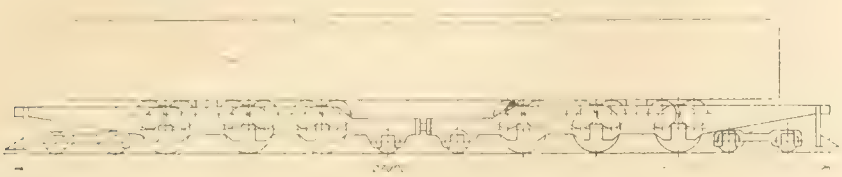


Fig. 3.—Express Locomotive, Type 2C1+1C2, of the Westinghouse Company, for the Chicago, Milwaukee & St. Paul Railway.

Recent European Locomotives.

The split-phase locomotive forms a bridge to European constructions which favour coupling-rod drives with or without gearing. The systems favoured in Europe are either the pure single-phase, with 15 000 V at 16⅔ cycles, as in Switzerland, Germany, Scandinavia and Austria; or the pure three-phase system, with 3 000 V at 15 cycles, as in Italy. As yet the continuous-current system has not produced any notable locomotive types in Europe.

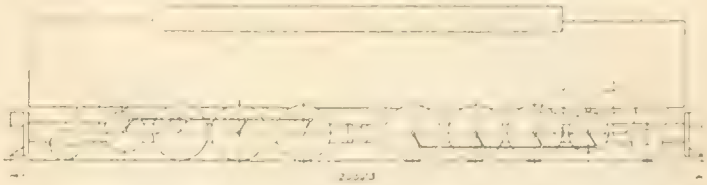


Fig. 4.—Goods Locomotive, Type 1C+C1, of the Westinghouse Company, for the Pennsylvania Railway.

As a European example of the single phase type there is the 1C+C1 locomotive for the Swiss Federal Railways (Fig. 5), and of the three-phase type the 2C2 locomotive of the Italian State Railways (Fig. 6). These two types, both due to the Oerlikon Company, represent the most powerful European locomotives; and can be directly compared with the American types, since they are likewise equipped for regeneration—a point strongly emphasised by American firms in favour of their constructions. Corresponding to European conditions, these locomotives are built for much smaller powers than the American locomotives. This acts against them in any comparison, since large locomotives are relatively lighter than small locomotives.

Comparison between American and European Locomotives.

In order to compare the above locomotives, a new idea must be introduced, namely, a coefficient of utilisation, based on the virtual power of each locomotive. Among the locomotives to be compared are: Two good locomotives (Figs. 1 and 4), one locomotive for goods and passenger service (Fig. 5), two locomotives for passenger and express services (Figs. 2 and 3), and one express locomotive (Fig. 6). To compare locomotives for various services according to their weight per unit power would lead to wrong results; such a comparison would be correct for locomotives built for the same duty only.

Table I.—*Coefficient of Utilisation.*

Fig.	Type.	System.	Z in kg. per H.P.	No. of speed steps.
6	Gearless, coupling-rod drive	Three-phase, 3 000 V	30	4
5	Geared, coupling-rod drive	One-phase, 15 000 V	40	21
3	Geared, twin-motor quill drive	Continuous current, 3 000 V	42	9
2	Gearless, motor-axle drive	Continuous current, 3 000 V	43	8
1	Geared motors with tram suspension	Continuous current, 3 000 V	55	3
4	Geared, coupling-rod drive	Split-phase (one to three phase)	56	2

Table II.—*Data of Recent American and European Electric Locomotives.*

Railway	Ch.-M.	Ch.-M.	Ch.-M.	Penn.	Swiss.	Italian.	
Manufacturer	G.E.C.	G.E.C.	West.	West.	Oerlikon.	Oerlikon.	
Weight of electrical part	112	106	120	128	56·4	42·7	Tons.
Weight of mechanical part	149	134	130	90	71·6	49·3	..
Total weight	261	240	250	218	128	92	..
Adhesive weight	204	208	151	180	104	54	..
Weight per driving axle	25·5	17·3	25	30	17-18	18	..
Non-spring-borne weight per driving axle	7·4	4·35	3·3	3·7	3·0	3·3	..
Total wheel base	31·29	20·42	24·15	19·48	16·5	10·6	Metres.
Fixed wheel base of driving axles	3·2	4·19	5·078	4·064	4·7	3·6	,,
Diameter of driving wheels	1 320	1 117	1 730	1 829	1 350	1 630	Mm.
Maximum drawbar pull	60 000	30 000	50 000	60 000	24 000	12 000	Kg.
Draw-bar pull on one hour's rating	38 500	20 800	30 000	39 600	17 000	9 500	..
Draw-bar pull on continuous rating	32 200	19 000	22 300	...	13 100	...	..
Horse power at periphery on one hour's rating	3 667	3 430	4 200	4 800	2 200	2 640	H.P.
Horse power periphery on continuous rating	3 215	3 250	3 400	...	1 700	...	..
Normal speed	25	44·3-45·7	38-42	33	35	75	Km. hr.
Maximum speed	54	100	105	33	65	100	..
Coefficient of friction (with draw bar pull on one hour rating	1/5	1/10	1/5	1/5	1/6	1/6	
Gear ratio	4·56	...	3·70	5·14	4·03	...	...
Virtual power on one-hour's rating L	5 750	5 600	7 350	4 800	3 150	3 100	H.P.
Weight reduced to axle load of 18 tons G	320	240	310	270	128	92	Tons.
Coefficient of utilisation Z on one hour rating	55	43	42	56	40	30	Kg./H.P.
Weight per H.P. on one-hour's rating	71	70	60	45	58	35	Kg.
System	C.C.	C.C.	C.C.	1 to 3 ph	1 ph.	3 ph.	...
No. of motors	8	12	12	4	4	2	
Economic speed steps	3	8	9	2	21	4	

In addition to its power, the weight of a locomotive depends on the speed range, since high-speed motors are smaller than low-speed motors. The higher the top speed, the lower is the speed of rotation corresponding to the normal speed or power, and the worse will be the utilisation of the motor. For this reason the two-pole axle-type of motor of the G.E.C. only becomes feasible for express locomotives with small driving wheels (1 117 mm. diameter for speeds up to 100 km. per hour).

Let L_v=the virtual power of the electrical part.

x=part of weight of electrical equipment due to motors.

v_m=maximum speed of locomotive.

v_n=normal speed of locomotive (for normal power L).

The coefficient of utilisation is then found from

$$L'_v=L\frac{v_m}{v_n}x$$

for the motors.

$$L''_v=L(1-x)$$

for the remaining electrical equipment, whence

$$L_v=L'_v+L''_v=L\left\{\frac{v_m}{v_n}x+(1-x)\right\}.$$

For the different systems, x varies from 0·35 to 0·65. Taking as an average value $x=0{\cdot}5$, then

$$L_v=\frac{L}{2}\left(\frac{V_m}{V_n}+1\right).$$

When $v_m=v_n$, then $L_v=L$,

,, $v_m=1{\cdot}5\,v_n$,, $L_v=1{\cdot}25\,L$,

,, $v_m=2v_n$,, $L_v=1{\cdot}5L$,

that is to say, for these speed ranges, the virtual power L_v will be equal to, 25 per cent. greater than, or 50 per cent. greater than the actual power L. This virtual power, however, cannot be taken in direct connection with the weight of the locomotive, since the axle loads are unequal. The locomotive weights must be first reduced to the same weight per axle, and this has been estimated for the customary European loading of 17 to 18 tons. The coefficient of utilisation is then

$$Z=\frac{G_v}{L_v}.$$

Where G_v is the locomotive weight reduced to 17-18 tons per axle. These coefficients for the locomotives discussed are given in Table I.

From the service standpoint, credit must also be given for the number of economical speed steps. In this respect, the single-phase locomotive in Fig. 5 is far and away the best. It possesses not only a wide range of economic speed control, but also economic starting (*i.e.*, starting without resistance). In the case of the continuous-current locomotives, part of the speed control is obtained by weakening the field, which means a larger armature current for a given drawbar pull at the higher speed.

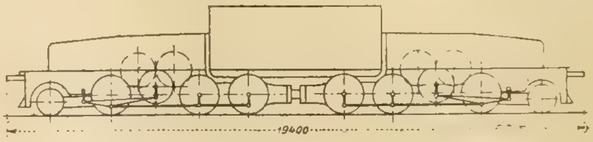


FIG. 5.—GOODS LOCOMOTIVE, TYPE 1C+C1, OF THE OERLIKON COMPANY, FOR THE ST. GOTHARD LINE OF THE SWISS FEDERAL RAILWAYS.

With regard to regeneration, the three-phase types in Figs. 4 and 6 are the best, in so far as this is automatic, but at hyper-synchronous speeds only. The Oerlikon system used on the single-phase locomotive in Fig. 5 satisfies all demands, but like the three-phase types, the power-factor suffers during braking. The regenerative braking methods in the types in Figs. 1 to 3 are also electrically complete, but lack simplicity, range and general safety.

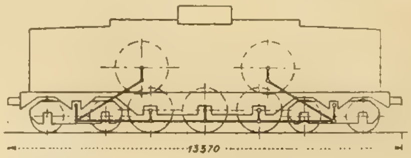


FIG. 6.—EXPRESS LOCOMOTIVE, TYPE 2C2, OF THE OERLIKON COMPANY, FOR THE ITALIAN STATE RAILWAYS.

In Table II. other particulars of the electric equipments are given; in certain of the items, assumptions had to be made.

Institution of Electrical Engineers.

A Wide Discussion on Tariffs.

A fair attendance celebrated the Papers on "Multi-Part Tariffs for Domestic Electricity Supply," by Mr. J. W. **BEAUCHAMP**; and on "Electric Supply: Present Conditions and the Hopkinson Principles," by Mr. J. R. **BLAIKIE**, which were read before the Institution of Electrical Engineers on April 28th. The discussion on the two Papers, of which abstracts were given in our last issue, was adjourned to May 5th, and we give an account of the remarks of both sets of speakers below.

The **PRESIDENT**, in his preliminary remarks, supposed that Mr. Blaikie was trying to convince himself that it was both proper and profitable to charge all classes of consumers as low rates as possible. In this connection Mr. Blaikie's methods for discovering fundamental constants were novel and worth deep consideration. At the same time he was not at all sure that the division of consumers into six- and seven-day classes was perfectly accurate, as it disregarded all questions of the use of the electricity which were as important as when it was used. The adoption of Mr. Beauchamp's arguments should do much to get the electric light into new dwellings. Tariffs for domestic loads must be given the fullest consideration, both from the technical and legislative points of view.

NECESSARY IMPROVEMENTS IN THE M.D. SYSTEM.

Mr. **ARTHUR WRIGHT**, who we were glad to see once again speaking at the Institution, showed himself as being among that small band of inventors who realise their invention can be improved. It was commercially impossible, he pointed out, to measure the demands on the investment of the intermittently used electrical appliances whose diversity factor entitled them to a high load factor rate. Rebates must be granted in proportion to the total consumption, an adequate service charge must be made, while to make the running charges the main source of profit necessitated a power factor clause based on the killivolt-ampere demands and not on the average power factor. The Hopkinson system modified in these ways would still be the best and most equitable basis for tariffs. For electricity supply a tariff based on a reasonable profit was better than one based on what the market would bear, notwithstanding ordinary trading principles. As regards cost of supply it was difficult to ascertain the cost of energy at the end of feeders or at sub-station switchboards. Means were therefore required for allocating the demand and the service costs among the various consumers. He did not think that the development of electricity supply had been retarded by complicated tariffs, and he did not agree with Mr. Blaikie that present-day fixed charges were a smaller proportion of the total cost than in pre-war days. Turning to the future, shortage of capital and high rates of interest would be as much an obstacle to development as shortage of coal. Until the industry was allowed to earn a rate of interest about equal to double the Bank rate, and to have a tenure on ordinary business lines, capital would be difficult to obtain. He did not see the idea of Mr. Blaikie's six- and seven-day grouping unless it was to get two flat rates. The correctness of Mr. Beauchamp's conclusions were emphasised by the enormous development of electric cooking in America owing to the breaking away from the old standard pressure regulations. Automatic thermostatic control allowing a varying pressure was essential. To supply electricity for cooking was expensive, because in the winter it came on the peak. Altogether an excursion into the finance of electricity supply generally rather than of tariffs in particular, an excursion which was perhaps encouraged by the suggestiveness of the two Papers.

How to Develop the Cooking Load.

In contradistinction to Mr. Arthur Wright, Mr. **H. W. Couzens** thought that the cooking demand was one to be encouraged by allowing it a tariff which would appeal to the ordinary consumer. Up to now most of the cooking development had been done by the manufacturers with the supply station engineers as mildly interested spectators. What could be done in the way of developing the cooking load was shown by the work of the Brompton & Kensington Company, where 2 000 kW of cooking load had been obtained during the past 12 years with a summer peak load only 500 kW higher than when this development began in spite of an additional 500 kW for power, so that probably only about half the increase was due to cooking. The fixed charge should not be too high to frighten the consumer and its intelligibility was an important point. A tariff on a basis of £30 annual charge plus 2d. a unit, which was mentioned in the schedule of charges of a London council, included in addition to a number of other complications 30 per cent. of the wattage of the lamps installed as a basis. This was quite unintelligible to the ordinary consumer. The mains question was not so difficult as some people imagined. But where the system of distribution was direct current the possibility of a change-over to alternating current would have to be faced.

A Solution of Small Undertakings' Difficulties.

Mr. **P. D. Tuckett** welcomed Mr. Beauchamp's suggestions as a solution of the difficulties of small undertakings. A flat rate was too generous to some consumers and not generous enough to others, while with an adequate fixed charge and a low unit charge both classes would assist in overcoming the miserable thinness of the electricity supply business. In future there must either be a compulsory multi-part tariff or a much higher maximum rate, and future charges must be based on future and not on past capital expenditure. It was doubtful whether the heating gave a better load factor than the lighting, or whether any undertaking was well off with a heating load at 2d. a unit which coincided with a lighting load at 8d. per unit.

"Too Cheap" Electricity.

Mr. **F. W. Purse**, who spoke with his usual air of enthusiasm, saw in Mr. Beauchamp's suggestion for dealing with blocks of loads, the difficulty that one consumer would object to paying more than his neighbour did. This difficulty would be greater in municipal undertakings owing to the political pressure that could be brought to bear. He was revolutionary enough to think that electricity had been too cheap up to now. The apparatus was not all that it should be, which was a pity, for the public would pay more for a reliable article and if the apparatus was reliable the question of price would not be so all important. The lighting circuits ought to be separate from the power circuits even if there was only one meter. A charge of 8d. or a 1s. a unit for lighting was justifiable, and for that reason he did not see why Mr. Blaikie's seven-day consumers should have a lower kilowatt charge than the six-day consumers, because any load that came on the peak should be charged at a higher rate than a load which did not come on the peak. Shop lighting was an absolutely disastrous load, while it was anomalous to charge 8d. for power and 1d. for heating.

Price and Demand.

Mr. **E. W. Cowan** very rightly congratulated himself on the fact that the electrical industry was now endeavouring to bring itself into line with other industries and to adapt its prices to market conditions. All the business of the world was done on these lines. Though it was important to know the approximate cost to individual consumers this should only be treated as an influence and not as a determining factor in fixing prices. It ought to be laid down that no consumer or group of consumers should be charged a low rate at the expense of the others. Mr. Blaikie's reference to the application of profits to the relief of rates surprised him and was inconsistent with the rest of the Paper, but it had not surprised him as much as the suggestion that we might be suffering from too cheap coal. He could not agree with Mr. Beauchamp's statement that in many places consumers who paid less than £5 per annum were a loss to the undertaking. It was as well to realise that price-making could not be treated as a precise science, and it would be more accurate to regard it as partly a science and partly an art.

Mr. **W. J. Minton** was relieved to hear that meter engineers were still needed. And the meeting was then adjourned for a week.

Tariffs and "Summer" Weather.

The discussion on these two Papers was resumed at the Institution on Thursday, May 5th, before a very meagre audience. In the ordinary course we should ascribe this lack of interest in a very important subject to the increasing length of the days and the call of the tennis lawn, but with the northerly winds we have been "enjoying" recently, when it is certainly more comfortable to be indoors than out, we must suppose it was due to the meeting-curve reaching saturation or to an anxiety about the last train home.

The meeting opened by Mr. Blaikie producing a table showing the serious increase in the coal consumption during the past year for a relatively small increase in units generated. If the units consumed were divided into six- and seven-day groups there was an increase in the fuel consumed per unit in the seven-day group, and a larger drop in the six-day group. When the seven-day group was reduced there was a correspondingly large reduction in the coal bills.

The Unit an Unsatisfactory Basis.

Mr. **Beauchamp** then read a letter from Col. **W. A. Vignoles**, pointing out that for lighting purposes the unit of electricity was an unsatisfactory basis for charging. In Grimsby it was found that unless a consumer took a 100 units per annum he was not profitable to the undertaking. But in 1920 235 consumers, or 9 per cent. of the total, had used less than a 100 units each, while out of 131 consecutive consumers in a main street 51, or 39 per cent., had used less than was necessary to cover their fixed and standing charges. The cost of supplying the consumer using light for 100 hours and consuming 250 units was 1s. 6d. a unit. It was therefore quite impossible to fix any rate per unit that would be fair to all classes of consumer, and the employment of a two-part tariff seemed the only way out of the difficulty.

The Small Consumer Problem.

Mr. **A. N. Rye** also dealt with the difficulty of obtaining a satisfactory revenue from the small consumer. The generating costs were trifling compared with the capital cost in the case of the small consumer. In pre-war days it had been possible to establish a two-part traffic which paid, and was also attractive in comparison with the flat rate, but inadequate maximum prices had killed that. For the inadequacy of the maximum price had the effect of making the better consumer pay the losses on that large block of consumers who remained on the maximum flat rate price, because there was no power to compel them to use the two-part tariff. He instanced the case of a consumer who in 1905 took 10 000 units, and in 1920 not 5 000 units, owing to the combined effect of metal filament lamps, the Summer Time Act and shorter shop hours. It was important that tariffs for small consumers should be considered more in regard to the total money received per consumer than to the price per unit.

"Peaks" and the Cooking Load.

Mr. **W. A. Gillott** said that any tariff worthy of the name should give a satisfactory return, encourage the increased use of electricity for all purposes, be attractive to the consumer and be simple to understand. Of these conditions the last was the most difficult to achieve. With regard to the cooking load he had been much struck by the load curves of a London gas company, showing the enormous height of the peak on Sunday compared with week days. The Sunday output was practically equal to that on weekdays, but on week days the period over which the load spread was 10 to 11 hours, while on Sunday it all fell between 10.30 a.m. and 2.30 p.m. In Newcastle experience had shown the desirability of regulating the fixed charge in accordance with the consumption of the consumer, and the average watts per lampholder had been found in practice a good basis in this respect. The fixed charge thus equalled the average previous year's lighting consumption, so that with a running charge of ¾d. per unit the consumer paid the same as in the previous year with a flat rate of 3¾d. It was only, therefore, on the extra consumption that he benefited from the lower rates, and it was this extra that the supply companies wanted. The result of this tariff was that about 12 000 kW of electric cooking were now installed in Newcastle without any noticeable effect on the peak. In his own house he had about 20 kW of apparatus installed, and his maximum demand seldom exceeded 4 kW with a consumption of 3 500 kWh per year or with a revenue of about £30. For an exactly similar house next door the revenue was not more than £5, while the difference in the two capital charges was so small as to be hardly worth consideration. He did not like the idea of a higher charge per unit to compensate for higher capital charges. Selfridge did not charge 6d. for soap in his new shops, and 4d. in his old shops, but 3½d. in both shops, realising that that was the only way to increase his output.

A Too Rigid Division.

Mr. **W. R. Cooper** called attention to the great convenience of electrically heated water, the lack of which often meant that consumers did not employ electrical appliances so freely as they might. There were many advantages in the two-part tariff that it was impossible to get with the ordinary tariff if the running charge was made low enough. There was the further advantage that the quarterly charge could be adjusted as required. He thought that Mr. Blaikie's division of consumers into six day and seven day was too rigid. What, for instance, would happen to the six-day consumer who worked two shifts. On the other hand, there were many seven-day loads which were extremely useful, such as domestic heating and cooking, street lighting, tramways and sewage pumping. He did not think Mr. Blaikie could justify his use of simultaneous equation, and he was not at all sure whether the accuracy of the figures in the tables was not spurious. What was wanted were the actual calculations so that the method of arriving at the results could be seen.

A SOUND PRINCIPLE.

Mr. J. R. DICK's object in speaking was to show that the electrical industry was not under a specially malignant curse in regard to standing charges. Fixed charges were not homogenous, and the only sound basis was therefore to subdivide them into a great number of categories as had been done in engineering works. Mr. Blaikie had perhaps gone too far in putting six- and seven-day consumers into two distinct categories, but the principle was sound, as they should become more and more analytical. There was no question that the standing coal should be allocated in different proportions from that laid down by Hopkinson, while rent, rates and taxes would probably have to be distributed on some other principle. He was therefore inclined to think that Mr. Blaikie had been quite scientific in finding diversity in the midst of uniformity, each individual being dealt with in his own category. With regard to Mr. Beauchamp's anxiety regarding the gradual growth of the heating and cooking load and its effect on the distribution system, the time would come when the heating and cooking load would completely swamp the lighting load and the question of extensions of the distribution system would therefore certainly have to be faced sooner or later. Using a distribution system on the constant-current principle had been suggested as a solution, but this, of course, would not be applicable to the lighting load. Even so, however, a separate network might be the cheapest way out of the difficulty.

FROM THE BUSINESS POINT OF VIEW.

Mr. W. L. MADGEN thought that the Electricity Commissioners were beginning their work at the wrong end. They should first put the distribution centres into a more healthy condition, as otherwise it would be many years before some undertakings would be worth connecting to the main transmission system. In many of the smaller towns the best electricity consumers were already connected to the mains and he only new business was among the rest. The consumer who paid less than £5 a year was a loss, and the only way to make him a better-paying proposition was some two-part tariff. Unfortunately, the Commissioners showed no signs of approving the raising of the maximum rate, in spite of the fact that a deputation headed by the President had suggested the advisability of a clause making compulsory this method of charging being inserted in the Electricity No. 2 Bill "which was now pending and which he hoped would continue to pend." The position was the more serious since offices and private houses now consumed next to nothing in the summer months, while, if rumours from the Continent were true, and we were shortly to have ½-W lamps, it would be fatal for many small undertakings if they could not have some method of compulsory two-part charging.

METERS AND OTHER MATTERS.

Mr. J. C. ELVY thought that the condition of the meter was a point that should receive more attention. The advantage of a large meter from the consumer's point of view was that he got a great deal of his light for nothing. The wide use of meters necessitated a reserve stock, constant maintenance, and periodical changing, and it was doubtful whether it was worth it.

Mr. H. M. SAYERS thought the division of consumers into six- and seven-day groups was fairly logical. He did not like the idea of putting the traction supply among the seven-day consumers. In fact, traction supply should be given at a lower charge than any other supply. He had found the simultaneous equation method successful in arriving at the ratio of standing coal to unit coal. It was crying for the moon to try and establish a value-for-service charge as it could not be enforced by anything but a practical monopoly. The difficulty in the way of extending the use of domestic electricity was the cost of apparatus and installation. Supply undertakings would never get a large number of domestic consumers until apparatus was given free or hired at a small rental.

"READY-TO-SUPPLY" CHARGE.

Mr. W. B. WOODHOUSE pointed out that as by law undertakers were bound to supply electricity they should also be entitled to charge for being ready to supply it. They should also be relieved from the obligation of supplying unprofitable customers or, alternatively, be allowed to charge a tariff which gave them a reasonable return. For this reason Mr. Beauchamp's Paper was timely, and he hoped that it would have the desired effect.

THE POLITICAL SPECTRE.

The PRESIDENT, in winding up the discussion, said the Papers were a step on the way from the flat rate to multi-part tariff. It was futile to talk of multi-part tariffs except from the point of view of crystallising the opinion of the whole profession and industry on the question. The deputation to the Electricity Commissioners had received fair words, but nothing had happened. In his opinion the delay was not due to the Commissioners, but to political interests behind them.

THE REPLIES.

Mr. BLAIKIE, in reply to the discussion, said that it was quite possible to get absurd results with his simultaneous equations, and they were only valuable if they would stand a test of reconstructing the coal costs for four years in succession. The same results could be obtained by using the Willans law for each unit of plant. It was probably cheaper to run a 1 000-kW machine light in the way criticised than to drop back on small reciprocating sets. Mr. Dick had thought he was wrong in assuming that the present relation of capital to coal cost was only temporary. This was true in undertakings which had a large amount of active capital, but would not apply to new undertakings.

Mr. BEAUCHAMP said that seeing how many people agreed with the two-part tariffs there was no reason why they should not be put into practice straightaway. He had not said that charging on the basis of cost was improper, but it was painful to sell a man an article that he appreciated at less than what could possibly be screwed out of him. They not only wanted to accumulate money, but to attract people who had money to invest it in the industry. The one great difficulty in front of them was the cost of detailed distribution. It was obvious that some gigantic distribution work would have to be undertaken, and the best thing was to get their present consumers to subscribe therefor in some way or other.

Daysohms Low Tension Welder Regulator.

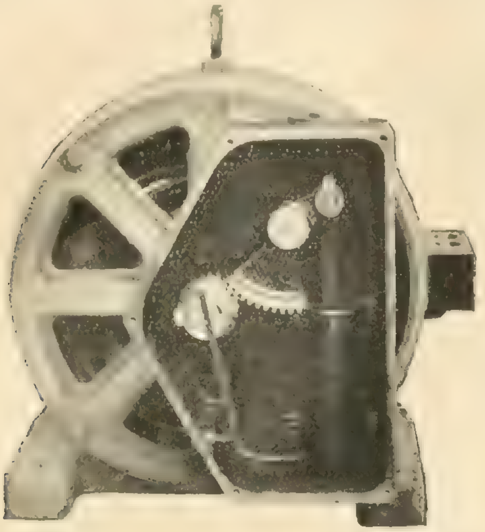
The conditions present in an alternating current circuit when energy is being taken for welding are such as to make the use of some means of limiting the current desirable. In our issue of November 7, 1919, we described an equipment which had been designed by Messrs. DAYSOHMS, LTD., for limiting current rushes in alternating current circuits, and the other day we had the opportunity of seeing its particular adaptation to the control of welders. It may be said that the chief recommendation of the regulator lies in the fact that the current limiting regulator protects one welder against another, whereas in the ordinary way, if two welders out of three working together were stopped, the third would get too much current. There is also the question of protection of the operator. With alternating current of 80 to 110 V unpleasant shocks are not unusual, but the danger is reduced considerably when the voltage is limited to 40 or 60. The apparatus is, it is claimed, also more portable than that used in any other alternating current system, for as it only needs half the kVa capacity its weight is much less. From the power supply companies' point of view such a system of control has the important feature that it keeps the power factor of the system as high as possible.

Turning to the apparatus in more detail it may be said that for the purpose of electric arc welding it is not necessary that the current should be mechanically regulated through its whole range. To enable an arc to be struck and subsequently drawn out with as little as 50 V on open circuit, it is however essential that for an instant, when the arc is being struck, there should be very little choke in series. As soon as the arc is established a relatively greater choke must be introduced to stabilise it, and keep the current within the desired limits. In the case of hand operated electrodes it is impossible to maintain exact current and volt values through and across the arc.

EFFECT OF VARIOUS FACTORS.

Under the same electrical conditions the average values of these factors will vary with various makes of electrodes, various thicknesses of work with the same electrode, and also with various operators doing the same work with the same type of electrode. Also owing to the unavoidable variation of the length of the arc due to the hand of the most skilled operator and a bubbling of the molten metal and slag forming the terminals of the arc, and also owing to the inherent tendency of an arc to set up rapid variations of its own, the instantaneous variations of the volt wave across the arc varies widely from the impressed volt wave.

Rapid variations of the volt wave across the welding arc of 1/2 000th sec. and less have been observed with an oscillograph. It is also impossible for an operator to maintain an arc and read an ammeter at the same time, without varying the current he is taking from that he would be taking when only welding. In consequence of the above facts it is considered quite unnecessary to install either a volt meter or ammeter provided a regulator which can be simply and continuously set between the maximum and minimum current values is used. Under these circumstances the weld itself is the best indicator of whether the correct electric values are being employed.



View of the Daysohms Regulator for Welding Work.

In the Daysohms low-tension alternating-current arc welder there is one adjustment only, *i.e.*, the hand screw shown in the accompanying illustration. A fraction of a turn frees the screw and it may then be slid up or down the slot and clamped at any point, turning the average value of the current down or up precisely as a gas stove may be turned up or down.

Construction and Operation.

The construction and operation of the machine is as follows: The electro-magnetic portion consists of a stator and rotor wound as a two-pole machine, the stator and rotor windings are connected in series with one another and connected in series with the arc. There are rather more turns on one member than on the other.

In one position of the rotor, when the stator and rotor coils are all in one plane, the choke introduced in the circuit is due to the difference between the stator and rotor windings, and is quite small. This is the position for striking the arc. When current flows there is a torque set up between the rotor and the stator. This torque is to some extent counterbalanced by a fixed spring and the speed at which the rotor can turn is regulated by a fixed dash pot.

If the rotor can revolve 180 deg. the choke increases as it turns until it reaches a value due to the sum of the turns on the stator and rotor windings and the current and volts across the arc are reduced to the lowest value, the amount to which this reduction can take place is set by the position of the hand screw. This hand screw terminates in a pin projecting into the case against which an arm fixed to the rotor shaft can engage. The position of the pin fixes the angle through which the rotor can rotate, and therefore the amount to which the current will be reduced. This is the only adjustment.

On striking the arc a very considerable torque is set up between the rotor and stator and the rotor would deflect so rapidly that there would not be time to volatilise the small bit of electrode required to set up the arc, a dash pot is, therefore, provided to control the speed at which the armature deflects, and as the torque at striking is the same irrespective of the ultimate current the regulator is set for, the dash pot is set and does not require any regulation. This dash pot, however, plays a more important part in the regulation. The piston is provided with a valve so that it retards the rotor in one direction only, and it is free to return as rapidly as possible to the zero position under the pull of the controlling spring, with the result that when the arc is struck the volts across it are reduced at a speed controlled by the dash pot, but, if owing to the sputtering of the arc its resistance is suddenly raised, the rotor can drop back and raise the volts, catching it, as it were, before it goes out.

The Multi-Part Tariff Problem.

During the past twelve months the British Electrical Development Association Joint Committee on Tariffs has collected a considerable amount of evidence and opinion on the question of multi-part tariffs for domestic supply, and has considered in detail the difficulties under which many electricity supply undertakings, both company and municipal, are labouring at the present time. As a result of all this work, a deputation from the Committee waited upon the Electricity Commissioners some time ago, a memoranda being subsequently prepared and sent in to the Commissioners for their consideration. We have now received from Mr. J. W. Beauchamp, director and secretary of the British Electrical Development Association, a copy of this memoranda, from which we extract the salient points below.

Multi-Part Tariffs to be Legalised.

The main object of the deputation was to ask that it should be made lawful for the Commissioners to grant requests from electricity supply undertakings to enforce systems of charging which should bring in sufficient to recoup such undertakings for the expense of being "ready to supply," and in addition to allow them to charge for the energy actually used by consumers. In order to effect this, a draft clause for insertion in the Electricity Bill was submitted.

The system of charging contemplated is, of course, that generally referred to as the multi-part tariff, and is already in fairly extensive use for power supply. For domestic use, the fixed or first charge, although based on the capacity of apparatus installed, is often conveniently translated into other simpler terms, such as the size of the house, its rateable value, its floor space, or the number of supply points, all characteristics which are found in practice to bear a reasonable relation to the fixed expense of being "ready to supply," while at the same time they are of such a character as to appeal to the consumer's sense of equity.

The Advantages of Multi-Part Charging.

The memoranda details at some length the advantages of this method of charging from the supplier's, the consumer's and the industry's points of view. To the supplier the method gives a guaranteed return from each consumer, affords the ability to offer to consumers electricity at a flat rate per unit which diminishes with the hours of use, gives relief from risk of energy being used from a lower rate circuit for purposes which are chargeable at a higher rate, and generally encourages the consumer to use appliances which tend to lower the costs of generation and distribution. To the consumer it allows a supply of energy for all purposes from one meter at a single rate per unit, with consequent ability to use apparatus of any kind, simplifies wiring, while the small consumer knows in advance the amount of the principal item in his supply account. To the electrical industry generally, multi-part tariffs will have the advantage of leading to an extended use of electricity, resulting in an increased demand for apparatus and installation work, and a simplification of methods. The system of charging by various flat rates according to the apparatus for which the supply is required leads to a good deal of the supply being given at unduly low rates, while really extensive use is discouraged by too high charges. Under the two-part tariff these disadvantages cease, and the customer automatically secures the service of a falling curve of average price, which, to a great extent, coincides with the fall in the curve of cost of supply.

The Minimum Charge Question.

Although large increases in charging per unit have been necessary in recent years, yet the small consumer has not only secured an advantage, but the expenditure on electricity has actually been reduced in certain cases. This state of things is not altered by modifying the minimum charge arrangements, for merely to increase the maximum charges at present in force would not meet requirements so well as would a multi-part tariff. Experience has shown, however, that there are difficulties in securing the general use of such tariffs, particularly because the statutory maxima for ordinary flat rate metered supplies are not fixed high enough as to make the advantages of a combined fixed charge and a low rate for energy used obvious. This difficulty can only be overcome by propaganda, and if it is considered that the use of multi-part tariffs must remain voluntary, the maximum flat rate should be substantially increased to ensure that each consumer pays sufficient to justify the extension and development of the business.

Extraordinary Variation in Charges.

Attention is next drawn to the extraordinary variation of charges in various districts, and the opinion is expressed that unification schemes for large areas will lead the public to demand more uniformity in tariffs than exists to-day. This difficulty can be overcome so far as the domestic load is concerned by the use of multi-part systems, as consumers can be made to understand that the rate of fixed charge must vary considerably in relation to distance along the distributing lines, while the running rate per unit could be made uniform. The necessity for the use of multi-part tariffs if the development of electricity supply in rural areas is to take place is also emphasised.

The memoranda concludes by pointing out that under existing conditions many electricity undertakings are supplying their small lighting consumers at a loss, whilst the statutory obligation which rests upon them to connect further consumers of this class can only result in their incurring a still heavier loss, to the prejudice of all the consumers and to the detriment of the industry generally. At present, also, the extension of mains is being carried out in the better-class residential areas in too piecemeal a way, in spite of the fact that it is realised that the most economical way of laying down a distribution network is to put in ample metal, so that consumers can be connected up without being subjected to unnecessary charges, and suppliers can ultimately obtain the highest return on the money expended. It is contended that the use of multi-part tariff systems would help to overcome many of these difficulties. They are not difficult to explain to the public, and in practice have the advantage of enabling each unit to be sold at a moderate and nearly uniform price to the different classes of consumer.

The Long Distance Telephone System of the United Kingdom.

A discussion of Sir Wm. Noble's Paper on the "Long Distance Telephone System of the United Kingdom" recently took place before the Liverpool sub-centre of the North-Western Centre of the Institution of Electrical Engineers. An abstract of the Paper was given in our issue of March 20th.

Mr. A. J. **EAMES**, in opening the discussion, referred to early Papers before the Institution in 1896 on telephone exchanges and trunk systems. Subsequent developments in the direction of a common battery and automatic exchanges and in trunk systems had been remarkable up to 1896. Underground sections had been regarded as comparatively detrimental to clear speaking, yet Sir John Gavey, in his 1896 Paper, evidently anticipated progress in this direction, as he drew attention to paper insulation. Now balanced cables with repeaters were considered preferable to alive cables. However, there were still difficulties—*e.g.*, in determining the best distribution of loading. In the London–Liverpool cables, 75 circuits, including phase loss, was the best that could be done in 1916, as compared with 240, in the same size duct, in the London–Manchester cable in 1921. Alternatively, 104 pairs for telephone and 56 pairs for telegraph circuits could be provided with satisfactory results. Such improvements should relieve difficulties in the provision of local exchange plant. The margin for exchange line extension circuits was rather small at the larger centres.

ADVANTAGES OF THE FOUR-WIRE REPEATER.

Mr. H. H. **HARRISON** said the Paper was a valuable record, but did not afford much ground for controversial discussion. Among the steps leading to the present stage of efficiency reference might be made to the early use of Edison's duplex system, the invention of the double amplifier type of repeater, and the design of a network of condensers and resistances to behave externally in the same way as a line with distributed constants. This made possible balancing networks and frequency band filters. The four-wire repeater method, though at first sight an uneconomical solution, enabled the weight of conductors to be greatly reduced by introducing repeater stations on route, and facilitated the use of new methods of multiple telephony. Carrier current multiplex telephony was not new in principle; it was indicated in the work of Hutin and Le Blanc in 1897, and by Cornelius D. Ehret. But none of these earlier workers put their ideas to the test, possibly owing to the lack of a high-frequency galvanometer. Multiplex telephony and telegraphy were still far from general adoption in Europe, owing to the high losses in underground cables. Carrier current transmission gave an absolutely silent line. Loading had revolutionised telephone transmission, and could itself be partially dispensed with by the use of the valve amplifier. The valve, in turn, might ultimately be replaced by a mechanical rotary amplifier.

Prof. E. W. **MARCHANT** recalled some personal experiences of the blizzard in 1916 and the havoc it wrought among telegraph wires in the Midlands. It was amazing that the Post Office did so well, and this was due entirely to the telephonic cables available. The application of the thermionic valve had great possibilities, and it was surprising that Mr. Harrison contemplated its possible replacement by the rotary amplifier. The latter seemed to him inevitably less efficient. The wired-wireless system seemed the best way of effecting multiplex telephony. The silence was due to the accurate tuning, but he supposed it could not be used on an underground line. Yet apparently speech between New York and San Francisco was partly carried out in this way. One would anticipate that the heavy charging currents would make it impossible in such circumstances.

Mr. W. **HOLTTUM** said that the Paper was very opportune. He inquired whether the Post Office had determined the most economical combination of size of conductor, weight of loading and spacing of repeaters in order to give the cheapest transmission line. Would such a combination hold good for any distance of transmission? There were transmission lines in America with 22 repeating points. Did this occasion any noticeable distortion, and was there any practical limit to the number of repeaters? Would a loaded and repeatered line give speech equal to one of similar length that was loaded only? It was a question whether wired-wireless was really impracticable on special underground cables.

CABLING TENDENCIES.

Mr. F. **MERCER** remarked that the tendency was to lay cables with a large number of circuits. A breakdown on such cables was serious unless the traffic could be diverted. If the cable broke down the aerial lines could not cope with the situation. The only remedy was to provide one or two extra cable channels. It seemed wiser to avoid cables containing a very large number of circuits. Loading could not be replaced by repeaters for some time—*i.e.*, until the weight of conductor became so small that a limit for mechanical reasons was attained. Much work could be done to render balancing a simpler and cheaper process. Balancing might be effected on long sections of cable containing several loading coils—even by interconnecting the circuits of a "quad," with suitable condensers, inductances and resistances. Post Office engineers did not anticipate the general adoption of high frequency telephony for some time, as it would profoundly affect transmission schemes. It would be noted that (1) loading, unless continuous, would be uneconomical, owing to the large number of loading points required; (2) the number of repeating stations would have to be largely increased to make up for lack of loading and extra losses involved in high frequency currents; and (3) the tendency to interference between neighbouring circuits would be much greater than with ordinary speed circuits.

Mr. A. J. **PRATT** remarked that the use of repeaters on conductors weighing not more than 40 lb. per mile would reduce the number of long distance cables required in a given period. Large underground chambers would, however, be needed to accommodate loading coil pots, and as the underground system developed it would become increasingly difficult to secure suitable sites for manholes. It would be interesting if the lecturer would give some information on the possible application of continuously loaded cables to land lines, especially in view of progress in the manufacture of such cables. Mr. Pratt also referred to the modern methods of securing balancing, much of the work being done on the road, and inquired what progress had been made by manufacturers in balancing lengths of cables in their works during manufacture.

Engineering Conference, 1921.

We understand from the **INSTITUTION OF CIVIL ENGINEERS** that arrangements have been made to continue the series of engineering conferences which were interrupted by the rebuilding of the Institution premises and the war.

The conference this year will be held on Wednesday, Thursday and Friday, the 29th and 30th June and the 1st July—the mornings of those days being given to discussions upon selected topics, and the afternoons to visits to engineering works.

For the purpose of the meetings, the Conference will be divided into seven sections: (I.) Railways, Roads, Bridges and Tunnels; (II.) Harbours, Docks, Rivers and Canals; (III.) Machinery; (IV.) Mining and Metallurgical Processes; (V.) Shipbuilding; (VI.) Waterworks, Sewerage and Gasworks; (VII.) Electricity Works and Power Transmission. The topics to be discussed at the meetings of each section will shortly be notified, and it is intended that prints of the Notes introducing the several subjects shall be made available before the date of the Conference. The complete programme, including the list of visits to works, will, it is hoped, be also ready for issue early in June.

The twenty-seventh James Forrest Lecture will be delivered by Sir George T. Beilby, F.R.S., Assoc.Inst.C.E., on the afternoon or evening of Tuesday, the 28th June—this date having been arranged especially for the convenience of members who may come from a distance to attend the conference. After the lecture, the President of the Institution will receive the members in the library.

Incorporated Municipal Electrical Association.

The following preliminary arrangements have been made for the twenty-sixth Annual Convention of the Incorporated Municipal Electrical Association which is to be held at Dundee from Monday, June 13, to Friday, June 17. The headquarters of the Convention will be at the Grand Hotel, St. Andrews.

On *Monday*, Badges will be issued at Headquarters in exchange for signed registration cards.

On *Tuesday*, at 9.30 a.m., the Convention will be opened at the Victoria Art Galleries, and the Lord Provost of Dundee (Bailie Alex. Spence) will extend a welcome to the Association. An address by Major H. Richardson, O.B.E., M.C., (president of the Association and General Manager and Engineer of the Dundee Electricity Supply Department) will follow, and a Paper by Mr. E. Cross (Rotherham Electricity Department) and Mr. C. W. Charlesworth (Wolverhampton Electricity Department) on "Financial and Business Aspects of Electricity Supply," will be read.

At 1.30 p.m. there will be a luncheon at the Albert Hall, Dundee, by invitation of the Electricity Committee of the Dundee Corporation.

At 2.45 p.m. a visit will be paid to the works of Messrs. James Keiller & Sons, Ltd., and the Corporation Electricity Works, Carolina Port.

At 8 p.m. there will be a reception at the Victoria Art Galleries by the Convenor of the Electricity Department (Councillor J. Hynd, J. P.). This will be followed by a social evening.

On *Wednesday* the Convention will temporarily move to Perth, where at 10 a.m. a meeting will be held in the City Hall, and a Paper on "Modern Boiler-House Practice," by Mr. David Wilson (Messrs. Babcock & Wilcox, Ltd.), and Mr. W. M. Miles (Electricity Supply Department, Sheffield) will be read.

Luncheon will follow at 1.30 p.m. by invitation of the Corporation of the City and Royal Burgh of Perth, and at 2.30 p.m. there will be a visit to the works of Messrs. Pullars' Dye-Works, Messrs. John Dewar & Sons, and also Scone Palace. Members will return to Dundee in the early evening.

At 9.15 a.m. on *Thursday*, Conveyances will leave Albert Square, Dundee, for Monikie, where a meeting will be held in the Pavilion, at 10.15 a.m., a Paper by Mr. I. V. Robinson, B.E.A.M.A., on "State of the Electric Supply Industry after the War," being read. At 1.30 a luncheon will be held at Monikie by invitation of the Dundee Water Commissioners. Conveyances will leave for Dundee at 3 p.m., and at 7.15 p.m., the Annual Dinner will be held in Albert Hall, Dundee.

On *Friday*, at 9.15 a.m., there will be a meeting of the Council in the Board Room, Victoria Art Galleries, and at 10 a.m., the annual general meeting will be held in the Victoria Art Galleries. In the afternoon there will be a motor char-a-banc trip to Arbroath and also a golf match between teams chosen by the President and Vice-President will be held at Carnoustie.

GENERAL INFORMATION.

Accommodation.—The hotel accommodation in Dundee is limited, but the following hotels in the district are available : *At St. Andrews:* Marine Hotel (Russacks), Grand Hotel, Athol Hydro Hotel, West Park Hotel, Alexandra Hotel, Seaton Court Hotel. *At Perth* : Station Hotel, Royal British Hotel, Royal George Hotel, Salutation Hotel. *At Carnoustie* : The Bruce Hotel and Station Hotel. *At Monifieth* : Panmure Hotel. Members are requested to make their own arrangements for hotel accommodation.

Travel.—The Railway Companies have been approached with a view to securing special travelling facilities for members, &c., residing outside Dundee during the Convention week.

Attendance Register.—Those entitled to attend the Convention will be provided beforehand with a Registration card, which, after being signed with the usual signature of the recipient, is to be handed to the Secretary on arrival at the Convention. A badge will be issued in exchange for such signed registration card.

Communications. Prior to the 7th June all communications should be addressed to the Secretary of the Association at the Electricity Works, Factory Lane, Croydon. From 8th June, and during the Convention, communications should be sent to the Secretary, Convention Office, Grand Hotel, St. Andrews.

The Latest Benjamin Products.

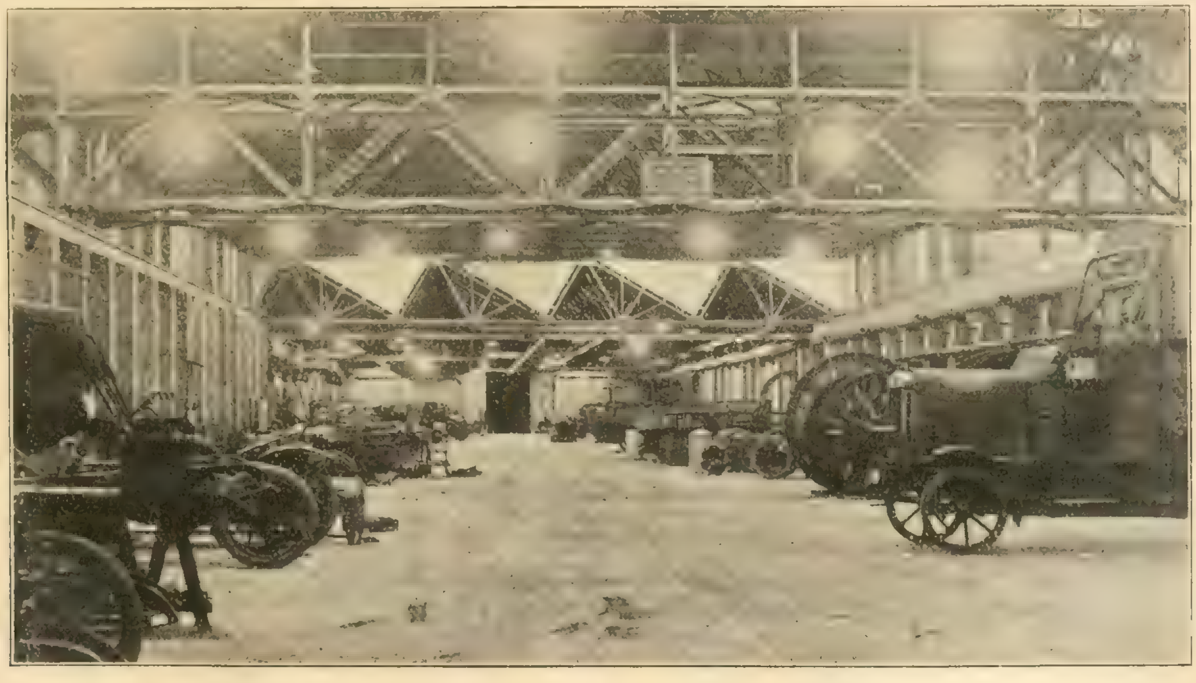


FIG. 1.—A TYPICAL RESULT OF USING "BENJAMIN" FITTINGS.

A comprehensive catalogue with a title similar to that of this article has been issued by THE BENJAMIN ELECTRIC, LTD. The information is arranged in an enterprising manner, features being the way in which illustrations and dimensions of typical reflectors are assembled and the excellent photographs, taken by artificial light, of a considerable number of lighting installations.

Under the heading of "General Information" a number of fundamental principles of adequate lighting are indicated and a chart summarises in tabular form the various material advantages of correct lighting in any industry. A telling illustration in this connection is the monthly chart of reported accidents, which is a maximum in the dark winter months and least in the summer when more daylight is available. This is reproduced in Fig. 2. Fig. 1 shows a typical method of lighting in a garage and is indicative the excellent result obtained by modern methods. Attention is also drawn to the distinction between local and general lighting and a combination of the two, and types of reflectors are briefly discussed. Charts showing the method of deciding the spacing of units, and the selection of the requisite types to yield a certain foot-candle intensity are next provided and there is a useful table setting out suggested values of illumination for various industries.

Attention is next devoted to industrial lighting. Here the variety of reflectors illustrated is considerable. In general they are either of the intensive distributing or concentrating type. Fig. 3(*b*) shows a distributing type of the detachable flange pattern which appears particularly suited for industrial lighting. It is a parabolic type, useful for lighting vertical areas. Another interesting development is the "anti-glare" pattern of reflector, which combines the use of a fairly shallow upper reflector with a lower and more or less conical diffusing screen. The chief feature of this form of unit is that it enables a wide distribution of light to be obtained—but at the same time avoids the exposure of the bare filament—always a difficult problem in lighting large areas. The steel reflectors, largely used for local lighting of machines, form a distinct section. A typical intensive type is seen in Fig. 3(*c*).

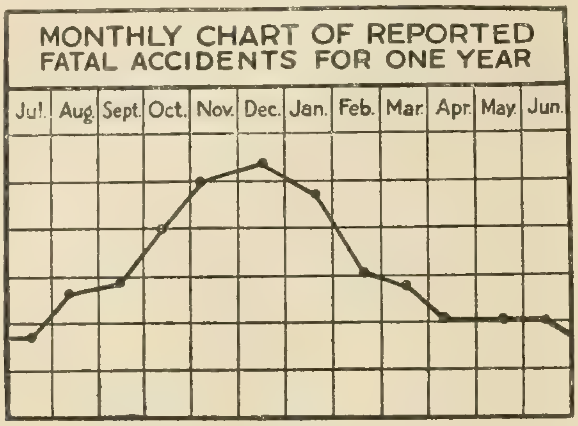


Fig. 2. Showing How the Number of Accidents Depends on the Illumination.

Semi-indirect units are also illustrated. Fig. 3(*a*) being an enclosed type which would appear to have advantages when deposits of dust are apt to give trouble; it will be noted that the canopy is detachable. One special device shown hereabouts in the catalogue deserves mention, viz., a special lighting unit for illuminating boiler and other liquid level gauges. Such gauges are not always as well lighted as they should be considering the trouble that a failure to locate the level of liquid may occasion.

Section three deals with lamp-holders of various kinds and "dim-a-lite" devices, section four with shop-window lighting. Here the advantages of the standard method of lighting windows by lamps mounted in proper reflectors and concealed along the top-front of the window are emphasised. The contour of the reflector can be selected according to the dimensions of the window, with a view to modifying the distribution of light and getting even illumination. A form of reflector specially designed for use with gasfilled lamps is shown in Fig 3(*d*), which illustrates a reflector of the extensive type and intended for 60 W or 100 W gasfilled lamps.

The remaining sections deal with signalling devices and various accessories. The catalogue as a whole forms a remarkable complete production which should be of considerable service to lighting contractors and others concerned with illumination.

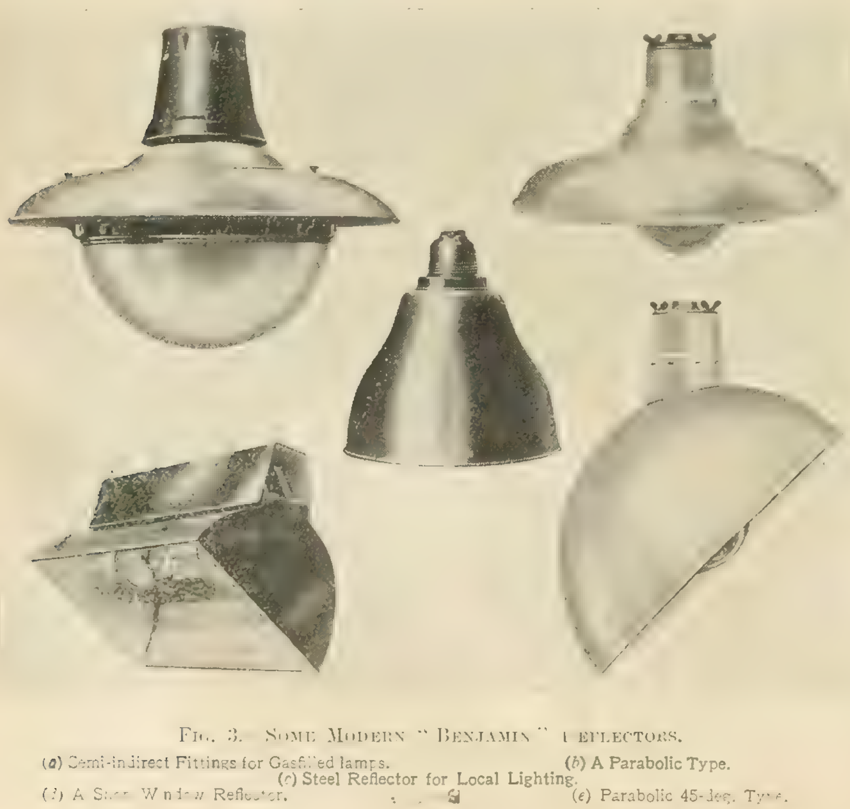


Fig. 3. Some Modern "Benjamin" Reflectors.

(*a*) Semi-indirect Fittings for Gasfilled lamps. (*b*) A Parabolic Type. (*c*) Steel Reflector for Local Lighting. (*d*) A Shop Window Reflector. (*e*) Parabolic 45-deg. Type.

Industrial Position of Sweden.

A report on the commercial and industrial situation in Sweden at the close of last year has been prepared by Mr. H. Kershaw, Commercial Secretary to H.M. Legation at Stockholm. It is pointed out that the country's resources in valuable raw materials are enormous, but it has also been realised that though the export of raw materials is useful, it is of still greater national importance to develop manufacturing, and to work up the native materials at home. The high cost of coal helped to push up costs of production in 1919 and early in 1920. It is uneconomical to burn wood, in spite of its existence in vast quantities, and Swedish industries have grown up on the basis of a relatively cheap supply of coal. When coal rose to about Kr. 150 and Kr. 160 a ton, manufacturers began to feel the injurious effects of increased costs of production. In consequence of these adverse factors, many suggestions were made to press forward schemes for the extensive utilisation of the great waterfalls for the generation of electrical energy for power and lighting on a commercial basis. Coal has now fallen to about Kr. 70 a ton, and some of these schemes may be postponed.

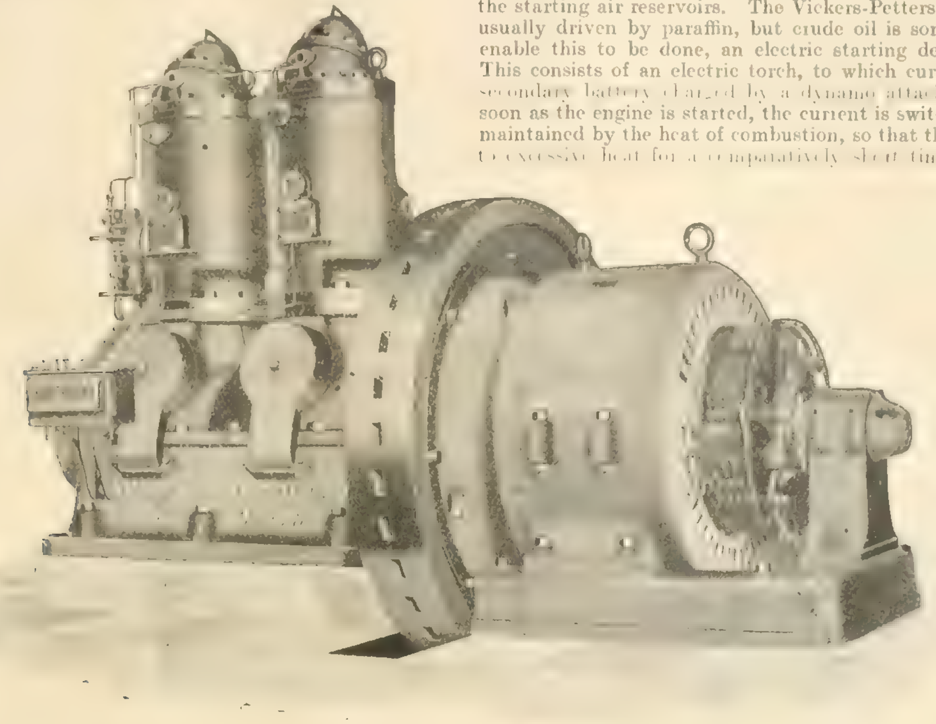
Probably the most serious factor in the industrial situation is German competition, owing to the very low rate of exchange of the mark. The Swedish Press is, therefore, devoting much attention to the subject of the low rates of wages in Germany and the ability of that country to compete with Swedish manufacturers of nearly every kind of commodity on the Swedish market. Owing to the drop in prices, the falling off in the demand for goods and forced curtailment in production the position is difficult at present.

British Agencies.

According to Mr. Kershaw, the time has arrived when British manufacturers and exporters must seriously consider the methods of conducting their agencies in Sweden. There has grown up during recent years a considerable number of very experienced import and export merchants —whose business is well supported by the great banks. A feeling of keen resentment has gained ground in Sweden towards the prevailing custom, which often compels them to carry on British import trade through the medium of travellers from other parts of Scandinavia, who visit the country periodically in much the same way as a commercial traveller from London makes his quarterly visits to the provinces in England. An enormous amount of trade has been and is being lost to British manufacturers for no other reason than that many Swedish traders are placed in the position of being required to carry on their British import business through such indirect channels. With the rapid growth of harbour facilities at Swedish ports, especially Gothenburg, Stockholm and Malmö, and with the building of "free" ports and warehouses, all of which are well supported by a rapidly increasing mercantile marine, a gradual but none the less definite and organic change is taking place in the country. The present is a most appropriate moment for considering the matter in all its bearings. German travellers are visiting the country in large numbers, and many applications are being received from German firms for agents in Sweden. British travellers are warned against the too-prevalent habit of confining their visits to a few of the larger towns, such as Stockholm, Gothenburg, Malmö, Norrköping, and missing, on the ground that it entails too much trouble, the considerable number of smaller towns where a thriving business is to be done. German travellers never fail to go out into the byways and hedges, and this is one of the principal reasons for the very large trade which Germany built up in this country before the war. The Swedish market has been seriously neglected by British exporters and manufacturers in the past, but it is encouraging to observe that representatives of important British firms are visiting Sweden in increasing numbers, though these numbers are by no means sufficient in view of the large amount of trade which awaits enterprising firms.

Vickers-Petters Oil Engines.

An interesting series of semi-Diesel engines are now being made by Messrs. VICKERS-PETTERS, LTD. Our illustration shows one of these sets, the particular one illustrated being made in two sizes, with outputs of 70 H.P. and 100 H.P. respectively. They are designed for direct coupling to a dynamo and are mounted on concrete beds.



VICKERS-PETTERS SEMI-DIESEL ENGINE DIRECT-COUPLED TO DYNAMO ON CONCRETE BED.

It is claimed for these engines that, in contradistinction to the usual semi-Diesel plant, they are capable of running economically on light loads, this valuable property being obtained by the use of a patent light running gear, which consists of an arrangement whereby a portion of the full supply is injected at a point well in advance of the point of normal injection. Vaporisation of the fuel thus injected is completed before the main charge enters the cylinders, and there is, therefore, always a nucleus of perfectly vapourised gas to promote and assist ignition and combustion when the remainder of the fuel enters the cylinders.

Another interesting feature is the safety rapid starting burner, which enables the engine to be started from cold in one minute, and the burner to be extinguished immediately the engine is started. This apparatus is rigidly attached to the engine, and is operated by compressed air from the starting air reservoirs. The Vickers-Petters semi-Diesel engines are usually driven by paraffin, but crude oil is sometimes employed. To enable this to be done, an electric starting device has been devised. This consists of an electric torch, to which current is supplied from a secondary battery charged by a dynamo attached to the engine. As soon as the engine is started, the current is switched off, and ignition is maintained by the heat of combustion, so that the torch is only exposed to excessive heat for a comparatively short time. The batteries used for this purpose have a capacity of 100 Ah. It may be added that the governor automatically regulates the stroke of the fuel pump, the moment of injection and the timing of the ignition thus reducing the stress to a minimum and ensuring regularity in working. The working parts are enclosed, and there are no valves, lappets or levers. These engines are now being made at Ipswich in sizes up to 300 H.P.

The Telephone Inquiry.

The Select Committee on the Telephone Service has continued to take evidence. Last week Sir Wm. Noble and Major Purvis were heard and some evidence was also given by representatives of Glasgow Corporation.

COMPARISON WITH OTHER COUNTRIES.

As to which country possessed the best service, **SIR WM. NOBLE** said he believed the statement made by American engineers before the war that America had the best system was correct. He had been to America in 1919, and he came to the conclusion that the telephone system in New York, Chicago and Washington was not any better than our own system in this country at present. The American system, like ours, had suffered during the war, but it was improving fast, and it would certainly be up to the standard sooner than ours, because it was better than ours before the war. As to other countries—Belgium, France, &c.—his view was that it was not so good as the service which was provided by the National telephone system. There was no question that ours was the second best system. Wireless telephones were hopeless for local purposes.

Asked if he could suggest anything to improve the general conduct of the Post Office, witness replied: "If you mean as regards the telephone service, I believe as to 99 per cent. of the officials all that they want is to be left alone and to get on with the job." With all that newspaper campaign going on, things were not normal. While they fell behind during the war, they were now beginning to pull up. When the service was taken over by the Post Office it was not so efficient as the American system. The Post Office began to spend money on it and had there been no war our service to-day would have been better.

In regard to automatic telephony, Sir William said that they now had 15 automatic exchanges, and each one was working satisfactorily. They had tried in those stations four systems, and were about to try a fifth. Of the four already tried they were not satisfied with one, and it would not be further used.

On Wednesday the Committee took the evidence of two members of Glasgow Corporation, Councillors T. Stark Brown and W. B. Smith.

Councillor **SMITH** said the Corporation had asked on what terms the Government would be prepared to lease or to sell to them the telephone undertaking in the Glasgow area, but the Postmaster-General would not entertain the proposal. For a few years the Corporation carried on a telephone undertaking over an area of 143 sq. miles, but in 1906 the undertaking was transferred to the Post Office, the Corporation then believing that as they had made a success of the system it would be nothing but a continued success if the telephone services were unified under the Government. The Corporation were of opinion that they could run a better and much cheaper service than the present system. During the time that the Corporation had its telephone service there was no friction or trouble with regard to trunk calls. The service under the Post Office had gone down. Their view was that the Government were making such a mess of it that they wanted it into their own hands to improve it. They were satisfied that the charges were beyond the capacity of the ordinary user to pay. He preferred the message rate, but in his opinion the rental should be reduced from £8 to £5. That was ample at the time the Corporation had the service. He thought they could run it at a £5 rental and make a profit with a message rate. Three halfpence was a fairly high rate. Large users should not receive a rebate. As large users paid the same rental, their messages cost less on the average than small users' messages. Better control would be obtained by a committee on the spot than by the present system, but the working to-day was pretty fair. It was on the score of price that the Corporation desired to regain control of the telephones.

VIEWS OF COMMERCIAL MEN.

On Monday Mr. A. J. **HOBSON**, President of the Association of British Chambers of Commerce, gave evidence and stated he could not see any objection to a flat rate, with limitations. It occupied the same position as the season-ticket system on the railways, and he could not see why it could not be extended to the telephone subscriber.

When he was in New York he expected to get a call from his bedroom to Chiacgo in under five minutes, but here he did not expect to get a call from Sheffield to London under an hour. A Select Committee could not adequately examine the administration of the telephone system, as it was an intricate technical problem. The Government should have appointed a small committee of experts, with full powers of investigation. The development of the telephone system in the fullest sense had never been comprehended or undertaken seriously by the Post Office.

Getting Rid of the Experts.

The National Company had on its staff, when the undertaking was transferred to the Post Office, officers whose knowledge of telephony was second to none in Europe and it paid those officers salaries corresponding to their work. The Post Office announced that no officer of the company would be taken over whose salary exceeded £700 per annum; it deliberatley cast off those men, and it ruthlessly scrapped the greater part of the company's organisation. Instead of devolution there was concentration, and an efficient business system gave way to the bureaucratic control of a Government Department. Telephones were thrown in with all the other business of the Post Office, and the telephone administration was willy-nilly squeezed into the inadequate confines of the old organisation. The telephones had been under complete Government control for over nine years, and the time was ripe for removing the telephones from Post Office control. The system should be placed under some body analogous to the Port of London Authority, and it should be administered by the best experts to be obtained and (as it was hopeless to expect to obtain the best experts at Post Office salaries) under a board of business men with a paid chairman of the highest calibre.

Electricity Districts.

The Electricity Commissioners have extended the time until July 30 for making representations in regard to the determination of the North Lancashire & South Cumberland Electricity District, and for submitting schemes for improving the electricity supply organisation in the area.

Referring to the recent decision of the Electricity Commissioners in regard to the Mersey & West Lancashire Electricity District, Mr. F. C. Wilson, chairman of the Liverpool Tramways Electric Power and Lighting Committee, stated last week that the Wirral Committee would apparently be in the position of authorised undertakers, and responsible for the supply of electricity throughout their area. He did not know whether it was the intention of the Commissioners to authorise the Wirral Committee to expend money in the purchase of new plant for supplying that area, or whether it was the intention that supply was to be obtained from the joint authority. He could say on behalf of the other authorities in the joint authority's district that every effort would be made by the joint authority to assist, and work in harmony with the Wirral Committee, so as to ensure to the whole Merseyside area a cheap and efficient supply of electricity, and thus promote the trade and prosperity of the whole district. The area of the Mersey Power Company was included in the joint authority's district, as was also a new area lying to the south-west of the present district of supply of the company. He was sure it would be the wish and policy of the joint authority, when constituted, to do everything in their power to make the fullest use of the company's generating plant, and to assist the power company to extend their area and develop their resources as a distributing authority. Before the Order could be finally drafted certain additional powers would have to be obtained, and as those powers were embodied in the Electricity Supply Bill, 1921, a conference of local authorities had passed a resolution requesting that the various local authorities in the district should ask their members of Parliament to support the Bill in order that it might be passed this session.

Another Electrician's Strike.

While the strike of electricians in Scotland is still unsettled, there is a prospect of an extensive and prolonged strike in this country also. Apparently, a good many are out already on the question of a reduction in wages, and there is a possibility that the trouble may extend. The Executive Council of the Electrical Trades' Union, which met in Manchester last week, decided to resist the agreed wages reductions in the shipbuilding trade, and that if any attempt were made to enforce them their men should cease work at once. The affected members of the Union have already been called out. As a sequel the men have come out in all the shipping centres, and many employees of private firms have also struck. There are said to be 22 000 electricians on strike, including 2 000 in London.

The National Federated Electrical Association recently put before the men a proposal that wages should be reduced by 5 per cent. on May 9 and by over 5 per cent. on July 9. At a conference of the workers affected, which was held in York on April 20, it was decided to take a ballot of the members on the employers' proposals. The actual voting figures have not been issued, but the official statement is that there was a great majority against the reduction. On receipt of the result of the ballot the district secretaries sent notices to the members of the Union that they are not to turn up for work. In the Newcastle area about 1 000 men who are employed in shipbuilding yards or by electrical contractors are affected, but the men employed by the Electric Supply and Tramway services are not involved in the dispute, as their wages are fixed by the District Industrial Councils. Through the shipbuilding slump hundreds of the electricians on the Tyneside were already out of employment, and the new development will aggravate the situation. The reductions proposed on the Tyne represent about 6s. a week.

Parliamentary Intelligence.

LOCHABER WATER POWER BILL.

The Select Committee of the House of Commons which has been considering this Bill, found the preamble proved on the 4th inst., and the clauses were adjusted on the 5th inst.

Mr. A. W. Tait, chairman of the British Aluminium Company, gave evidence in support of the Bill, more particularly in regard to the financial clauses. He said that aluminium was regarded as a key industry.

Mr. Wm. Murray Morrison, general manager of the British Aluminium Company, said the opponents of the scheme of 1918 were now their friends in the Spean valley, and a considerable amount of support was also forthcoming in the Spey valley. The contribution of the flood waters of the Spey was of the greatest importance for their scheme. One of the handicaps of the aluminium industry in this country had been the relatively small amount of water power at their command. If they found they could not get the water power they desired in this country, there were other countries in which it was available. They desired, however, to keep the industry in Scotland as far as they could. It had always been their policy to employ local labour, and satisfactory accommodation was provided for them. The scheme would give employment to several thousands of men. The flood water of the Spey was useless for commercial purposes unless one could store it, and in the Spey valley there were no facilities for storing the large amount required. The character of the valley was such as to render it unsuitable for the utilisation of the water power. To get a drop of even 60 feet they would require to go back three or four miles and hold up the water, whereas under their scheme they hoped to get a minimum drop of 690 feet. If power were wanted in the Spey valley for lighting and less expensive industries than the manufacture of aluminium there were important tributaries of the Spey, the water of which could be harnessed. They had between 30 and 40 petitions from the Spey valley in favour of the scheme.

Mr. C. S. Meik, consulting engineer, said the scheme under consideration was the embodiment of his recommendations. The rainfall experts had given them a general idea of what the rainfall might be expected to be in the district; the scheme was bound to have a substantial effect on the flooding on the upper parts of the Spey. By absorbing $1\frac{1}{2}$ inch of rainfall in 24 hours large areas down below which were usually inundated would not be inundated at all. He said that there was no suggestion in the various reports of the Water Power Resources Committee that the Spey valley presented possibilities for the utilisation of the local waters for power purposes except for installations ranging from 100 to 2 000 h.p. The erection of such plant would not be interfered with by the present scheme. The promoters hoped to get 18 per cent. of their power from the Spey for 10 per cent. of the expenditure.

In cross-examination witness said it was impracticable to utilise the Roy watershed instead of the Spey valley; it was on the wrong side of the Spey and the expense would be prohibitive. The low summer flow was enough to keep the River Spey in good condition.

Mr. W. J. E. Binnie, consulting engineer, gave evidence as to the rainfall, &c. He said that, in so far as the scheme would prevent the flood water from overflowing the banks of the Spey, the velocity of the flow would be greater and the scouring action thereby improved.

Mr. W. H. Armistead said he had been employed by the British and foreign Governments to advise them upon fishery matters. He understood objection was taken to the effect of the scheme on the spawning beds both of the Mashie and the Spey. As to the Mashie, there would be no interference with the spawning beds there, and as to the Spey, he felt confident in saying that for five miles above the site of the dam the spawning was more wasteful than below the river. That was partly due to dispersion by flooding and heavy deposits of silt and sand. The apparent spawning ground on the Upper Spey was much greater than the actual spawning ground. One of the great advantages of the dam would be security for the spawning grounds. Although he believed it undesirable that there should be access for the fish to the upper reaches, the promoters told him to do all he could to meet the view of the Spey Fishery Board. The original idea was to have a fish ladder in the dam, but he favoured a tunnel, and at great sacrifice the promoters agreed to that method of giving access to the fish. As a result of what was proposed, there could be no injury to fishing.

In cross-examination he said he had satisfied himself that the flow of water and the aperture provided, as well as the general conditions, would prevent any injury to the spawning interest and to the maintenance of stock.

The Opposition.

Several witnesses gave evidence in opposition to the scheme, mainly in order to show that the salmon fishing industry would be prejudiced.

Mr. K. P. Hawksley thought a flow of 100 million gallons of water down the Spey would be a fair compromise and would meet the wishes of the fishing interests. It was far better in their interests to have an uncontrolled, fluctuating flood rather than a regular flow throughout the year.

Mr. W. D. Johnstone, chairman of the North and South Esk Fishery Boards, considered that the effect of the abstraction of water from the Spey would be detrimental to the fishing. There would be a loss of spawning ground and a loss of flow of head water throughout the whole course of the river. He did not regard it possible to give the fish reasonable access to the upper parts of the stream with a dam 30 ft. high. It was not possible to eliminate altogether in any kind of scheme the injury resulting from the limitation of the summer freshets.

The Duke of Richmond and Gordon also gave evidence against the Bill, and counsel having addressed the Committee, the chairman (Sir Harry Samuel) announced that the Committee, after giving the greatest care and consideration to the whole of the question, were of opinion that the preamble of the Bill was proved, subject to counsel submitting clauses to carry out the following alterations: The natural flow of the upper Spey above the intake at Loch Laggan was to be abstracted up to a flow of 30 million gallons in 24 hours. In addition, the Spey Fishery Board should have the right to demand on 12 days in the year, not necessarily consecutive, that water shall not be abstracted until the flow of the river reaches 100 million gallons. A clause would also be inserted laying down that the conduit at the intake at Loch Laggan shall be increased by 75 per cent.

On the 5th inst. when the Committee met in order to adjust the clauses of the Bill, Counsel for the promoters said the conduit at Laggan would be constructed so as to allow a capacity of 1 600 cubic feet per second. There was no difficulty in substituting 30 000 000 gallons flow per day above the intake in the upper part of the Spey for the figure of 25 000 000 originally proposed. As to the third condition of the Committee that the Spey Fishery Board should have the right to demand a flow of 100 000 000 on 12 days of the year, the Spey Fishery Board, after consideration, preferred to have a flow of 40 000 000 gallons per day on such days all the year round as the flow of the river allowed it. After some discussion the Committee allowed this alteration.

SAFEGUARDING OF INDUSTRIES BILL.

In the House of Commons on Monday, Mr. Baldwin, President of the Board of Trade, moved the two resolutions which are to form the basis of the Government Bill for the safeguarding of Industries. The complete text of these resolutions appeared in our issue of the 8th ult.

The first resolution relates to the protection of key industries, and provides that for a period of five years a customs duty equal to $33\frac{1}{3}$ per cent. of the value of the article shall be charged on all imported articles specified in the list, and on any other articles which may from time to time be included by the Board of Trade.

The second resolution is intended to prevent dumping. It is proposed to authorise a charge, in addition to any other customs duties to which they are already liable, a customs duty equal to $33\frac{1}{3}$ per cent. of the value of imported articles in respect of which the Board of Trade makes an order, on the ground that they are being sold or offered for sale in the United Kingdom at prices below the cost of production in the country of origin, or at prices which by reason of depression in the value in relation to sterling of the currency of the country in which the goods are manufactured are below the price at which similar goods can be profitably manufactured in the United Kingdom.

There was an animated discussion on the resolutions, which was continued on Tuesday, and ultimately an amendment to limit the operation of the $33\frac{1}{3}\%$ duty to one year was defeated.

GRIMSBY CORPORATION BILL.

A Select Committee of the House of Lords recently considered this Bill, which confers further powers in regard to the construction of tramways, the use of trolley vehicles, &c.

Mr. J. B. **Hamilton**, manager of the Leeds City Tramways, said the additional tramways proposed were necessary to complete the system. Trolley vehicles had a number of advantages; they were particularly useful where streets were too narrow for laying down tramlines and for serving scattered districts. The Ministry of Transport made no objection to any of the proposed clauses.

The committee agreed to allow the Bill to proceed as to trolley vehicles, subject to certain amendments and to disputes coming before the Transport Ministry.

Legal Intelligence.

A Motor Agreement.

Last week Mr. Justice Peterson heard an action by the Rose Street Foundry and Engineering Company, of Inverness, against the Submersible Motors (Ltd.), for an injunction to restrain the defendants from selling or offering for sale in Scotland submersible motors or their parts, or alternatively for the rectification of an agreement dated August 10, 1916, by which defendants granted the plaintiffs the sole right to manufacture and sell such articles under defendants' patents.

After hearing evidence his Lordship said in substance the question which arose out of the construction of the agreement of 1916, was—Had the plaintiffs the sole right of supplying customers in Scotland or had the defendants the right, notwithstanding the licence granted by the agreement, to manufacture the patented articles, or cause them to be manufactured in England for supply to customers of their own in Scotland? It was notable that in the provisions with regard to improvements which might eventually override the original invention, defendants were precluded from "constructing, making use of, or vending them in Scotland." A provision with regard to the termination of the licence of the royalties did not exceed a specified sum also seemed to contemplate that the activities of defendants were to be in England and not Scotland. On the whole, he thought the agreement of 1916 constituted an exclusive licence to plaintiffs for the manufacture and sale of the patented articles in Scotland and defendants were not entitled to sell the patented articles there in competition with the licensees. There would be an injunction to restrain defendants from selling the patented articles in Scotland.

An International Credit Scheme.

We have frequently referred to the urgent necessity of taking steps to revive trade and commerce, and especially to develop the export trade, and we have drawn attention to various proposals that have been put forward, including the "ter Meulen" scheme, with the object of assisting exporters by creating credit. The International Credits Office of the League of Nations (Trafalgar House, Waterloo-place, London, S.W.), of which Sir D. Drummond Fraser, Joint Managing Director of the Manchester, Liverpool and District Bank, was recently appointed organiser, has just issued a short booklet which gives a clear account of the operation and effect of the International Credits (or "ter Meulen") scheme. It is rightly pointed out that the state of the commerce and industry to-day—with unemployment rife everywhere, and goods piling up unsaleable in one-half of the world, whilst the other half is unable to purchase necessary commodities—is forcing business men to recognise that special measures are needed to restore credit. It explains that the "ter Meulen" scheme is not a panacea, but is merely an attempt to assist traders in impoverished countries to import on credit.

How It Is Done.

The Government of such a country will inform the International Financial Commission which is to be formed by the League, what national assets it is willing to pledge as security for credit. The Commission will then decide what is the value of these assets in gold, and will authorise the country in question to issue Government bonds up to that value. These bonds will then be available to be lent by the Government to its own traders, who can use them as security in order to obtain credit from traders in other countries. The Committee will see that the amount of bonds issued does not exceed the "gold value," and will also receive the revenues. It may, therefore, be expected that traders will recognise the bonds as valuable security and grant credits on them.

The Scheme at Work.

The scheme will make no real alteration in the way in which business is done at present. The importer and exporter will arrange all terms together in the ordinary way (purchase price, rate of interest, length of credit, &c.). The importer will then borrow from his Government for the period of the credit he has arranged with the exporter, and the necessary amount of bonds to deposit as security. If the importer fulfils all his obligations under his contract, then, at the conclusion of the transaction, the bonds will be returned to him, and he will give them back to his Government. They will then be cancelled; but the Government may create new bonds in place of those cancelled up to an equivalent sum, which will be available for a fresh transaction.

If, however, there is default, the exporter detains the bonds and may either hold them as an investment, or sell them and pay himself out of the proceeds. If he decides to sell, he must first offer them to the issuing Government, so that it may redeem them against payment in full of the exporter's claim. If it declines to do this, he may sell them in the open market. If on sale they realise more than the amount of his claim he must give the balance to the Government that issued them, but if they realise less he has a claim for the deficiency against the importer, but not against the importer's Government.

Special Cases.

The scheme appears to be also valuable in cases where credits are required for long terms, and it can be adapted to work in conjunction with export credit schemes, such as those which are to be introduced in this country and in France. Indeed, the British Government has agreed to accept ter Meulen bonds as first on their list of approved forms of security for transactions under their Export Credit Scheme.

The great advantage of the ter Meulen scheme is its flexibility. It does not place a large amount of money all at once at the disposal of the borrowing country, but provides a reservoir of credit which can be drawn on when required, and which, so long as it is not drawn upon, places no burden on the "borrowing" State. The authors recognise that every scheme for international credits may be open to objection, but they claim that this scheme has many advantages, and that it provides a means for effectively mobilising the whole credit of a country behind each of its individual traders.

Inauguration of the Scheme.

For the purpose of making a start with the practical inauguration of the scheme the Governments of "importing countries" must apply for an issue of bonds, and the best way to get these Governments to do so is to stimulate a public demand in those countries for such a step. Exporters in this country can also assist greatly in creating such a demand by impressing on any foreign importer, who cannot obtain credit without providing some special security, that this scheme provides his best chance of obtaining financial facilities on reasonable terms. By doing this, British exporters who wish to take advantage of the scheme, can best help to accelerate its inauguration. It should be pointed out that the adoption of this scheme is not advocated in cases where traders are able to do business, by the ordinary methods, without it.

An annex to the booklet (published at 6d.) contains the complete text of the ter Meulen scheme.

The Belgian Minister of Industry has submitted to the Chamber of Deputies EXPORT CREDIT PROPOSALS somewhat similar to that of the British scheme, and to that proposed for France. The Belgian Government proposes to grant a credit of 250 000 000 fr. and in its allocation preference is to be given to industrial groups rather than individual firms. Documents giving full details of the proposed transactions must be produced, together with covering bills signed by the importer or his bank. In other cases guarantees in some form or other must be produced. The credit covers a period of three years, and each individual application will be considered by a committee of nine members.

Electricity Supply.

The Darwen Council have received a request from the borough electrical engineer (Mr. Fletcher) for an increase of salary.

The Electricity Commissioners have sanctioned the borrowing of £107 600 in respect of the completion of the Walsall electricity station at the Birchills.

The city electrical engineer of Aberdeen (Mr. J. A. Bell) is advising the Town Councils of Banff and Macduff in connection with the introduction of electric lighting and power into both burghs.

Boston Council has been informed by the National Electric Construction Company, which obtained a provisional electric lighting order in 1915, that there is no prospect of providing a supply at present.

Dartford Urban Council has received authority to borrow £12 106 for additional generating plant and mains extensions, but owing to the estimate having been exceeded an additional sum of £4 562 will be required.

On Monday the members of the Salford Electricity Committee paid a visit to the site of the proposed new power station at Agecroft when a new turbo-alternator was also started at the electricity works in Pendleton.

A recommendation of the Electric Light Committee to apply for sanction to borrow £30 000 for new mains and services led to some discussion at the meeting of Bath City Council last week but ultimately the proposal was adopted.

Loughborough Electricity Committee has overspent the amount recently sanctioned for mains and house services, and application has been made to the Electricity Commissioners for sanction to borrow the excess expenditure and £3 000 for future requirements.

The Minister of Transport proposes to confirm the special order granted to Guildford Corporation for the supply of electricity in the borough and in parts of the Guildford and Hambledon rural districts. Objections must be lodged with the Secretary of the Ministry by June 1.

Hull Corporation is applying for a special order to extend the area of electricity supply to certain parishes in the Sculcoates rural district and to enable the Corporation to increase the maximum price for the supply of electricity and to change the method of charging, &c.

The Urban District Council of Scunthorpe and Frodingham is applying for a special order to enable it to take electricity in bulk from Messrs. John Lysaght, Ltd., and to distribute same for public and private purposes, &c.

The Minister of Transport proposes to confirm the special order made by the Electricity Commissioners in favour of the Eston Urban District Council and notice of objection must be sent to the Secretary, Ministry of Transport, 6, Whitehall-gardens, London, S.W. 1, by May 30.

Blackburn Electricity Committee has decided that it cannot grant the applications of Billington Parish Council and Oswaldtwistle Urban Council for a supply of electric current from the new station, and a sub-committee has been appointed to deal with the application of Blackburn Rural District Council for a supply.

Several extensions of electricity supply mains have been authorised by Burnley Electricity Committee and the cost will be defrayed out of a loan of £20 000 recently sanctioned. In order to remedy complaints by Reedley Hallows Council of the unsatisfactory electricity supply it will be necessary to lay an additional feeder cable for a distance of 1 200 yds. at a cost of £1 800.

Col. T. C. Ekin held a public inquiry at Weybridge last week into the application of the Urban Electric Supply Company for authority to increase the maximum price of current at Weybridge and Walton from 10d. to 1s. per unit. Though there was no opposition by the Weybridge and Walton Urban Council some consumers appeared and objected to the proposed increase.

The continued coal crisis has caused a good many electrical engineers and others to fall back upon oil fuel for the boilers. At Hull, Leeds, Swansea and other places successful experiments have been made with oil in generating electrical energy. At the Lot's-road Station of the Underground Electric Railways Company of London, 24 out of the 60 water-tube boilers are now fired by oil fuel, and it is possible that more of the furnaces may be converted. Fuel oil supplies are reported to be plentiful and the oil will be brought to the Chelsea station by tank steamers.

There was an interesting discussion as to the part electricity will play in scientific farming of the future at a meeting of the Carmarthenshire Agricultural Committee on Saturday last. It arose on the question whether it would be best to install generating plant at Pibwrlwyd Farm, near Carmarthen, which is to be used as an institute and demonstration farm, or whether it would be more satisfactory to lay mains from the Carmarthen electric supply. The architect favoured the latter course, which he estimated would cost £600, while their own plant would cost about £500 to install. A member (Mr. Ll. Griffiths) said the farms of the future would have electric power installed, and in an institute where young farmers were to be educated the students should certainly be taught the way to deal with electrical plant. Another member (Mr. Davies) said many farmers were thinking of going in for electric light and power, and it was a very important part of the education of farmers' sons to have a practical experience of the working of electrical plant at the institute.

It was, therefore, decided by a majority to install electric plant at the farm and also an oil engine.

Electric Traction.

Owing to the coal crisis the Birmingham Electric Tramway services have been reduced 35 per cent., spread over the whole day. As the railway services have been curtailed the pressure on the trams is phenomenal, the queues being of inordinate length.

On the Rochdale Corporation Tramways there was a loss of £9 335 on the past year's working, bringing the total deficit to over £12 000. It is proposed to take the whole of the reserve fund (£10 882) and levy the balance on the rates. The revenue showed an increase of over £25 000, but this was more than absorbed by increased expenses.

The Minister of Transport has extended by one year from July 8, 1921, the period limited by the Chesterfield Corporation Act, 1914, for the completion of tramways Nos. 1 and 2, and has also extended by one year from August 15, 1921, the period limited by the Chesterfield Corporation Railless Traction Act, 1913, for the completion of the equipment for working trolley vehicles.

There is an actual surplus of £5 580 on the past year's working of the Leeds Corporation Tramways Department, instead of an anticipated deficit of £15 000. The gross profits amounted to £266 250. Despite the increased fares more people used the cars than in 1919-20, the population served (580 000) being carried 239 times, against 235. The Corporation is applying for powers to increase the maximum charges for passengers from 1d. to 2d. a mile.

The British Road Traffic, Ltd., 54, George-street, W.1, announces that it will shortly place upon the market a patented device for minimising street accidents. The invention is stated to be an electromagnetic device which can signal the intentions of motor-car drivers to either front or rear approaching traffic, and is operated from steering column or other convenient position. The device consists of a white opal dial with an arrow working at the will of the driver or operator. It is said to be most effective in daylight and visible at a distance of 50 to 100 yards and when illuminated at night it can be seen very nearly the same distance. The working model has been tested in all sorts of traffic and on the worst roads, and it is claimed to be absolutely fool-proof.

In moving the report of the Salvage and Stables Committee at Birmingham Corporation last week, the chairman (Mr. Lancaster) said that a third of the city was now covered by the system of continuous collection with very satisfactory results. The system of continuous collection was only possible by the aid of electric vehicles, and at present there were about 30 at work. They were giving every satisfaction. Each vehicle showed a saving of something like £250 a year. The committee had hoped to extend the system, but as their estimates had been curtailed he supposed they would have to wait until there was more money available. He referred to the success of the generating plant already installed at one destructor, and said it was proposed to lay down an installation at the Montague-street depot which would effect a saving of about £2 000 a year.

A sub-committee of the Southend Tramways and Light Railways Committee recently inspected the trolly omnibus systems of Rotherham, Bradford and York, and as a result of their investigations they recommend the use of trolly vehicles instead of extending the existing tramways. The members of the sub-committee state that they are convinced that the system would be very suitable for communication between tram termini and upon routes where it would not be possible or desirable to install light railways, or where the cost of laying down permanent way (the present cost of a double track being approximately £54 000 per mile) would be prohibitive, and the volume of traffic to be catered for would not justify the capital outlay required for extensions of light railways. The sub-committee enumerate a number of routes upon which it is expected the vehicles would be found satisfactory, and they conclude by stating that the cost of power for driving a trackless trolly car is only 1½d. per mile, compared with 6d. per mile for a petrol omnibus.

Personal and Appointments.

Maidenhead Corporation has increased the salary of the electrical engineer (Mr. Milton) to £620 a year in order to bring it up to the proper scale rate.

Major A. E. Carr, D.S.O., has been appointed as repairs superintendent at the Greenwich power station of the London County Council. and Mr. A. E. Evans, assistant engineer to Messrs. Preece, Cardew & Rider, as technical assistant.

The Court of the Manchester University has conferred the D.Sc. degree upon Prof. Horace Lamb, D.Sc., LL.D., F.R.S., formerly Beyer Professor of Mathematics in the University, and upon Sir Ernest Rutherford, M.A., D.Sc., Ph.D., LL.D., F.R.S., formerly Professor of Physics in the University.

Owing to the election of the Rt. Hon. J. H. Whitley, M.P., as Speaker of the House of Commons, he has resigned the Joint Presidency of The Industrial League and Council, which he has held for so long in conjunction with the Rt. Hon. G. H. Roberts, M.P. Viscount Burnham, C.H., has, however, consented to become Joint President.

On June 29 a deputation of distinguished civil, metallurgical, mechanical and electrical engineers of the United States will arrive in England to express the obligations which the world owes to the Engineers of Great Britain for the part they played in Winning the War. The American engineers will present to Sir Robert Hadfield on June 29 the John Fritz Medal, on account of his invention of manganese steel. The medal has already been awarded to Lord Kelvin, Mr. Edison and Prof. Graham Bell.

Imperial and Foreign Notes.

The RAILWAYS IN NEW ZEALAND are all steam-operated at present, but a contract has been placed with the English Electric Company for the electrification of the Arthur's Pass section of the Midland Railway, 8¼ miles in length. The power house will be at Otira station. Direct current at 1 500 V will be used, and the prime movers will be steam turbines. Five miles of the section are in a tunnel, in which the ruling gradient is 1 in 33. The English Electric Company will also provide the tunnel lighting, equip the repair shops and train the staff.

A conference has been arranged between representatives of towns on the NORTH WEST COAST OF TASMANIA to consider the desirability of the acquisition by the State of the existing electrical undertakings and the substitution of a supply of electric power in the district from the Government Hydro-Electric Department. Mr. Harold Lord, of the Latrobe Hydro-Electric Company, is of opinion that the cost of bringing a transmission line from the Great Lake power house to the district in question would not be justified as a commercial proposition. As to the desirability of constructing a big dam in Denny's Gorge across the Dan river to obtain water power for a general electric supply for the towns concerned, neither Mr. Lord nor Mr. G. D. Basille, the municipal engineer of Devonport (Tasmania), is prepared to give an opinion.

The Australian Postmaster-General (Mr. Wise) is devoting attention to the development of WIRELESS COMMUNICATION IN THE COMMONWEALTH. In connection with the Imperial trans-oceanic scheme, preliminary steps have been taken for the selection of a site for a station in Western Australia. Also the policy of establishing radio stations in Australia for inland communication, where it would be too expensive to erect telegraph or telephone lines, is being carried out. The scheme is to erect public stations to collect traffic from stations maintained by private owners under licence. Two public stations are in course of erection in pastoral districts at Powell's Creek and Camooweal. Mr. Wise stated recently that immediately the technical and financial difficulties are removed it is intended to establish a public radio-service.

It is announced that a new Franco-German company has acquired a controlling interest in the HOMBURG power station of the PFALZWERKE A.G., belonging to the Rheinische Elektricitäts), and that further capital will be procured by the issue of 70 000 000 marks in debentures. The Homburg station is only a part of the works of the Pfalzwerke, which have been considerably extended of late and need large sums for completing the scheme of extensions. Of the share capital of 14½ million marks, the Rheinische Elektricitäts A G. holds a quarter, but the debentures now amount to 63 million marks. The reasons for the projected developments are connected with the supply of coal to the Homburg station as the Pfalzwerke experience considerable difficulties in the matter of coal supply. For some time the administration of the Saar withheld entirely the delivery of Saar coal, upon which the Homburg station depends. Then, when coal was supplied, payment had to be made in francs, and at such a figure that the price of current rose out of all proportion. It was found impossible to obtain Ruhr coal, owing to transport and other troubles, and the Pfalzwerke are endeavouring to escape from the dilemma through the negotiations with the French group, consisting of the Compagnie Generale d'Electricite, the Company Thomson-Houston and the Schneider-Creuzot Company.

Institution Notes.

Among the recently elected foreign members of the ROYAL SOCIETY are Prof. Albert Einstein and Prof. Peter Zeeman.

At the meeting of the ROYAL INSTITUTION on Tuesday, Sir J. J. Thomson was elected honorary professor of Natural Philosophy, and Sir Ernest Rutherford professor of Natural Philosophy.

The Bessemer gold medal of the IRON AND STEEL INSTITUTE has been awarded to Mr. H. Brearley, of Sheffield, for his services in the advancement of iron and steel metallurgy. Mr. Brearley is perhaps best known to the public as the inventor of stainless steel.

The Andrew Carnegie research scholarship of the same Institute has been awarded to Dr. Leslie Aitchison, of Birmingham, to assist him in carrying out an investigation of the low apparent elastic limit in quenched and work-hardened steels with particular reference to fatigue, strength, proof, stress and constitution.

At the recent annual meeting of the BRITISH INTERNATIONAL ASSOCIATION OF JOURNALISTS, Mr. Leon Gaster, F.J.I., the hon. secretary of the Illuminating Engineering Society, and editor of "The Illuminating Engineer," was unanimously elected honorary general secretary of the Association.

A summer meeting of the British Section of the SOCIÉTÉ DES INGENIEURS CIVILS DE FRANCE will be held in France between June 18 and 24. Participation in the tour will not be confined to the members of the British Section, but members of recognised British engineering institutions or engineers in general and ladies also will be welcome. During the meeting visits will be paid to the battlefields of Verdun and the factories of the Lorraine area. Further details may be obtained from Mr. H. Sloog, hon. secretary, 45, Great Marlborough-street, London, W. 1.

The latest publication of the BUREAU OF STANDARDS, Washington, D.C., is Technological Paper No. 170 on "Pyrometric Practice." It is really a complete treatise of the practical phases and applications of pyrometry of more than 300 pages. All general methods of measurement, instruments, use and standardisation of pyrometric apparatus are discussed. The illustrations shown are of modern American instruments. Many tables of data are included and the treatise contains an index for ready reference. The publication is issued at 60 cents., and anyone interested can obtain a copy from the Bureau.

Miscellaneous.

The death is announced of Mr. HUGH GEORGE MUNRO, O.B.E., secretary of the Electric & Ordnance Accessories Company, Ltd., of Birmingham, at the age of 41. He had been connected with the firm for nearly a quarter of a century, which he joined as a clerk in the accountant's office. He received the O.B.E. for services during the war.

The DIRECTIONAL WIRELESS TELEGRAPH STATIONS on the coasts of the United Kingdom have now been for two years at the disposal of the Mercantile Marine, and owing to the great use made of the system it has been decided to transfer the stations, with one exception, from the Admiralty to the Post Office. The change will be made gradually, those affected being Peterhead, Berwick, Flamborough, Amlwich, Rhyl, Carnsore, Larne and Seaview (Malin Head). At present a charge of 5s. is made for each bearing asked for and given. The station to remain under Naval control is that at the Lizard, which will be employed on development and research work.

In the spring meeting of the ENGINEERING GOLFING SOCIETY, which took place on the 4th inst., 47 competitors took part. The 18 holes stroke competition for the president's challenge cup, presented by Sir Alex. Kennedy for members in the first division (handicaps of 10 and under), was won by A. F. Holden with a return of 86 less 10—76, second prize going to W. E. Lane with 84 less 7—77. The scratch prize, presented by the captain (Mr. E. W. Timmis) was taken by Captain C. H. Hayward, 76. The Wilson challenge cup, presented by Mr. R. P. Wilson for handicaps of 11 and over, went to F. R. Phipps, 92 less 14—78; Colonel H. Cartwright Reid, 92 less 11—81, being awarded the second prize. The result of the bogey foursomes was: Captain C. H. Hayward and Colonel J. G. Hearson, 6 up; A. J. Boyd and K. A. Wolfe Barry, 3 up.

The tennis section of TUCKER'S ATHLETIC AND RECREATION CLUB commenced the season on Saturday, April 30, in glorious weather and amid ideal surroundings. The opening ceremony was performed by Mrs. T. R. Martin, supported by Mr. T. R. Martin (Joint Managing Director), Mr. S. R. Davies (Production Manager), Mr. W. Y. Smith, Mr. H. W. Rodgers, Mr. C. H. Walker, Mr. W. A. Wood (Hon. Sec., tennis section), Mr. H. Pratt (General Secretary) and a large number of players and friends. Apologies were received from Mr. and Mrs. J. B. Tucker and Mr. Tranter, who wished the club a successful season. After the opening ceremony the following took part in the first set: Mrs. T. R. Martin and Mr. W. A. Wood; Miss K. McGann and Mr. T. R. Martin, which resulted in a victory for Miss McGann and Mr. Martin. The first tournament takes place to-morrow.

The first annual meeting of the WEST MIDLAND DISTRICT INDUSTRIAL COUNCIL for the Electricity Supply Industry was held in Birmingham last week. Prior to the meeting there was a luncheon to celebrate a successful year's work, the attendance numbering 40 members and delegates representative of the electricity undertakings of local authorities and companies in Salop, Staffordshire, Warwickshire and Worcestershire, and of the trade unions interested, were present, and Mr. R. A. Chattock (city electrical engineer of Birmingham), chairman of the Council, presided. The report of the Council covered 17 months. There were 11 council and 34 committee meetings. All discussions were of a friendly character, and the opinion was expressed that practically all differences between employers and employed in the industry were capable of adjustment and equitable settlement, provided they were explored in a spirit of reasonableness and mutual respect.

One of the most important decisions at the meeting was to agree to a basis for the adjustment of the rates of pay of employees to correspond with variations in the cost of living within defined limits. This adjustment scale will not operate at present, as the scheme provides for crediting employees with an equivalent for the increase in the cost of living that has actually occurred since rates of pay were stabilised last June. Further particulars will be published later, and no actual alteration in the rates of wages will be authorised until the council at a subsequent meeting issue the necessary instructions. The relations between employers and employed in the industry are of a most cordial character. Steps were taken for the election of members of the council for the ensuing year. Votes of thanks, on the motion of the vice-chairman, Alderman Gregory, to the chairman for his services during the year, and to Mr. E. J. Jennings (Birmingham), the secretary and treasurer, terminated the proceedings.

Educational.

The UNIVERSITY COLLEGE OF SWANSEA has made arrangements whereby Mr. J. W. Burr, the borough electrical engineer, will deliver in the engineering department in the autumn and winter months of next session a short course of lectures on "POWER STATION ECONOMICS," which will be open to the public.

The directors of Barclay's Bank have voted a sum of £1 000 towards the cost of the new engineering laboratory at CAMBRIDGE UNIVERSITY. In order to facilitate the vacation of the portion of the present engineering buildings so that they may be occupied by the department of Chemistry, the Financial Board of CAMBRIDGE UNIVERSITY recommend that £17 500 be paid from the Chemical Endowment Fund in order to replace on another site the Hopkinson Memorial Wing of the engineering department. They further propose to borrow for five years £15 000 from the Chemical Endowment Fund, on the understanding that the building be vacated by the end of September, and they ask powers to find a further sum not exceeding £15 000 to enable the plans for the second part of the engineering laboratory on the Scroope House site to be completed. It is further proposed that the Electrical Engineering Laboratory should be [illegible].

Business Items, &c.

The new address of the Ivor Electrical Company, Ltd., is 56, Red Lion-street, Clerkenwell-road, London, E.C. Telephone: Clerkenwell 3663.

Mr. P. M. Robinson, having left the service of the United Engineers, Ltd., of Singapore, the company ask us to state that his authority to sign indents and other documents on their behalf ceased as from March 31 last.

John Richard Kirkham and Daniel Weightman, manufacturers of lighting glassware, and trading as the London & Midland Lighting Company, at Prince's-square and Bilston-road, Wolverhampton, have dissolved partnership. Debts by Mr. Kirkham.

Frank Whitworth Brierley, John Sugden, Alfred Daniel Wickham and Ashton Taylor, electrical engineers, trading as J. K. Cotton & Company, at 2, Water-street, Rochdale, have dissolved partnership. Messrs. Brierley, Sugden and Wickham continue the business under the same style.

Messrs. J. B. Garnham & Sons, metal merchants, have removed to 44/47, Devonshire-street, Theobald's-road, London, W.C.1. The telephone number: Museum 4116; telegraphic address: Garnham Westcent London, but the cable address ("Garnham London") remains unchanged.

The partnership between Walter Balmford and Francis Albert Salt, trading as Balmford & Salt, manufacturers and wholesale factors to the electrical and allied industries, "Electric House," Whittall-street, Birmingham, has been dissolved as and from April 23. Debts by Mr. Balmford, who will continue the business in his own name.

Catalogues, Price Lists, &c.

Messrs. Higgs Brothers, Sand Pits, Birmingham, have issued their May stock list of a.-c. and d.-c. motors and dynamos.

A leaflet giving the reduced price and some particulars of the "Electrolux" Suction Cleaner has been issued by the Z. Electric Lamp & Supplies Company, Ltd., 73, Newman-street, London, W.1.

For the purpose of educating the general public in the economy to be effected by the use of Osram Gasfilled lamps, the General Electric Company, Ltd., has prepared two window showcards stating the case for gasfilled lamps in clear non-technical language. One card deals with the 40 W, and the second with the 60 W Osram gasfilled lamp. Supplies of these cards can be obtained by the trade from Magnet House, Kingsway, London, W.C. The Company has also issued a neat folder giving prices and particulars of Osram gasfilled lamps.

A nicely printed and well-illustrated pamphlet on Electric Arc Welding has been issued by the Metropolitan-Vickers Company, Ltd. Commencing with a brief introductory sketch of the history of welding, the advantages, the applications and the equipment required for various kinds of arc welding work are set out. A good deal of useful technical information is given about the material to be welded, about the carbon and metallic electrode processes, with some practical suggestions for preparing work for welding, &c. Several examples are shown of repairs and other work carried out as well of the electric welding equipment and accessories supplied by the company.

Messrs. Donovan & Company, 47, Cornwall-street, Birmingham, have issued an illustrated price list (No. 1 421) giving particulars and prices at current rates of the whole of the electrical lines likely to be used on ordinary installations for housing schemes, the wiring of private houses, works and factories, &c. A variety of lamp holders, switches, wall plugs, conduits, flexible wires, cables, motor starters, fuse boards, and other accessories is included, and the prices are subject to a trade discount of 20 per cent., except motor starters and Safuse gear, which are subject to 25 per cent. discount. Copies of the list will be sent to those interested.

Bankruptcies and Liquidations.

A meeting to receive an account of the winding-up of the Harman Electric Company, Ltd., will be held at the office of Mr. F. M. Jeboult, 9, Walbrook, London, E.C.4, on June 16.

A meeting of members of T. Emery's Automatic Power Generating Motors, Ltd., will be held at 18, Adam-street, Strand, London, W.C. 2, at 3 p.m., on June 6, to receive an account of the winding up.

Claims on the estate of Geo. Dolby, electrician, 39, East Marsh-street, and 129, Freeman-street, Great Grimsby, must be sent by May 31 to the trustee (Mr. J. F. Wintringham), St. Mary's-chambers, Great Grimsby.

A receiving order has been made against William Aaron Davis, electrical engineer, lately trading at 3, Coronation-street, but now at 14, Basinghall-street, and residing at Low Villa, Nutting Grove, Farnley, Leeds.

The first meeting of creditors in the bankruptcy of Samuel Beckett, junr., electrician, 50, Deane-road, Bolton, takes place at the O.R. Offices, Byron-street, Manchester, on May 24th. Public examination at Bolton Courthouse, on June 15.

A first and final dividend of 7s. 5d. was payable on May 10 at the Official Receiver's office, York City Bank-chambers, Lowgate, Hull, to creditors of Edgar Stirling Elam and John Walton, trading as Elam, Walton & Company, electricians, 63, King Edward-street, Hull.

Francis Edward James Padmore, electrical contractor, of Marlborough-road, Nuneaton, has been adjudicated bankrupt. First meeting of creditors on the 19th inst. at the O.R. Offices, The Barracks, Smithford-street, Coventry, and public examination on June 13, at the County Hall, Coventry.

Tenders Invited and Accepted.

Edinburgh Corporation requires tenders by May 26 for e.h.t. and l.t. switchgear for sub-stations. Specification (No. 29) from Sir Alexander Kennedy, 17, Victoria-street, Westminster, S.W.1.

Plymouth Gas Committee requires tenders by May 26 for works including the supply and erection of an electrically-driven push-plate conveyor. Specifications, &c., from Mr. Isaac Carr, M.Inst.C.E., Farnborough, Widnes.

The Borough Council of King William's Town (S. Africa) invites tenders for steam-driven electrical generating machinery, boilers, switchgear and cable. Specifications from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C.2, to whom tenders by June 25.

The time for tendering for the telephone switchboards required by the Postmaster General's Department, Melbourne (Schedule No. 1 670) has been extended from 19th April to 31st May. Specifications can be seen at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

The Uruguayan Ministry of Public Works invite tenders for three electric gantry cranes and a "Temperley"-type aerial transporter for the port of Paysandu. Tenders (in Spanish) by June 28. A translation of the specification may be seen at the Department of Overseas Trade.

The Department of Sanitary Works, Buenos Aires, requires tenders (by June 13) for the supply and erection of electric batteries and lighting plant at Mar del Plata. Local representation is essential. Specification at the Department of Overseas Trade.

It is notified that the date on which all tenders for the supply of plant and material for the electrification of the Cape Town-Simonstown & Durban-Pietermaritzburg Railway lines has been extended to noon, July 5. Tenders to the High Commissioner for the Union of South Africa, Trafalgar-square, London, W.C.

Glasgow Corporation invites tenders for the supply of cables and meters for 12 months from May 31. Specifications, with forms of tender, from the engineer, Mr. R. B. Mitchell, 75, Waterloo-street, and tenders to the town clerk, Mr. J. Lindsay, City Chambers, Glasgow, by May 20.

Mexborough & Swinton Urban District Council invite tenders for the supply and erection of a 750-kW rotary converter with transformer. Specifications, &c., from the engineer and manager, Mr. J. B. Feltham, and tenders to Mr. J. W. Hattersley, clerk to the Council, Hope-street, Mexborough, by noon, May 21.

The Victorian Government Railway Commissioners invite tenders for the supply and delivery of 50 oil-immersed single-phase track and signal transformers for power signalling (contract No. 33 901). Tenders to the Commissioners, Spencer-street, Melbourne, by June 15. Specifications may be consulted at the Department of Overseas Trade.

The Electricity Commissioners of Victoria invite tenders for the supply and delivery at the Morwell Power House of street poles and copper cable. Copies of tender forms from the Agent-General for Victoria, Victoria House, Melbourne-place, Strand, London, W.C.2, and specifications may be inspected at the offices of the consulting engineers, Messrs. John Coates & Company, Ltd., also at Victoria House. Tenders to the Secretary of the Commissioners, 673, Bourke-street West, Melbourne, Australia, by May 31.

Auckland (N.Z.) Council has accepted the tender of the British General Electric Company for generating plant, at £94 000; that of the British Thomson-Houston Company for other plant, at £77 000; and that of Babcock & Wilcox for boilers, at £81 000.

Glasgow Tramways Committee has accepted the following tenders: British Insulated & Helsby Cables, Ltd., trolley feeder poles; D. King & Sons, pole tops; P. & W. MacLellan and J. Stewart & Co., iron and steel; and Albion Clay Company, stoneware conduit.

Stepney (London) Council has accepted the following tenders: Sutton & Company (lowest tender), for supply of troughs and covers and for three-way earthenware conduits, at £12 027. Three tenders received, highest £12 669 16s., in addition to one for conduits only, £7 276 10s.). A. Reyrolle & Company (only tender received), for a trifurcating box, £181; and Agricultural & General Engineers, Ltd., overhauling electric van at £250.

Gainsborough Urban Council has placed an order with Messrs. Mossay & Co. for an electric tipping wagon at £1 324 10s.

The U.S.A. Naval Authorities have established a commercial wireless telegraph service between the United States and the Dutch East Indies.

Canterbury City Council has accepted the tender of the Agricultural and General Engineers, Ltd., for a "Garrett" 2½-ton type electric street-watering van at £1 357 10s.

For wiring 62 Municipal houses Gillingham Town Council recently received tenders from six firms, varying in amount from that of the accepted (Mr. W. McDonald, at £717 10s.) to £967.

The vexed question of German versus British meters was settled at the meeting of the Swansea Electricity Committee last week. The borough electrical engineer (Mr. Burr) reported that he had communicated with Messrs. Robert Hornby & Company, agents for the Siemens Schuckert meter, who replied that the meters were in stock in London, the 50 per cent. tax not therefore applying. Mr. R. G. Clarry proposed that, as no part of the sum they paid would go to the British Government, the order be given for British-made meters at an average higher price over the German meters of 16s. This motion was agreed to.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

[illegible]
[illegible] direction of the rotation in alternating current motors. (11/12 18.)
159 377 Robinson & Crowther. Wireless reception apparatus. (17/12/19.)

The invention consists in a receiving system comprising an oscillatory circuit controlling the current through the telephones and having a condenser which is made variable by electro-magnetic means controlled by the intensity of the received electro-magnetic waves so as to vary the frequency of the oscillatory circuit and thereby the pitch of the note heard in the telephones according to such intensity.

159 395 Hansen. Electrically-propelled vehicle. (20/1/20.)
159 408 Gibson & Yorke. Magnetic deflectors for electric arcs in lamps, searchlights and the like. (14 2 20.)
159 421 British Thomson-Houston Co., Ltd. (General Electric Co.) Compositions for insulating and protecting electrical apparatus and for other purposes. (17.3 20.)
159 424 Berry & Markham. Device for variably tilting the shades of electric lamps. (29.3 20.)
159 436 Jamin. Electrical time-keeping mechanism. (5.5/20.)
159 445 Blaney & Williams. Overhead trolleys or collectors for electric tramway and railway vehicles. (9 6/20.)
159 448 Weid. Field magnets for magneto-electric machines. (12/6/20.)
[illegible] Simplex Conduits, Ltd., Waterhouse & McLaughlin. Electric fuses (21/8/19.)
159 528 Chantler. Insulators for overhead transmission lines such as telegraph and telephone line-wires. (25/9/19.)
159 544 Shaw. Electric lamp holders or attachments. (28.10/19.)
159 564 Dowsett. Thermionic devices. (22/11/19.)
159 570 Jensen. Electric resistance switches. (24/11/19.)
159 572 Watson. Magneto-electric machines. (25/11/19.)
159 573 Rose. Electric switches. (26/11/19.)
159 574 Automatic Telephone Manufacturing Co., Ltd. (Automatic Electric Co.) Automatic switching mechanism for use more particularly in telephone or like systems. (26/11/19. Addition to 154 698.)
159 591 Verdini. Electric water-heating apparatus. (28 11 19.)
159 598 British Thomson-Houston Co., Ltd. (General Electric Co.) Time element switch devices for controlling electric circuits. (29/11/19.)
159 603 British Thomson-Houston Co., Ltd. (General Electric Co.) Electric signalling systems. (1/12/19.)
159 607 Stanfield. Magneto-starters. (1/12 19.)
159 614 Jamie. Electric switches. (3/12/19. Cognate Application 23 282/20.)
159 616 Wood, Hague & Hague. Apparatus for re-magnetising magnetos. (3/12/19. Cognate Application, 11 445 20.)
159 618 Jones. Plugs and sockets for electrical fittings. (3 12/19.)
159 620 British Thomson-Houston Co. (General Electric Co.) Cores of electrical transformers and like apparatus. (3/12/19.)
159 645 Claremont & Glover & Co., Ltd. Aerial electric conductors and supports for same. (8/12/19.)
159 647 Archibald. Balancing the voltages in a three-wire direct-current system by means of static balancers. (9/12/19.)
159 653 Abogado. Apparatus for heating liquids electrically. (9/12 19.)
159 654 Abogado. Process of heating liquids electrically. (9 12 19.)
159 665 Gardner. Electric miners' lamps. (13/12/19.)
159 675 Railing & Connaught. Electric relays for signalling. (16.12/19.)
159,679 Radio Ltd., Williams & Donisthorpe. Thermionic valve apparatus for telegraphic and telephonic purposes. (16/12/19.)

Consists of apparatus constructed and arranged as a self-contained unit with male and female plug connections adapted for connecting aerial, earth, telephones, and batteries or for connecting together a plurality of said units in cascade to form an amplifying system.

159 681 British Thomson-Houston Co., Ltd., & Whitaker. Dynamo electric machines. (17/12/19.)
159 683 Robinson & Crowther. Wireless reception apparatus. (17/12.19.)
159 694 Robinson & Crowther. Thermionic amplifiers. (24 12/19.)

Comprises a plurality of valves arranged with the anode of each valve connected to the grid of the next valve, an inductance in the anode-filament circuit of one valve, a second inductance in the grid-filament of the succeeding valve, a variable condenser between the anode terminal of the anode inductance, and the grid terminal of the grid inductance, and a fixed condenser between the filament terminals of these inductances.

159 696 Igranic Electric Co., Ltd., & Curtis. Housings of electrical switchgear. (24/12/19.)
159 706 Hankee. Electro-magnetic devices for operating signals and for like purposes. (30/12/19.)
159 709 Loring. Electrodes for oxidising nitrogen. (31 12 19.)
159 732 Duthoit. Medical electrodes. (15 1 20.)
159 742 Ogden & British Arc-Welding Co., Ltd. Electrodes for electric arc-welding. (24/1/20.)
159 760 British Insulated and Helsby Cables Ltd., & Bayles. Electric cables. (2/3/20.)
159 764 Hawkins, Hanstock, Higgs & Ferranti, Ltd. Generation transmission or distribution of electricity. (11/3/20.)
159 776 Kearton & Riley. Telephones. (19 12 19. Divided Application on 31 940/19.)
159 782 Allen. Electrodes for secondary or storage batteries. (6/5/20.)
159 786 Igranic Electric Co., Ltd. (Cutler-Hammer Manufacturing Co.) Controllers for electric motors or the like. (27 5 20.)
159 803 Luca. Pouring channels for electric and other furnaces. (2/9/19. Divided Application on 150 532.)
159 906 Estelle. Process of electrolytically producing iron and alloys thereof. (27/3/18.)
159 909 Hughes. Electric irons. (18/6 19.)
159 917 Illingworth. Electrical cutout. (28/10/19. Cognate application 14 414/20.)
159 918 Marks. (Toledo Metal Products Co.) Means for supporting electric fittings for conduit outlet boxes and the like. (3/11/19.)
159 920 Scott-Taggart. Construction of vacuum tubes and the like, especially of the type used in wireless communication. (6/11/19.)
159 932 Hall. Suspension chains for the support of electric lamps, lamp fittings and electric cables and wires and other purposes. (10/11/19.)
159 939 White. (U.S. Light & Heat Corporation.) Dynamo-electric machines. (11/11/19.)
159 955 Crowther & Makower. Manufacture of thermionic valves and the like. (4/12/19.)
159 958 B.T.-H. Co. (G.E. Co.) Conducting-leads for electrical apparatus. (5/12/19.)
159 959 Robinson & Crowther. Electro-magnetic wave signalling apparatus. (5/12/19.)
159 975 Lord & Taylor. Magneto-electric machines. (9 12 19.)
159 934 Round. Thermionic amplifiers and detectors. (9 12/19.)
159 997 Wade. (Coto-Coil Co.) Electric coils and the manufacture thereof. (11/12/19.)
160 017 B.T.-H. Co. (G.E. Co.) Protective devices for electric circuits. (22 12/19.)
160 019 B.T.-H. Co. (G.E. Co.) X-ray apparatus. (23/12 19.)
160 020 B.T.-H. Co. (G.E. Co.) X-ray apparatus. (23.12 19.)
160 031 B.T.-H. Co. & Trencham. Electric insulators for electric switches and like connection. (3.1/20.)
160 043 Hunt. Insulation of conductors of submarine cables. (17/1/20.)
160 074 Nobbs & Nobbs. Electric heaters for liquids. (20 2.20.)
160 082 Marks. (Scovill Mfg. Co.) Electric furnaces. (15.3.20.)
160 086 Broadbent. Flexible pendant electric light fittings. (8/4/20.)
160 113 Thorrowgood & Bushrod. Pneumatically-operated electric [illegible] (30/12/19. Divided application on 150 778.)

APPLICATIONS FOR PATENTS.

October 6 1920.

28 330 Talbot. Automatic control of electric motors.
28 338 Long. Automatic telephone pay station.
28 342 Metropolitan-Vickers Electric Co. & Davies. Electric oil switches.
28 357 Marks. Electric traffic-signalling devices.

October 7, 1920.

28 385 Bishop. Electric cable terminals.
28 386, 28 387 and 28 388 Ide & Painter. Switches.
28 395 Maag. Electric heating devices. (8/10/19, Switzerland.)
28 400 Wilkinson. Valves for electric heating, &c.
28 406 Railing & Butler. Trolly heads.
28 430 B. T.-H. Co. (G. E. Co.). Electric welding apparatus.
28 452 Ges. für Drahtlose Telegraphie. Means for [illegible] (8/10/19. Germany.)
28 461 Johnson & Phillips & Wood. Electric switchgear of truck type.

October 8, 1920.

28 495 Walton. Electric lamps.
28 514 Crust. Electric junction box.
28 517 McGregor. Electrically-operated warning signals.
28 520 Davies & Thompson. Magnetic separators.
28 528 Sykes. Electric apparatus for recording and reproducing sound.
28 547 Bennett. Magnetic-electric machines.
28 559 Ventileta, Ltd., & Ogle. Electric heating and ventilating apparatus.
28 577 Richard. Insulators for high potential lines.
28 599 Creed. Circuit controlling apparatus for wireless telegraphy

October 9, 1920.

28 603 Simpson. Apparatus for indicating opening or closing of electric contacts, &c.
28 605 Canniford. Electric-warning signals for left-hand driven cars.
28 613 Cordes. Radio-interference preventers. (21/10/19, U.S.).
28 616 Sharp. Slow motion device for electric motor starters, &c.
28 650 Kirk. Automatic switches for electric heating apparatus.
28 665 Metropolitan-Vickers Electric Co. & Gittins. Electric oil switches.
28 672 India Rubber Co. Moulds for battery jars. (18/12 19, U.S.)
23 681 Scott. Electric contact makers for steering wheels.

October 11, 1920.

28 763 Morkrum Co. Printing telegraph apparatus. (13/10/19, U.S.)
28 783 Rivers-Moore, Burten & Hawes. Fuses.

October 12, 1920.

28 815 Brierley. Electric safety hand lamps.
28 835 Turnock. Fuses.
28 853 Rohde. Suspension insulators for electric wires, &c. (14/10 19, Germany.)
28 863 Igranic Electric Co. (Cutler Hammer Mfg. Co.) Electric regulating systems.
28 864 Igranic Electric Co. (Cutler-Hammer Mfg. Co.) Driving mechanism for electric motors.
28 866 Jhamuotila. Electric counters.
28 867 Jhamuotila. Disposition of safety devices, &c., in electric generators.
28 874 Dimitrievitch. Electric signalling.
28 875 Stroud. Electric light fittings.
28 876 Lesage. Incandescent cathode valves. (30/10 19. France.)
28 898 Simonetta. Switch mechanism for intercommunication telephone instruments
28 906 Agate. Controlling electric currents and recording radio signals.
28 915 Drury. Electrical generating plant.
28 917 Winterbotham. Electric sad irons.

October 13, 1920.

28 923 Taylor. Electric transmission.
28 947 Thomson. Accumulator-driven vehicles.
28 956 Drummond. Current indicators.
28 972 B.T.-H. Co. (G.E. Co.) Electric valves or oscillators.
28 980 Gush. Electrolytic systems of protection for boilers, &c., against corrosion.
28 986 Kominik & Nossig. Fuses, &c. (10/3/19, Austria.)
28 993 Politawski. Dynamo-electric machines.
28 997 Neumeyer (F.) Akt.-Ges. Electric starters for internal-combustion engines. (14/10.19, Germany.)
29 012 Telephone Mfg. Co. & Murray. Diaphragms, &c., for telephone transmitters

October 14, 1920.

29 031 Taylor. Electric transmission.
29 034 Cable Accessories Co., Reeves & Crawford. Switches.
29 035 Donovan. Plug and socket switches.
29 044 Hailwood. Miners' electric lamps.
29 049 Efandem Co. & Eaton. Switch for lighting sets of motor cycles, &c.
29 050 McNeil. Electro-thermically cutting metals.
29 088 Vandervell & Midgley. Electric starters for internal-combustion engines
29 089 Grant. Telegraphic transmission of pictures.
29 091 Akt.-Ges. Brown, Boveri et Cie. Regulating d.c. voltage in metal vapour rectifier installation. (14/10 19, Switzerland.)
29 097 Henderson. Electrical apparatus.
29 110 Oldham. Magnetic locks.

October 15, 1920.

29 153 Automatic Telephone Mfg. Co. Telephone systems.
29 154 Automatic Telephone Mfg. Co. Distributing arrangements for telephone systems.
29 181 Holland. Wireless telegraph systems.
29 185 Mond. (International Precipitation Co.) Electrical precipitation of suspended particles from gaseous media.
29 189 Siemens. Automatic and semi-automatic telephone systems.
29 225 Glaser & Wickens. Brush gear for electrical machinery.
29 229 Lustig. Electromotors.
29 241 Andrew & Bradley. Means for coupling electric cables.

October 16, 1920.

29 252 Landgon-Davies & Soames. Electric welding apparatus.
29 258 Smith. Electric switches.
29 299 Götz & Schmidt. Switches.
29 304 G. E. Co. & Trippe. Vacuum as low pressure bulb electron-discharge apparatus.
29 312 Elektrische Gluehlampenfabrik Watt A.G. Fastening electrodes in Röntgen tubes, &c. (18 10 19, Austria.)
29 318 Mathys & Muir. Electric lighting apparatus for motor cycles, &c.
29 319 British Electric Plant Co. & Whitesmith. Brush-holder for electric machinery.

October 18, 1920.

29 321 Kent, Avery & Pistor. Brush holders of dynamo [illegible]
29 335 Automatic Telephone Mfg. Co., Webster & Mercer. Automatic telephone systems.
29 378 Williams & Middleton. Electric generators for lighting cycles, &c.
29 380 Byrne. Electrical apparatus.
29 383 Eriksson & Jonasson. Electric indicator boards, &c.
29 416 Voglhut. Regenerated incandescent lamps. (17/10/19, Germany.)
29 431 Allgemeine Elektricitats. Device for preventing impulse shocks and fluid treed supply conduits. (16/10 19, Germany.)
29 436 Oldham. Portable electric lamps.

Companies' Reports, &c.

JOHNSON & PHILLIPS, LTD.

The directors' report of Johnson & Phillips, Ltd., states that the profit for 1920, after providing for bad and doubtful debts and charging upwards of £23 000 for maintenance of buildings, plant, &c., was £98 405, and with £32 658 brought forward, the total was £131 063. After paying directors', auditors' and trustees' fees (£1 511), interest on debenture stock (£3 657), providing for reserve *re* debenture sinking fund (£9 227), interest on second debentures (£2 500), depreciation on machinery, &c. (£12 235), interest on loans (£4 450), income-tax and excess profits duty (£24 312), loss on sale of 4 per cent. funding loan (£2 776), the balance is £70 394. A dividend at rate of 12½ per cent. per annum (less tax) has been declared on the ordinary shares, and £32 113 carried forward, subject to taxation demands.

At the meeting on the 5th inst., the chairman, Mr. W. Claude Johnson, after giving an explanation of the report and accounts, said that the directors considered the profits earned during the year were very satisfactory, and they were pleased to be able to recommend the same dividend on the increased capital as was paid last year on a much lower figure. The new capital was not received until well towards the middle of the year, so that they had only had the benefit of it for just over six months. The profits must also be considered satisfactory from the point of view that the year under review was one of exceptional difficulty from the manufacturing standpoint. It was very pleasing to be able to report that their order books at the end of the year were as full as it was considered safe for them to accept. Indeed, some departments had from eight to ten months work in hand, including large and important Government contracts, so that the prospects for the current year might be considered highly satisfactory. Orders were still coming in, in spite of the troubled times, and they were justified in looking forward with the fullest confidence to the future, as it seemed to them a clear indication of an early trade revival, in which the electrical trade was bound to take the lead. The depression in trade which set in during the closing months of 1920, and unfortunately still continued, had been felt by the electrical industry to a much smaller extent than by other branches of industry. That was largely due to the increasing recognition of the fact that in the extended application of electric power lay the chief hope of reducing production costs in every direction. Further, the fact that for a long time past the demand for their manufactures had exceeded the supply prevented their suffering losses due to depreciation to the value of stocks.

Progress of Company.

Since the formation of the company in 1905, Mr. Johnson said that £277 477 had been spent on additions to plant, machinery and buildings. During the same period £146 130 had been spent on repairs and maintenance, and £119 500 written off for depreciation out of profits. It had recently been necessary to obtain financial assistance from their bankers, and they now wished to put their finances on a more solid basis by the creation of £350 000 in new debentures. That would enable them to redeem the balance of the first debentures and pay off the £50 000 second debentures, also to repay the bankers' advances and provide further working capital to enable them to tackle the ever-increasing volume of business offered to them, and for which they were now fully equipped. They could not borrow the amount at present, as their powers were limited, and therefore they proposed to alter the articles of association by increasing the borrowing powers of the company at an extraordinary general meeting to be held after the termination of this meeting. They proposed to create £350 000 8 per cent. first mortgage debenture stock, redeemable in 25 years by a sinking fund. They might have made a preference share issue, but having regard to the high rate of interest which was being paid by other industries for such issues, they should have had to pay 10 per cent. interest at least, and that would have been a permanent drag on the business. They had had the advantage of the advice of a prominent financial corporation on the matter, and they felt sure they were adopting the best course for the benefit of the company. In conclusion, he said their relations with their workpeople were most excellent and satisfactory. They were one of the first businesses in the country to start a works committee, and it had always had the most beneficial results. Suggestions were brought forward at times aiming at greater efficiency in the works or for the comfort of the employees. The latter were received always sympathetically, as to get the highest efficiency they must have a contented staff of workpeople. They had equipped a canteen, run entirely by the committee of the works club, and it had created a very fine feeling of good fellowship among all classes of employees.

The report and accounts were adopted, and at the subsequent extraordinary meeting the articles of association were altered.

BRUSH ELECTRICAL ENGINEERING COMPANY, LTD.

The annual meeting of the Brush Electrical Engineering Company, Ltd., was held on Tuesday, the chairman (Mr. E. Garcke) presiding. In moving the adoption of the report and accounts, he said they again reflected the prosperous condition of the company. Adding to the balance of profit of £191 096 the amount of £74 726 brought forward, there was available £265 822. The directors recommended, among other appropriations, the addition of £53 377 to general reserve, bringing it up to £75 000, and the payment of a dividend of 15 per cent., leaving £143 268 to be carried forward, subject to excess profits duty for 1920 and previous years. The gross profit on trading amounted to £285 328, compared with £223 000 in 1919, but the expenses were also higher. Increased capital had been provided in order to deal with the largely increased volume of business, which had necessitated extensions of buildings and plant and a larger lock-up in stock of materials and work in progress. A valuation of the plant and buildings of the company had been made and showed an aggregate figure which was nearly double the book value of those assets. He thought they might regard the present position with satisfaction and look forward to the future with confidence. The specialities they controlled placed them in a favourable position, notwithstanding the prevailing depression in most branches of industry.

The Brush-Ljungstrom Plant.

Their order books were well filled and there had been a gratifying increase in the demand for their Brush-Ljungstrom turbo-generator plant for electric power production. The installation of plant of that type effected such marked economy in coal and consequently in the cost of electric power, that its introduction had, in the cases of some electricity supply undertakings, been directly instrumental in converting a yearly loss into a substantial profit, while in stations already working at a profit there had been a corresponding improvement in results. Reports showed that the efficiency of the turbine was well maintained and did not fall appreciably in service. They recently had an official independent test made, without preparation, of two sets which had been in constant use for 45 months, when the results showed that the steam consumption was well within the guaranteed figures. The orders in hand represented in horse-power more than the total they supplied in the whole of the period from the commencement of manufacture in 1914 to the end of 1920. Whatever might be the result of the coal controversy, it seemed clear that economy in coal consumption was at once a duty and a necessity. From this view-point they had every reason to believe that their turbine which effected such a marked saving in fuel, and which time had proved to be in every way reliable in service, must command a good market. The directors hoped that the large new factory now under construction at Falcon Works, Loughborough, to be devoted to the manufacture of that plant, would enable them to cope better with the demand. He referred at the meeting last year to the company's difficulties in carrying through large contracts, and in this respect the position had improved, as they were now able to take the risk of making contracts at firm prices, which was more satisfactory both for their costumers and for themselves.

The directors of the Adelaide Electric Supply Company, Ltd., have declared an interim dividend on the ordinary shares for the half-year ended Feb. 28, 1921, at the rate of 12 per cent. per annum (6 per cent. actual), free of British tax, payable June 1.

The Melbourne Electric Supply Company, Ltd., has declared an interim dividend on the consolidated ordinary stock in respect of half-year ended Feb. 28, 1921, at rate of 10 per cent. per annum (5 per cent. actual), free of British tax, payable June 1.

Messrs. Lazard Bros. & Company, Ltd., who have purchased £250 000 4½ per cent. first mortgage debenture stock of the Newcastle-upon-Tyne Electric Supply Company, Ltd., at 70 per cent., are offering the stock for sale at 71¼ per cent., less a brokerage of ½ per cent.

The directors of the Aster Engineering Company (1913), Ltd., have declared a final dividend of 2½ per cent., tax free, making 7½ per cent. for the year. A sum of £6 000 is placed to special reserve for bad debts, £3 685 to depreciation and £40 573 carried forward, subject to taxation demands.

The directors of the Peterborough Electric Traction Company, Ltd., recommend a dividend of 18 per cent. on the preference shares for three years ended Dec. 31, 1920. A sum of £768 has been placed to reserve, £3 000 to renewals fund, £6 132 for repairs and maintenance and £932 carried forward.

The directors of the Metropolitan Electric Tramways, Ltd., have declared dividends of 4½ per cent. for 1918 and ½ per cent. on account of 1919 on the preference shares. A sum of £10 868 is placed to reserve, £10 000 to reconstruction and renewals, £262 309 to repairs and maintenance, and £1 539 is carried forward.

The net profit of Bell's United Asbestos Company, Ltd., for 1920 was £64 670, and a final dividend on the ordinary shares of 1s. 6d. per share is recommended, making, with the interim dividend paid in October last, a total distribution at the rate of 122 per cent. for the year. £20 000 is placed to depreciation reserve and £34 124 carried forward.

The directors' report of Chiswick Electricity Supply Corporation, Ltd., for 1920 states that, after paying interest on loans, sinking fund premium and trustees' fees, the profit was £15 770. With amount brought forward, the sum standing to credit of net revenue account is £13 559. The directors recommend a dividend of 3 per cent., placing £6 500 to depreciation reserve and carrying forward £2 035.

It was reported at the meeting of the Tynemouth & District Electric Traction Company, Ltd., yesterday (Thursday) that the total revenue for 1920 was £38 654 and the expenditure £31 505, with £7 811 brought in, the available total was £14 960. After paying the dividend on the cumulative preference shares of 5 per cent. and a dividend on the ordinary shares of 10 per cent. for the year, £8 794 was carried forward.

The total revenue of the Bristol Tramways & Carriage Company for 1920 was £920 744. Working and general expenses and renewals amounted to £958 884, and in view of the abnormal conditions the directors have transferred £45 000 from reserve, so that with excess profits duty repayable and balance brought forward the balance is £90 224. After paying interest on the 4 and 4½ debenture stock, and a final dividend on the ordinary shares at rate of 4 per cent. (making 7 per cent. for the year), a sum of £3 727 has been carried forward.

The gross profit of the Rangoon Electric Tramway and Supply Company, Ltd., for 1920 was £98,340 (against £89,357 in 1919). Adding interest and transfer fees and deducting various outgoings including £3 115 for depreciation on sundry assets in Rangoon, £27 500 transferred to reserve for renewals and £4 151 for Indian income-tax, the net profit is £37 642 (against £27 304). A dividend on the Ordinary shares is proposed of Rs. 1·8 (10 per cent.) per share, free of all tax, leaving £9 303 to be carried forward, against £4 361 brought in.

The directors' report of the Bath Electric Tramways, Ltd., for 1920, states that after including £4 251 brought forward, the available balance is £17 533, out of which the following amounts have been deducted: £5 478 for interest on 4½ per cent. first mortgage debenture stock; £1 000 for sinking fund and £3 750 for dividend on the preference shares, leaving £7 305. From this the directors have transferred £5 000 to contingencies and renewals account, and recommend that the balance of £2 305 be carried forward to provide for contingencies and replacement.

The accounts of the North of Scotland Electric Light & Power Company, Ltd., for 1920 show that, after providing for interest on debentures and loans (£3 917), writing off £284 from suspense account and making provision for income-tax (£1 992), the balance is £7 529, and adding £729 brought forward, there is £8 259 to be dealt with. The directors recommend payment of a dividend at the rate of 1¼ per cent. for the year, being the maximum dividend allowed under the Temporary Increase of Charges Act, which will absorb £625. A sum of £5 000 has been placed to renewal reserve account and £2 000 placed to general reserve account, the balance (£634) being carried forward.

The net profit of the Craigpark Electric Cable Company, Ltd., for the year ended March 31 last was £15 677 (after making provision for taxation demands), and with £2 926 brought forward, the sum available is £18 603. The directors recommend that £2 000 be applied to depreciation off buildings and machinery and that £6 000 be placed to reserve, and after paying the year's dividend on the 6 per cent. preference shares, it is proposed to pay a dividend on the ordinary shares of 12½ per cent. for the year, leaving to be carried forward (subject to payment of directors' fees) a sum of £3 066. The directors regretfully record the death of Mr. Donald MacLean, who was recently appointed a managing director after serving with the company since its inception.

Mr. J. G. B. Stone, who presided over the meeting of the Indian Electric Supply and Traction Company, Ltd., last week, stated that there had again been an increase in the number of units sold in all departments, except under the heading of special contracts, where, owing to the temporary stoppage of mills due to labour unrest, the figure was 793 240 units, against 1 110 000 units in the previous year. The small tramway which they operated showed slightly more satisfactory results, but the system was too small to be an important factor in bringing the company additional revenue, and at present there was no profitable field for extension. Good progress was being made with the new power house which was in course of erection on the riverside, and the 6 000 kW of new plant was being shipped. They hoped to have effective use of the station early in the new year and there was already a demand for the whole output. They had a total of £38 784 for disposal, of which £11 011 had been disbursed on account of the interim dividend of 3 per cent. on the ordinary shares and the dividends on the seven per cent. preference shares, leaving £27 773. Out of this the board had placed £6 000 to reserve for depreciation and renewals, £6 500 to general reserve and £2 500 had been written off debenture issue expenses and £513 off new share issue expenses. A final dividend of 7 per cent. on the ordinary shares was declared, making 10 per cent. for the year, leaving £5 074 to be carried forward. Mr. Seton Eustace has joined the board in succession to the late Sir Ralph Ashton.

The revenue of the London & Suburban Traction Company, Ltd., for 1920 was £51 961. After deducting administration and general expenses, debenture and loan interest, &c., and including £1 205 brought forward, there remains £2 098 to be carried forward. Presiding over the meeting on the 5th inst., the Chairman, Lord Ashfield, said that they did not have a successful year. The primary interest of the company was in tramways, and almost without exception tramways throughout the country reached a condition some months ago in which they had become unremunerative. All payments for labour, services and commodities had moved upwards with the rise in economic levels occasioned by the war, but fares had, until quite recently, owing to the dead hand of the maximum powers legislation, been held almost at the old level. The Tramways (Temporary Increase of Charges) Act, 1920, was passed in May last, and the three tramway companies in which they were interested enjoyed during the latter part of 1920 the benefit of orders made under the Act authorising increased fares. The results for the year were an improvement on those for the preceding year, and bore the possibilities of much further improvement. The traffic receipts showed a growth in two years of 48 per cent., but in that period expenses only increased 46 per cent. The car mileage worked in 1920 was almost identical with that of 1919, and not materially greater than that of 1918. He looked forward to some appreciable advancement in their fortunes. The first three months of this year show a substantial gain on the results for the corresponding months of 1920. It was not possible to make any distribution on the share capital and the arrears of dividend on the 5 per cent. cumulative preference shares amounted to £280 605.

Mr. A. M. Quill, who presided over the meeting of the Madras Electric Tramways (1904), Ltd., stated that a strike occurred in January of last year and lasted nearly seven weeks. The men's union demanded the reinstatement of two men who had been discharged several months earlier. Though the Board indicated that while they ere willing to refer questions of wages, conditions of labour, or of principle to arbitration they could not refer any question of management or discipline, and ultimately the strike collapsed. The effect of the stoppage would be reflected in the accounts for 1921. In addition to the strike early in 1920 a partial stoppage of the employees of the Madras Electric Supply Corporation, which supplied the company with current, occurred between May 26 and June 22, during which period they had a restricted service of cars running. The balance from running account, after providing for maintenance and all expenses in Madras, was £40 893, compared with £26 986 for 1919. The increase was almost entirely accounted for by the difference in exchange. The entire increase of 16.6 per cent. in traffic receipts was absorbed in increased cost of running. In the latter part of last year the Madras Government authorised increases in fares up to 50 per cent., and on 14th March last their three principal stages were increased. They were paying a further dividend of 4 per cent. on the ordinary shares, making 8 per cent. for the year, tax free, the contribution of £1 000 to the employees' gratuity fund, and the transfer of £3 500 to general reserve, leaving to be carried to next year's accounts £5 555. The Mount-road extension had been practically completed, but the line could not be opened until the Government had strengthened the bridges.

The directors of Babcock & Wilcox, Ltd., report that the net profit during the year 1920 was £497 468, and with the balance from 1919, less the amount voted to the directors as bonus at the last meeting, the total available is £618 593. The interim dividends paid in November on the first and second preference shares and on the ordinary shares absorbed £157 894, leaving £460 699. The directors now recommend that the following dividends be paid for the half-year ended 31st December, 1920, viz.: 3 per cent. on the preference shares (£3 000), 2½ per cent. on the second preference shares (£4 476) and 9 per cent. on the ordinary shares (£193 395). It is also proposed to place £150 000 to the reserve fund and to grant £10 000 to the staff pension fund, leaving to be carried forward £99 828. The extension at the works to provide for greater output and to make good the reduction in output occasioned by the alteration in working time to 47 hours per week have been completed. The output of the workmen is still on the average below pre-war standard, and the continual interruptions, through trade disputes, militate against the business, as they do against every other industrial concern. The coal strike has caused a stoppage of the works in certain departments. New offices at London and Renfrew have been completed and occupied, and more workmen's dwellings have also been completed. New orders are somewhat difficult to obtain at present owing to the high cost and the financial conditions that prevail. The construction of the large works of the Sociedad Espanola de Construcciones Babcock & Wilcox in Spain is completed; the works are in operation and well supplied withorders.

The directors' report of the Calcutta Electric Supply Corporation, Ltd., states that 38 820 839 units of electrical energy were sold during 1920, compared with 31 881 710 units in 1919. The number of houses connected was 11 505, against 10 287, an increase of 1 218. The gross revenue was £398 382 (against £359 949), and the net revenue £263 482 (against £237 206). The total profit for the year, including interest received on money at deposit, was £270 160, and with balance brought forward (£45 699) the total was £315 859. Deducting debenture interest (£4 579), preference dividend (£24 750), the interim dividend of 4 per cent. on the ordinary shares paid (£16 775), the income tax and excess profits duty (£32 749) and interest on consumers' deposits (£1 385) the available balance is £235 621. The directors recommend that £24 793 be written off total cost of debenture issue in 1920, that £83 000 be placed to reserve for taxation, £5 000 be transferred to reserve, £43 760 to depreciation and renewals, £3 000 to insurance and £2 000 to the retiring gratuity fund, and that a final dividend on the ordinary shares be paid of 6 per cent. (actual), making 10 per cent. for the year, and also a bonus of 1 per cent. (£31 682), leaving to be carried forward £42 386.

It is pointed out that the ordinary shareholders obtain in the interim and proposed dividends the relief granted in respect of income and super tax paid in India, which for 1920 is equivalent to about an additional 1 per cent., and from July 1 last the reference shareholders have received their dividends free of all taxation on income, both British and Indian, up to 6s. in the £. It is proposed to grant to the staff in India a bonus equivalent to 2 per cent. of the net Indian profits, in respect of service during the past year. The capital expenditure last year amounted to £338 937, making the total outlay £1 764 844. The demand for electrical energy continues to increase, and satisfactory progress has been made in meeting it. For carrying out necessary extensions of the undertaking an issue was made in July last of £500 000 of 5 per cent. 1st mortgage convertible debentures (tax free), and the issue was fully subscribed.

The directors' report of the British Thomson-Houston Company, Ltd., for the year 1920, states that the works at Rugby, Coventry and Willesden have been maintained in good condition. The greater part of the extensions to the Rugby works, begun during 1919, is still uncompleted, owing to the various causes which have retarded building operations generally throughout the country. New buildings which have come into occupation at Willesden since the last report have materially increased the manufacturing facilities there. The changes necessary at the Birmingham works are being carried into effect as rapidly as possible. The profits for the year, after deducting all expenses and charges other than interest on debentures and loans, and after making provision for all estimated taxation for the year, were £470 470. Adding £208 431 brought forward and deducting interest on debentures and loans (£179 990, the balance is £498 911; of this amount the directors recommend that there be appropriated for depreciations, reserves, &c., £210 000; the dividends recommended will absorb £63 019, leaving £225 892 to be carried forward.

The dividends recommended are on the old and new shares for the respective times that they were outstanding during the year, and are as follows: On the old preference shares (since converted into ordinary shares) for 8 months at 4 per cent., on the new preference shares for one month at 7 per cent. and on the ordinary shares at 6 per cent. (tax free). In the last report the directors recommended the dividends aggregating £250 000 should be declared payable out of the capital reserve account and this was carried out by distributing £250 000 of £1 ordinary shares, of which £210 000 represented accumulated dividends on the old preference and £40 000 dividends on the old ordinary shares. At the same time the share capital was increased to £4 000 000; £2 000 000 in £1 ordinary and £2 000 000 in £1 preference shares. During the year there were issued at par the balance of the ordinary shares, amounting to £950 000, thereby completing the total issue of £2 000 000 ordinary share capital, and there were also issued at par £1 500 000 preference shares, leaving £500 000 to be issued. The total par value of debentures redeemed to date is £59 705, leaving a net amount outstanding at date of £152 295.

New Companies.

The following list is compiled from information supplied by Messrs. Jordan & Sons, Ltd., company registration agents, Chancery-lane, London, W.C. 2:—

"ALFO" ELECTRICAL ENGINEERING COMPANY. (174 379)—Reg. April 25, capital £2 000 in £1 shares, to carry on business of electrical engineers. Directors: H. G. Fowler and W. F. Almond. Reg. office: 37, Moorfields, Liverpool. Private company.

HEADS (ELECTRICAL) LTD. (174 402)—Reg. April 26, capital £3 000 in £1 shares, to acquire and carry on business as manufacturers of electrical accessories and motor and general engineers. Directors: B. M. Head, J. Rest and C. H. Carter. Reg. office: 165, Wardour-street, W. Private company.

KENT HOUSE ENGINEERING COMPANY, LTD. (174 403)—Reg. April 26, capital £3 500 in £1 shares, to carry on business of electrical and mechanical engineers. Directors: E. Robinson Ransden, R. F. Pearce, S. I. Hitchcock, E. C. G. Ottley, J. Murray and K. E. Bartlett. Reg. office: 32, Fenchurch-street, E.C. Private company.

MOODYS, LTD. (174 389)—Reg. April 25, capital £1 500 in £1 ordinary shares, to carry on business of electrical engineers and contractors. Directors: A. E. Moody, 24, Hungerford-road, Holloway, N.7 (man. dir.), V. H. Moody and B. Guest. Private company.

PREMIER PRIVATE TELEPHONE COMPANY, LTD. (174 408)—Reg. April 26, capital £2 000 in £1 shares, to acquire a certain patent for an invention in relation to improvements to telephones and carry on business of electricians, &c. Directors: E. C. Aspden, 92, Grenville-street, Stockport, D. Wallace, A. L. Barnes, J. Kay, S. Ridgway, A. Dutton, W. S. Whittaker, G. E. Pennington and G. Trafford. Private company.

RILEY PATENTS, LTD. (174 390)—Reg. April 25, capital £5 000 in £1 shares, to acquire and carry on business of manufacturers of and dealers in telephones and telephone apparatus, in metal, rubber, wood, china, glass, composition or other material. Reg. office: 20, Denman-street, W. Private company.

WOODALOID, LTD. (174 326)—Reg. April 20, capital £1 000 in 900 £1 preference and 2 000 1s. ordinary shares, to acquire and carry on business of mechanical or electrical engineers, pattern makers and wood workers. Directors: A. B. Shaw, S. J. Rouse and W. R. Gaff. Reg. office: 2, Tanfield-court, Temple, E.C.4. Private company.

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics": "The R.L.M. Air Line"; "The Van Berket Float Seaplane"; and "Circumferential Wiring of Rigid Airship," by E. H. Lewitt."

"The Cabinet Maker": (Annual Soft Goods Number).—"Textiles in the Theatre"; "Colour and Form," by M. McLeish, with coloured plate; and "A Review of Furnishing Textiles."

"Chemical Age": "Wood Distillation as a National Industry," by E. C. Powell; and "Reviews of New Chemical Works."

"Farm and Home": "The Taxation of Agriculture"; "Housing the Goat"; and "Continuous Cropping."

"The Fruit-Grower": "The Celery Fly and its Control"; "Fruit Crop Prospects"; and "Utilising Frames for Cucumber Production."

"The Gas World": "Analyses of some Gas Companies' Accounts"; "Complete Gasification of Coal"; and "Incombustibles in Town's Gas."

"Hardware Trade Journal": "Annual Meeting of the Iron and Steel Institute"; "The Future of the I.F.A."; and "The Prices of Cut Nails."

"Gardening Illustrated": "Early Flowering Spiræas"; "Rose Sovereign" (illustrated); and "Size of Seed Potatoes."

Arrangements for the Week.

FRIDAY, May 13th (to-day).

Physical Society of London.

5 p.m. At the Imperial College of Science, London, S.W. Papers on "Notes on Vacuum Tubes used as Detectors of Electrical Oscillations," by Mr. L. Hartshorn and Mr. E. S. Keeping; "The Coefficient of Diffusion of Certain Saturated Solutions," by Mr. B. W. Clack; and "Experiments on Thermal Transpiration Currents," by Dr. G. D. West.

Junior Institution of Engineers.

8 p.m. At Caxton Hall, London, S.W. Paper on "Scientific Developments in Gas Measuring Instruments," by Mr. H. G. Brown.

SATURDAY, May 14th.

Royal Institution.

3 p.m. At Albemarle-street, London, W. Lecture on "Chemical Reaction," by Mr. E. C. C. Baly, C.B.E., F.R.S. (Lecture II.).

WEDNESDAY, May 18th.

University of London.

5 p.m. At University College, Gower-street, London, W.C. Lecture on "Wireless Telegraphy and Telephony by Continuous Waves," by Prof. J. A. Fleming, F.R.S. (Lecture III.).

FRIDAY, May 20th.

Junior Institution of Engineers.

8 p.m. At Caxton Hall, London, S.W. Lecturette on "Liquid Fuels," by Mr. A. Arnold.

Forty Years Ago.

(The Electrician, May 14, 1881.)

The Legion of Honour.—M. Gaston Plante, the well-known electrician, has just been created Chevalier of the Legion d'Honneur.

Maxim v. Edison.—The appeal taken by Mr. T. A. Edison in the interference case of "Maxim against Edison" has been decided against Edison's claim by the "Board of Examiners-in-Chief" of the United States Patent Office.

City Guilds Institute.—On Tuesday last Prince Leopold laid the foundation stone of the new college for the advancement of technical education recently established by the City and Guilds Institute, in Cowper-street, E.C. The building is estimated to cost £25 000.

The Swan Light at the Royal Society.—At the annual reception by the President and Council of the Royal Society, on Wednesday evening, the 7th May, the library was illuminated by the Swan electric light, which was worked from an Otto gas engine in the basement. The light was steady and clear.

Prices of Metals, Chemicals, &c.

Tuesday, May 10.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£73 5 0	£1 15 0	—
Electro Wirebars	,,	£74 0 0	£1 0 0	—
H.C. wire, basis	per lb.	0s. $11\frac{7}{16}$d.	⅛d.	—
Sheet	,,	1s. 0½d.	—	—
Phosphor Bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. $3\frac{7}{16}$d.	⅛d.	—
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1d.	—	—
Wire, basis	,,	1s. 1d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£6 5 0	—	5s.
Galvanised steel wire, basis 8 SWG	,,	£27 0 0	—	—
Lead Pig—				
English	,,	£25 0 0	£2 5 0	—
Foreign or Colonial	,,	£24 0 0	£2 10 0	—
Tin—				
Ingot	,,	£176 5 0	£6 5 0	—
Wire, basis	per lb.	2s. 5d.	¾d.	—

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £13 10s.

,, (Roll-Brimstone).—Per ton £12 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £30.

Boric Acid (Crystals).—Per ton £69.

Sodium Bichromate.—Per lb. 7½d.

Sodium Chlorate.—Per lb. 4½d.

Rubber.—Para fine, 10½d.; plantation 1st latex, 10d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

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Notes.

The Return Home.

The jubilee of the Institution of Electrical Engineers has been celebrated in two ways, both equally appropriate. One is the re-opening of the building on Victoria Embankment from which the Institution was driven by the hoards of bureaucracy, which War engendered and Peace made unnecessary. This return took place without either pomp or ceremony last Tuesday; and we have no doubt that there will be a large gathering on Thursday next at the first ordinary meeting in the restored premises. Apart, however, from sentimental and historical reasons members would do well to make a point of hearing the lecture which is then to be delivered by Messrs. A. Johnsen and K. Rahbek on "A Physical Phenomenon and its Application to Telegraphy, Telephony, &c." Briefly, the lecturers' claim is that by sending an electric current through certain substances, such as, for instance, lithographic stone, an adherent force in some respects resembling, but entirely different from, electromagnetism is produced. This claim is, we have no doubt, put forward in the true scientific spirit for examination and criticism and in the further hope that it will inspire a series of inventions both inside and outside the field of wireless telegraphy. Dogmatic scepticism in such cases would be as wrong as a free acceptance of such a theory without due weighing. We are sure that what the lecturers have to say will be carefully considered and our hope is that some of their expectations at least will be realised.

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The Royal Charter at Last.

The second way in which the jubilee of the Institution is to be celebrated is by a petition for a Royal Charter of Incorporation and a resolution authorising the Council to apply to the Privy Council for such a document is to be proposed at a Special General Meeting on May 31st. Those who are informed on these matters will, no doubt, consider that this step is long overdue. For the Institution with its membership of nearly 10 000 is the largest body of its kind in the country. It represents a very wide range of interests, and if it is to possess that influence which is not only its right but a necessity, it should certainly be given that increased status which a Royal Charter bestows. An application for a Charter was made as long ago as 1880 but failed owing to opposition from one of the other engineering Institutions. If similar opposition arises on this occasion the Institution should be in a position successfully to meet it and it can be placed in that position by members sending the Council a postcard assuring them of their support. This is the more necessary as the possession of a Charter will give corporate members the right to designate themselves Chartered Electrical Engineers, thus conferring a status which is abundantly necessary and distinguishing them from those electrical engineers who are merely so by self-conferred title. Our desire is to see the electrical engineer taking a greater part in the country's affairs and in spite of the rather vague wording of the draft Charter we feel this is a great step towards that end.

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Electricity Supply in South Africa.

Following the example of Great Britain, steps are to be taken to reorganise and co-ordinate the electricity supply undertakings of South Africa. In a preliminary report on the subject, which is given in abstract in another column, Mr. C. H. Merz makes a series of recommendations to this end. These include the passing of an Act for unifying and modernising the existing legislation governing the electricity supply in the various states of the Union, for the appointing of a controlling authority and for fixing standard pressures and frequencies. The importance of developing the supply of electric power is justly emphasised in order that existing manufacturers may be encouraged and new industries attracted. Moreover, as it is intended to adopt electric traction on some of the railway lines, in accordance with a voluminous report Messrs. Merz & McLellan issued some time ago, it is essential that a definite line of development should be mapped out to provide a suitable supply of power for all purposes. The position in South Africa, a comparatively new and undeveloped country, is from this point of view much simpler than in Great Britain, for with the exception of the Rand the existing undertakings are mainly owned and run by Municipal Councils. It should therefore not be very difficult to co-ordinate the work of electricity supply.

Policy to be Adopted.

Perhaps the most interesting portion of Mr. Merz's Report is that devoted to a consideration of the policy to be adopted to bring this result about. The questions of ownership and control and the relative advantages of municipal and private enterprise are dealt with in an impartial spirit. It is pointed out that in a new country like South Africa, while there will be cases where the State will have to do things because other people will not or cannot, and many cases where the municipalities can well do them, it is certain that the State neither can or ought to deal with the whole question of the generation, distribution and supply of electricity. Private enterprise must be encouraged if the country is to be rapidly developed and this can best be done by giving security of tenure and opportunities for making adequate profits. This is obvious to all business men, but in these days of socialistic influences and tendencies it is well to emphasise it. On the other hand, Mr. Merz points out the need for the reasonable though not meticulous control of capitalisation of the undertakings and of the prices charged by them. Again, while the ownership of the generating stations and transmission lines would depend upon local conditions, the distribution system should be left to private enterprise or to the local municipal bodies, while the development of electro-chemical works and other industries should also be left in private hands. As there are abundant coal and mineral supplies in South Africa there should be a great future for electricity supply in that country, with a steadily-increasing demand for power as industries are established and as the white population increases. No doubt the time has arrived, as Mr. Merz points out, for laying down the general principles upon which this development is to take place if complications are to be avoided.

Continental and American Practice.

It is well known that the electrical industry originally became more firmly established in the United States and on the Continent than in Great Britain. It is not necessary to detail the reasons—traditional conservatism against the use of electricity, legislative repression, lack of combined action among manufacturers and the reaction of limited home experience on projects abroad—which caused the pre-war years of British electrical manufacture to be so lean, but it is obvious that close attention must now be given to tendencies both in America and on the Continent in order that the British industry may become as powerful as the great corporations elsewhere. To this end an article on "Tendencies in Electrical Manufacture in the United States," by Mr. A. M. Randolph, which we print on another page of this issue, is interesting. Mr. Randolph points out that markets hitherto satisfied by European suppliers are accustomed to greater individual consideration than is possible by makers of closely standardised products and that though wages in America are high, that country has probably still to undergo many industrial trials which this country has already weathered, particularly in connection with the recognition of Trade Unions. At the same time, there is no suggestion that the two great companies dominating the industry in that country are satisfied with things as they are. Both are continually branching out in new directions and possess powerful research organisations.

Economic Re-establishment of Germany.

On the Continent conditions are a little more difficult to gauge, as the future of the electrical industry there is largely bound up with the economic re-establishment of Germany. There is, however, little doubt that the qualities which made the electrical industry powerful before will do so again. Among these may be mentioned great thoroughness in detailed organisation, which makes for manufacturing efficiency but not for flexibility and adaptability (qualities which enabled English factories to play such a great part in winning the war), a willingness to supply clients with the material they require irrespective of standardised designs or whether it was good for them and a readiness to establish subsidiary industries—which frequently became key industries—to meet specialised requirements, such as the manufacture of insulating materials, including special papers, textile fabrics and the varnishes and porcelains, required exclusively for electrical work. The degree of technical excellence in design is also high. The application of scientific discoveries originating from any source is eagerly made. The connection between works and universities is close and many laboratories are subsidised jointly by manufacturers' associations, universities, municipalities and the State. Works research is generally conducted in the various departments and the extent to which dependence is placed on it is not obvious on the surface. There is close combination among manufacturers and recently movements towards amalgamation have been common.

Academic and Practical Knowledge.

It is generally admitted, however, that Continental engineers are more academic than British engineers and do not possess in the same degree that leaven of practical knowledge which is gained by actual experience in workshops. From this point of view the British method of training clearly has its advantages. They lack the publicity sense so keenly developed in America and service to the customer is not yet a slogan. The skilled Continental workman has not the same reputation for good workmanship as his British *confrère*, but he is very willing to work to instructions and accepts a standard of living considerably below that common in this country. Only by a careful evaluation of the policies of competitors can the future of the electrical industry in Great Britain, particularly with reference to export markets, be safely estimated.

The Royal Society's Conversazione.

The publication of our Manufacturers' Issue precludes us from dealing in the usual way with the exhibits shown at the Royal Society's conversazione held at Burlington House last week. Although few of the exhibits can be described as essentially of an engineering nature, there were some which were of electrical interest and to these we shall hope to refer in due course. Attention may, however, specially be called to Needham's pulsator system of speed measurement and control, which was shown by Messrs. Evershed & Vignoles in its application to such purposes as telegraphing from the navigation bridge to the engine room on board ship. Prof. K. Onnes, Sir Robert Hadfield and Dr. H. R. Woltjer exhibited apparatus and specimens used in a research on the influence of low temperatures on the magnetic properties of alloys of iron with nickel and manganese. The exhibits shown by the National Physical Laboratory included a relay for breaking moderately large currents designed by Dr. Guy

Barr, wherein the usual difficulties from sparking are avoided by causing the make and break to occur in an atmosphere of hydrogen. The Laboratory also showed radiotelegraphic direction finding apparatus of the type developed by Capt. Robinson of the Royal Air Force. In this two coils at right angles are connected in series and rotate together until the signal strength is unaltered by reversing actions in one of them. This gives the direction from which the signal is coming.

Electric Lighting of Suburban Stations.

An interesting method for the electric lighting of railway stations is now being used on the London & South-Western Railway. The introduction of electric traction on certain sections of the system necessitated a change over from direct current to alternating current track circuiting, so that the running rails could be used for the return traction current as well as for signalling purposes. This in its turn necessitated the provision of a thoroughly reliable alternating current supply, that is a supply which would not only be available at all times, but would have a frequency considerably higher than that of the 25 cycle main three-phase current used in connection with the traction supply. Mr. Herbert Jones, chief electrical engineer of the London & South-Western Railway, therefore decided to run a 3 300 V twin core single phase cable between Waterloo and Clapham Junction and from Clapham Junction to Clapham Junction via Wimbledon, Kingston and Richmond, tapping off this cable at each station and transforming the energy down to 220 V for lighting and signalling purposes.

A Combination of Lighting and Signalling Circuits.

The supply given for both lighting and signalling is single-phase at a frequency of 75 cycles, and is obtained from motor generators which are erected at the Durnsford Road power station and at the Waterloo, Clapham Junction, Raynes Park and Twickenham sub-stations. Four of these sets are driven by 25 cycle induction motors from the main alternating current supply, and the remaining three from direct current motors which obtain their supply from sources that are always available, such as auxiliary sets, a floating battery in the power station and a standby battery in the Waterloo sub-station. This continuity of supply is, of course, more than ever desirable owing to the fact that the signals must always be in working order. As a rule, we understand, supply is obtained from the induction-motor-driven alternators during working hours and from the direct current driven alternators during the night when the main 11 000 V supply is not available. The change-over from gas to electric lighting at the stations affected is now approaching completion; considerable delay having occurred owing to the shortage of labour and material caused by the war. To supply lighting for traction circuits is, of course, not unusual, but it would be interesting to know whether this combination of lighting and signal circuits is to be found elsewhere.

Gas and Typography.

The interest which we take in the somewhat feverish writings of our old friend "Electricity Supply Memoranda" is not unmixed with awe at the skill with which he is able to generate so large an amount of heat from so unpromising a fuel. But as Homer sometimes nods, so "Electricity Supply Memoranda" is sometimes caught tripping. It will have been generally noticed that on the Government posters which bear exhortations to "Save Coal," "Save Gas," "Save Electricity," the word electricity is not only put in the third place but in smaller type than the words "coal" and "gas." The subject has already been one for semi-facetious comment, even in electrical circles, but it has been left the "Electricity Supply Memoranda" to discover that the reason for electricity being relegated to the lowest place and smaller type is "that as a heating agent its popularity and use are not on the same level as coal and gas and the degree of its use for such a purpose is something the authorities felt they could almost ignore." We thank E. S. M. for that "almost," but, really, we are more than a little surprised. Surely E. S. M. must know that though gas is compressible, type is not, and that since there are twice as many letters in the line "Save Electricity" as in either of the lines "Save Coal" or "Save Gas," the reason for the smallness which has amused him so much is primarily due to typographical limitations, whatever the secondary reasons that E. S. M.'s ingenuity and ingenuousness may be able to discover. We might suggest that another reason for the smaller type is that the Government realise that as generating electricity is the most economical way of using coal, there is less need to spare it when used in this way than if it is employed directly or for making gas. But since E. S. M. also puts forward that as explanation himself, we refrain. We must, however, thank him for his paragraph. For many years E. S. M. has indulged in the fascinating pastime of pulling other people's legs. This is the first occasion on which we remember him pulling his own. It is as refreshing as it is novel.

Some Essentials of Manufacture.

Since we published our special Manufacturers' Issue on April 30th last year great changes have taken place in industrial conditions in this country. Then we were at the top of a trade boom, now we are wallowing in the depths of a slump. There is a strike—which, as far as external indications go, may continue for ever—in our master-key industry, a strike which has not only brought production to a standstill and reduced our export trade to an exiguous figure, but must also have a profound influence for evil on our future trade. But whether we are passing through a slump or a boom and whether we are making money or losing it, the essential problems which electrical manufacturing interests have to solve remain the same, for they go much deeper than such ephemeral things as coal strikes. At one end of the scale there is all that confused ramification of ideals, false analogies, muddled economics—in a word, that great congerie of the human element which is conveniently called the "labour problem" and at the other there is the paramount necessity of selling the product turned out from works in the best possible way, in the greatest possible numbers and in the widest possible market.

The Problems of Manufacturing Proper.

We dealt with a few phases of this wide problem in our Manufacturers' Issue last year. This year we take a different line and consider certain questions which, bounded by the four walls of the works, might justly be called manufacturing proper. There is much to be said for this course. Manufacturing, in the widest sense of the term, is undergoing a profound change. Indeed, we should not be going too far to call it a change comparable in importance to that caused by the introduction of the spinning jenny by Arkwright, by the improvements in the steam engine connected with the name of Watt or by the discovery of electromagnetic induction by Faraday. But there is this difference between the last of these and the other two: that while the effect in their case was to introduce machinery where hand labour had heretofore been pre-eminent, and so not only to increase production but to cause a re-orientation of labour, the electric drive will go a step further, and alter altogether the influence of the human factor in industry.

The Elimination of the Human Factor.

In other words, the two first began the transition from purely manual labour by using the operative as a link in a chain of machinery. The increased use of the electricity, coupled with much other mechanical invention, will go far to eliminate him altogether. How true this is may be gathered from the articles on modern machine tool practice in its relation to the electrical industry which appear on other pages of this issue. They show that, whether it be grinders, gear-cutting machines or turret lathes, the object of the designer is to obtain a machine which will operate for a maximum time with a minimum of attention, and so increase production and decrease cost. As far as the electrical industry is concerned, this is all to the good in two ways. The various processes of manufacture in most industries will be improved by the increasing use of the electric drive, while that increasing use will be facilitated by the employment of the most modern methods in the manufacture of electrical equipment. At present there is room for improvement, and electrical engineers would do well to obtain the assistance of the mechanical engineer and the machine tool expert, as Mr. Vernon and Mr. Asbridge rightly point out, in the solution of their specialised problems

Labour and Money Saving.

It may be argued that, owing to the extra capital expenditure necessary, the saving which will be obtained by the adoption of new methods is more apparent than real. As a matter of fact, it is more real than apparent. Capital has to be spent, it is true, but the extra productive capacity made available renders that capital essentially productive. More important still, a step will be taken towards the day when the men and women employed in engineering factories will be doing really human work, and not acting more or less efficiently as parts of a machine. This is an ideal that is well worth working for.

The Ways and Means of Efficient Production.

We do not intend in this place to say anything about labour troubles in their relation to all these questions except that the uncertainty which the ever-recurring industrial disputes engenders in the industry is not without its brighter side. It forces manufacturers, sometimes unwillingly, to adopt labour-saving methods, to overhaul their organisation and to consider in all their bearings the ways and means of more efficient production. It calls attention also to the need of co-operation in the widest sense. Such co-operation in fact as is particularly necessary in the investigations into the properties of materials, of equipment and of improved methods of manufacture! In pre-war days working in watertight compartments was the approved policy and there is a regrettable tendency to revert to it. But that sort of secrecy, even if it were possible, does no good and real advantages are obtainable from a combination of interests in the technical and manufacturing as well as in the selling fields.

From the employees' point of view there are many advantages in this course. It will certainly lead to a change rather than to a lack of employment, and it will bring into being that broader outlook and greater interest to whose absence may be ascribed a good deal of the present industrial unrest. This question, though it is not the all-in-all of engineering production and has perhaps been unduly stressed owing to recent events, is certainly of the highest importance. For it is useless, as Mr. Llewelyn Atkinson pointed out in his presidential address, to continue to perfect the machinery of material civilisation if in the end that civilisation is wrecked because of the dissatisfaction of the people for whose satisfaction the perfecting is designed.

Improvements in Methods.

Apart from an improvement in labour conditions there are many ways in which production can be improved, and it is with some of these that the articles published in this issue specifically deal. We may, for instance, call attention to the stress placed by Mr. Mensforth and Mr. Chambers on the need for paying greater attention to the extraction of the last ounce from all the material used, and to the examination of scrap metal and other material to discover whether the whole of its utility has been exhausted before it is finally consigned to waste. The importance of the scrap heap has always been an article of faith in engineering practice, but like a good many articles of faith it has often been more honoured in the breach than in the observance.

Capital versus Revenue.

As we have already mentioned more than one author argues that electrical manufacture would be better and more efficiently conducted if there were less of the professorial element in its lay-out. Prof. Miles Walker's article is a considered argument for the other point of view. He makes the important point that there is a limit to the cutting down of the material used in electrical machinery, however much such a policy may be desirable for economical reasons. It is in fact the old question of cheapness versus efficiency or, looked at from another point of view, of capital versus revenue. These are dual matters which must be considered together and the best practice is that which gives each of them their proper weight, whether it be in design, production or argument. While manufacturers of machine tools have taken the opportunity of giving advice to the electrical industry Prof. Miles Walker has something to say to machine tool manufacturers. We hope that mutual benefit will result, for only from a calm and open consideration of every point of view can we expect improvement, and it is the object of these special articles to suggest lines of thought out of which improvement may come.

It is both fashionable and easy at the present time to be pessimistic with regard to the future. True, things are changing, but they are not necessarily changing for the worse. There is a grain of comfort in the fact that if we are badly off other nations are worse off, and in any event the present depression is but a temporary phase and undoubtedly will pass. But its passing will be accelerated by a careful consideration of the many problems which are awaiting solution in the manufacturing world. But that rather than being a reason for downheartedness should be one for satisfaction. An industry without problems is already moribund.

The Organisation of the Salaried Classes.

The advantages of the organisation of both individuals and bodies having the same, or similar, objects, is now generally recognised, at least theoretically. This recognition is equally patent whether the association be one of employers whose objects are the stabilisation of trade conditions, the arrangement of contracts and the organisation of the supply of raw materials, or of employees with a view to the improvement of wage conditions, insurance against unemployment and the prevention of unqualified men working in their particular branch of the industry. Bodies of both these kinds have been long established and, in spite of certain spectacular and ill-conceived actions on the part of some of them, in both classes, have operated sufficiently for the good of those concerned and of the industry of the country generally.

But between these two sections of the country's industrial workers lies another large class which includes all engaged on the managerial, administrative and technical staffs of manufacturing and commercial concerns from the works manager to the draughtsman; or, in a word, comprises that useful body which is commonly called the brain worker. This class in its many ramifications is only now beginning to organise itself, and it is significant that, probably as a result, it has neither been treated in a way, nor has it taken that place in the body politic, to which its talents and utility, to say nothing of its numbers, undoubtedly entitle it. This is a bad thing for all concerned, and we are therefore glad to see that the movement which has got into motion during the last few years with a view to achieving a better organisation of these intermediate groups in industry into associations designed to safeguard their interests is gathering way and, given proper scope, is likely to have a profound effect on future industrial conditions.

A Complicated Problem.

The problem of organising such a body is, however, complicated by the very fact that those whose interests it is intended to assist belong to the middle class. In both the other two classes to which we have called attention the membership is drawn from a relatively limited and well-defined section of the community, and the aims and objects of such societies are, therefore, relatively simple and the policy followed can be made much more definite. In the case of an intermediate organisation, even when the actual membership is restricted to a relatively small group of workers, the positions of those comprising the membership may be very different, and it is therefore difficult to lay down one policy which shall in the best way deal with the varying claims of all those concerned.

This disparity of position and interests is one which every intermediate organisation must face at every turn, and the difficulty is the harder to overcome owing to the temptations offered to its members to ally themselves with already existing associations which have been established either by employers or employees. As we have often pointed out, however, from the intermediate point of view any such amalgamation would be in the highest degree disastrous, as it would lead to the objects of the particular association being submerged in those of the body with which it was amalgamated, and would in the event bring about a state of things even less likely to improve working conditions than exists at present. On the other hand, we feel that an amalgamation between intermediate societies or bodies with similar objects is a policy much to be recommended as, given good management and a broad outlook, the larger the organisation the greater power for good.

The Ideal Policy.

Having determined that intermediate organisations are necessary and that they must free themselves from the trammels and temptations that surround them on every side, it may next be useful to discuss generally the policy that such societies should follow to achieve their objects in the best possible way. It may be broadly stated that the objects of an intermediate association such as we have in mind are to regulate the relations between its individual members and their employers, to secure for those members a greater share in, and responsibility for, the conditions under which they work, to promote the general welfare of its members, to provide legal assistance, especially with regard to the intricacies of patent law, to improve education of existing and prospective members, and to inaugurate such propaganda, whether political or social, as may tend to improve the interests of those for whom it is working. But important and necessary as all these objects are, in our opinion the greatest use of the intermediate organisation is the power it gives to its members to present their case on every matter that concerns their interests not only to individual employers, but to groups of employers and to that great body in the country generally which is represented by public opinion with a clarity and generality that is not possible with the individual.

This is a point which must be stressed, for the unfortunate policy followed by a number of trade unions in recent years has rather obscured the large amount of valuable work which can be done by any professional organisations in putting forward the views of the class which they represent in a considered and Parliamentary fashion, either as a subject for general discussion or as a basis for future policy. Such a presentation of the case is useful to all concerned and its value is not in the least detracted from because neither in the foreground nor in the background need there be any threat of drastic action should the suggestions made not be found acceptable or possible of adoption.

Discarding the Strike Weapon.

Indeed, we think that one of the most important lessons that any intermediate organisation can learn and digest at the present time is not only the danger, but the futility, of flourishing of strike weapon at every possible opportunity. This is not only because at the moment there is no doubt that this weapon is gradually losing its power, but because in the long run very much more can be gained by agreement than by warfare. Again, a strike is only useful for enforcing wages claims on recalcitrant or retrograde employers. And, except in a general way, a true intermediate organisation can have little to do with wages claims. For its members are individuals first and trade unionists afterwards. As individuals, their own ability and enterprise will raise them to the position for which they are best fitted, and in that position they will, in a large majority of cases, be remunerated on an adequate scale. Exceptional cases can, of course, be dealt with as they arise by the association which is likely to be able to enforce its policy more easily the more it clings to the diplomatic methods. The one exception to this rule seems to be the drawing up of a wages scale for young men just out of their apprenticeship.

Desirable and Necessary.

Apart, however, from this question of wages which, in our opinion, in an intermediate organisation is not by any means the most important of its activities, the outlets for the energy of those in control are so wide and complicated as to be sufficient to provide not only useful employment but to bring about a great improvement in the present conditions. There is no doubt in our mind that intermediate organisations of this kind are not only desirable but necessary in spite of the fact that the typically English policy of neglecting technical, even more purely scientific, qualifications, in business has so far been usual. This being so, we are sorry to see the hostility of certain employers and employees' associations to the movement which is now taking place among the middle classes. Such hostility shows a wrong-headedness, which is much to be deplored and is, in the long run, likely to defeat the objects it has in view. There is no doubt that, whether it be a profession, a trade, or an industry, much more is to be gained by a combination of those concerned into appropriate organisations and a working together where possible of these organisations with a common object than by internecine strife which can do no one any good.

The Future of Electrical Manufacture.

By H. MENSFORTH, C.B.E., M.Sc., M.I.M.E.
(Director-General of Factories, War Office.)

DURING the war we effected two changes in our industrial life which, now that the war is over, are having a profound influence on our whole population. These changes were the reduction in the hours of the working week, and the general improvement in the average standard of living. Neither of these changes, desirable as they undoubtedly are, were purchased out of revenue, but by expenditure of capital accumulated out of past working and by mortgages on our future output. To-day, therefore, we are faced by the problem not only of justifying our new hours and standard of life, but of liquidating the mortgage we have given on the future.

In considering the above, it should be realised that none of us can, by unaided effort and without utilising the machinery of industry, maintain either our present working hours or standard of living. This being so, it follows that any improvement in the machinery of industry should, if fully utilised, benefit all.

THE VITAL IMPORTANCE OF CHEAP POWER.

If the above be true, then at no time in our industrial history was a supply of cheap power with efficient transmission of such vital importance as now, and with our present knowledge our only hope of obtaining this supply is by the utilisation of electricity for its distribution. We are fortunately placed, from the point of view of power distribution, inasmuch as the country is small, and our coal fields are fairly well distributed, but much has to be done, both technically and by legislation, to enable us to furnish a cheap and plentiful power supply without ruinous capital expenditure.

A secondary consequence of the shortening of the working week has been to cause further congestion of the means of transport during certain hours of the day, until in some parts of the country the overcrowding during these hours is nothing short of a scandal. This has the effect of irritating people who, whilst having shorter working hours, lose part of the benefit by extra time occupied in getting to and from their work. In addition, the population is driven into the congested areas around the manufacturing centres. A system of cheap quick transport would do much to settle our industrial population, as it would enable many more of the people to live some distance away from the more or less sordid surroundings of their daily work, and would also allow those working in the country to take part in the pleasures of the town, which at present tends to attract the agricultural worker away from the country.

THE POSSIBILITIES OF ELECTRICAL MANUFACTURE.

The part that electrical engineering will have in the removal of our difficulties is dependent upon the vision and courage of the men responsible for its development. Given the right men, electricity has possibilities greater than were those of steam power of 100 years ago.

How are these possibilities to be best developed ?

1. By the education of the general public as to the utility as well as to the convenience of electricity.
2. The technical development to the highest state of efficiency and reliability of all apparatus.
3. The better standardisation of apparatus to facilitate manufacture.
4. The provision of the best plant and facilities in the factory manufacturing the apparatus.
5. The efficient utilisation by all concerned of these facilities up to the fullest extent.

Much may be done to educate the public as to the possibilities of electricity, especially in the homes, and in this connection the activities of the Gas Companies may be profitably studied.

Is it sufficiently realised that whilst we have shortened hours, and improved the working conditions of all classes of industrial workers, we have done nothing to help the ordinary woman in her home ? In this direction America is far ahead of us, a condition of affairs very largely brought about by the shortage of, and difficulties with, domestic help, which has been experienced there for years, a position in which we now find ourselves.

The whole possibility of domestic electrical apparatus has been changed the last two or three years by the servant problem, combined with the increasing cost of towns gas, and a determined effort should be made to develop and market apparatus suitable to our needs, advantage being taken in the design of this of any ideas women may have in connection with its use.

THE ELECTRICAL ENGINEER AND THE FUEL SUPPLY.

As pointed out earlier, our future prosperity is intimately associated with the supply of cheap power, the two largest items going to make the cost of power supply being coal and capital charges.

Dealing with the item of coal first, the electrical engineer has done more by far than any other user of steam power to improve the efficiency of steam prime movers, perhaps not directly by either manufacture or design, but by keeping alive and keen the spirit of competition for low steam consumption. Until recently, however, he has confined his attention too much to steam consumption in the prime mover, and has not paid nearly enough attention to the question of economy in boiler house and auxiliary plant. He has placed heavy penalties on any increase over guaranteed steam consumption, but has paid much less attention to the purchase of his fuel, to its economical use, or to the efficiency of the apparatus, other than the prime mover, in which it is employed.

The modern tendency of increased speeds and running temperatures in turbo prime movers is all in the direction of economy, both in first cost and also in operation, and there is no reason why the largest units should not run at the maximum speed possible of 3 000 revs. per min. This does not necessarily involve any higher stress than at 1 500 revs. per min., as the peripheral speed will be approximately the same in the two cases, but the weight, particularly at the steam end, will be very much reduced.

The question of future capital expenditure depends of course very largely upon how far we are able to take full advantage of the possibilities of the materials available, standardisation, and our manufacturing facilities.

THE MATERIALS OF ELECTRICAL MANUFACTURE.

The materials needed by the electrical engineer are very much more numerous than those needed by almost any other manufacturer, covering as they do the whole range of both ferrous and non-ferrous metals, all sorts of textiles, porcelain, rare gases, gums, solvents, rubber, and synthetic compounds, most of these except the metals being used in some form or other as insulation.

It is only recently that the country has devoted any real attention to the study and commercial development of insulating materials, and very much more will have to be done in this direction if we are to hold our own in the future, and further, to bring down the cost of much of our electrical apparatus. If some genius could find an insulating material, that could be run in like, say, babbitt metal, capable of carrying away heat, and at the same time with a certain amount of flexibility, the cost of electrical apparatus would be revolutionised. A railway motor or turbo-generator is built of an infinite number of bits of rag, mica and string, and many of these unsuitable and unstable materials are subjected to intense mechanical stress and varying temperatures. A static transformer depends for its successful operation upon parts made of wood and paper, and is subjected to serious distortion due to short circuits.

Standardisation in Electrical Manufacture.

The problem of standardisation from the point of view of manufacture of electrical apparatus is a difficult one, inasmuch as all design is a compromise based on the necessity of the individual case, and it is hard to decide whether it is wiser to sacrifice a certain amount of material, in a machine, to enable a size to be used which is in stock, or to put in the exact amount and use special sizes with consequent increased stock and possible delays. The tendency with most designers is to do the latter, largely due to their not being conversant with the delays and expense of large stocks of materials. The ideal that should be before all designers is that embodied in the mechanical toy, which, consisting of a few simple parts, enables a model of anything from a loom to a crane to be made.

Standardisation of this kind is of the utmost value to the factory as it cuts down the stock to be kept, and renders it much more mobile, diminishes delays, lessens the number of jigs and tools to the minimum, and altogether merits much closer attention than it has had up to now.

We are infinitely better equipped at the present time with plant and manufacturing facilities than was the case in 1914, but this plant has not been used to anything like full capacity since the war, and general feeling is current amongst employers that it is very little use extending their manufacturing capacity or improving their facilities until a proper understanding is achieved between themselves and the workers who operate this machinery.

Much more attention and effort should be directed to the problem of convincing the ordinary working man not only of the fact that maximum production is not a menace to him or his class, but that unless we get this in the very near future, we shall cease to survive as an industrial nation. The workman may of course reply that his experience up to now has been that so-called over production has resulted, sooner or later, in his being unemployed, but it can be shown that, whatever else is the cause of unemployment, maximum production is not.

The Importance of Efficiency in Electrical Machinery.

By MILES WALKER, M.A., D.Sc.

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THE tendency among manufacturers of electrical machinery during the last twenty years has been to cut down, to a very small limit, the size of the frame upon which an electrical machine of a given output is built. In some ways, the improvements in design that have made this possible are to be welcomed; but it not infrequently happens that the cutting down of the size of the machine has resulted in a loss of efficiency. Where this has occurred, the net result to the community has been loss instead of gain. The loss in efficiency by the undue cutting down of sizes of frames and amounts of material employed is well illustrated in the case of industrial motors, both direct current and alternating current; these motors are now commonly supplied with a fan, which so improves the ventilation that a fairly large loss can occur on a small frame without causing undue heating. Not only is the loss increased by the cutting down of the weight of copper in the armature and field circuits, but the fan itself adds considerably to the windage losses.

The Influence of the Buyer.

This tendency towards electrical machines of smaller weight and lower efficiency has been greatly due to the attitude of the buyer, who thinks more about the initial price that he pays than about the running efficiency of the machine. On account of the difficulty of making accurate efficiency tests, he has not as much confidence in the statement of the manufacturer who promises high efficiency as he has in the lower price quoted by a foreign competitor. The cumulative effect of this tendency has been the installation of hundreds of thousands of kilowatts of plant which, from the point of view of the community at large, is not as efficient as it should be.

One cannot, of course, hope for any improvement in this matter until the user is taught to see the importance of efficiency and is assured that he can really get more efficient machines by paying for them. It will ultimately be to the benefit of the manufacturer to put the user right upon this matter.

Weight of Shunt Coil Copper.

Diagrams such as that given in Fig. 1 are of service in enabling us to find at a glance the most economical specific rating of copper and iron. Suppose we wish to find what is the most economical specific load at which to work the copper of the field coils of a direct current generator or motor. We can announce in the first place a few propositions that are sufficiently true so long as they are intelligently applied.

On a given frame, or at any rate with a very inexpensive extension to a frame, it is generally possible to increase the weight of copper in the shunt coils of the machine up to a value very much higher than is commonly found on commercial machines of any given rating. If it were decided to make any very substantial addition to the weight of shunt copper employed, this could always be done by lengthening the pole shanks and increasing the diameter of the yoke. The cost of this would in general be small in comparison with the increased cost of the shunt coils; and it could always be included in the figures taken when employing the curves in Fig. 1.

As a first approximation we may say that the number of watts lost in a shunt coil is inversely proportional to the weight of the copper. The curves are plotted on this assumption, but it would be quite easy, in a case where any considerable departure from the law was observed, to make a suitable correction for it in the slope of the hyperbolic curves.

The straight lines radiating from the origin, Fig. 1, give the interest at 12 per cent. on the cost of the weight of copper denoted by the abscissæ. The rectangular hyperbola 0·5d. gives the annual cost of power wasted in field coils, plotted on the basis that there is a loss of 3½ W per pound where one pound of copper is at present used in the coils and on the assumption that the loss would be reduced to 1·75 W if two pounds of copper were used on a new machine. The field coil is supposed to be in operation for 5 000 hours in the year. The various hyperbolas refer to various prices paid for power; and the various radial lines refer to the various prices paid for field copper. The price paid for coils should include the cost of insulating and assembling, but one should have regard to the actual cost per pound of increasing the weight of copper in a shunt coil as well as to the total cost of the assembled coil.* Taking the cost at 0·5d., we see that if the copper is worked at 3·5 W per pound the annual expenditure for power comes out at 8·75d. Taking the cost of the field coil at 20d. per pound, the interest at 12 per cent. comes out at 2·4d., so that it would obviously be economical to spend more money on copper. The point *A*, at which the 20d. line crosses the 0·5d. curve, shows that it would be economical to increase the weight to almost double the weight of the shunt coils. If the price paid by the consumer was one penny per unit, it would pay to make the coils almost four times the weight, provided that this did not involve changes in the frame the expense of which was prohibitive.

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* For instance, when the weight of a coil is increased the main addition to the cost will be the cost of the insulated wire. An assembled small coil may cost 30d. per lb., but as the weight is increased the price per lb. will lead us to a curve such as that shown dotted in the figure.

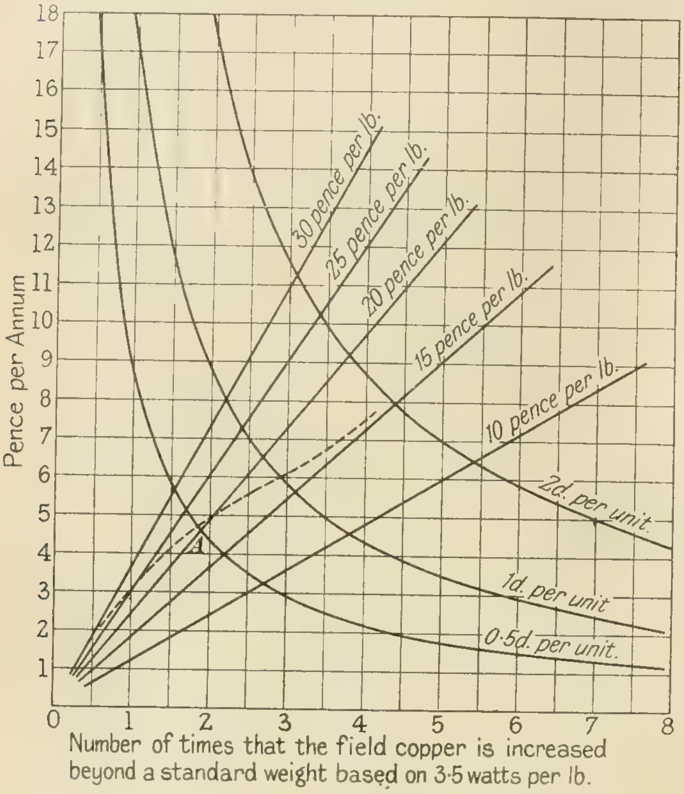


Fig. 1.

The same kind of argument is applicable to the increase of copper in armatures. On many machines it would, of course, be necessary to increase the size of the armature slots and even the armature itself, in order to make any considerable addition to the copper; but in these days of high cost of electric power and the return of copper towards its pre-war price, it will often pay to make an armature that contains twice the weight of copper that is contained in present commercial machines. When more copper is put into an armature, it is, of course, always necessary to see that the arrangement is such that no undue eddy-currents occur in it. This leads us to another direction along which great improvements can be made in the efficiency of machines.

Copper Losses.

In a number of instances that have come under the notice of the author within the last 10 years, the actual copper losses occurring in direct-current machines was four or five times as great as the loss calculated from the measured resistance. The eddy-current losses occurring in armature copper can be divided into three classes: (1) That caused by the flux which passes down the slots in a radial direction owing to the super-saturation of the teeth, which is effective in producing eddy-currents only in copper conductors that have a certain circumferential thickness; (2) that caused by the flux crossing the slots in a circumferential direction, owing to the high saturation of the tooth on one side of the slot and the lower saturation of the tooth on the other side. This is effective in cases where the conductor has considerable radial depth; (3) that due to the flux crossing the slot, set up by the magnetomotive forces exerted by the currents in the conductors themselves.

(1) Eddy-currents of the first kind do not occur very often in direct-current machines, because the circumferential width of conductors in these machines is generally small; but in many turbo-generators having conductors of considerable circumferential width they are by no means negligible. The armature distortion generally leads to a very high saturation of the teeth opposite the trailing corner of the pole and greatly aggravates the loss.

(2) Eddy-currents of the second class are responsible for an enormous waste of power in direct-current generators all over the country. It is common practice to make the radial depth of the strap in direct-current armatures from ½ in. to 1 in., and some of the teeth at full load have 3 000 or more ampere-turns expended upon them.

(3) Eddy-currents of the third class are also very pronounced on many machines as built to-day.

Cheapness v. Efficiency.

As long as the buyer of electrical machines will placidly take a cheaper machine without taking heed of lower efficiency, very little will be done by the manufacturer to remedy these defects. The cure of the defects is known; but there is a great reluctance on the part of manufacturers to go to the trouble of effectively laminating and crossing over the conductors, as long as the purchaser is prepared to put up with the simpler construction.

Some Practical Suggestions.

Apart altogether from the lamination and crossing-over of conductors, great reductions in the losses (1) and (2) above can be effected by suitably shaping the pole. In the case where a machine is used as a generator, the air-gap between the poles and the armature may be tapered off so as to have a much greater length under the trailing horn than under the leading horn. In a case within the author's experience, a machine originally had a uniform air-gap of ⅛ in., and the eddy-current losses under class (2) produced so much heat as to burn the insulation surrounding the top conductors in the slots. As in this particular case it was impossible to re-wind the armature with well-laminated conductors, the expedient

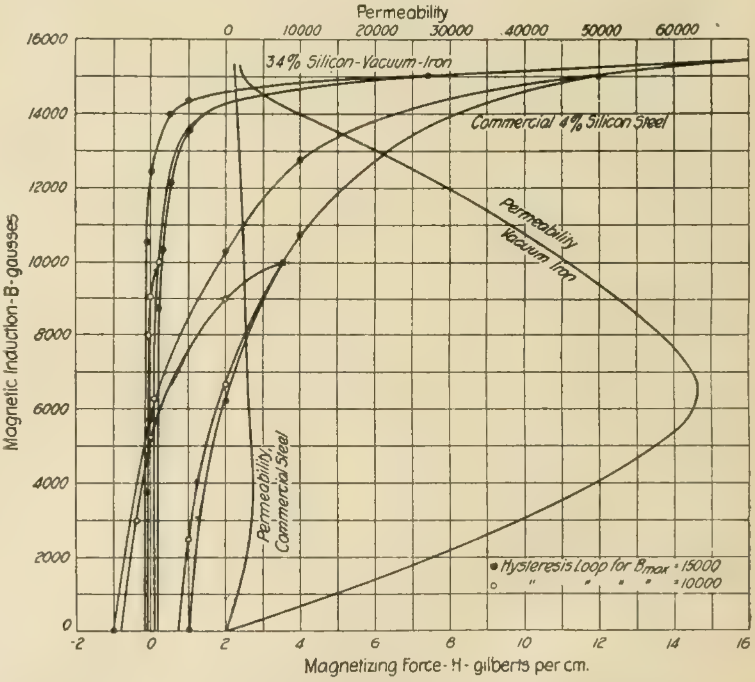


Fig. 2.—Comparison between Vacuum Iron and Commercial Steel, both containing between 3 per cent. and 4 per cent. Silicon—thoroughly Annealed.

	Vacuum Iron.	Commercial Steel.
Hysteresis loss for $B_{max.}$ = 10,000; ergs per cu. cm. per cycle	280	2,160
„ „ „ „ 15,000; „ „ „ „	1,025	4,290
Specific electrical resistance, michroms	48·50	51·15

was adopted of tapering the gap from 1/10 in. under the leading horn up to $\frac{1}{2}$ in. under the trailing horn. The effect was to reduce the eddy-current losses so far that no injurious heating took place: the temperature rise was reduced from over 180°C. to 76°C. There are many machines in existence upon which this simple expedient would result in a saving of power.

The tapering of the air-gap so as to make it greater under that horn of the pole at which the flux-density tends to increase when the machine is on load, has the effect not only of reducing the copper losses in all generators having conductors of appreciable radial depth, but of reducing the iron losses ordinarily brought about by the super-saturation of the teeth. The iron losses in the teeth of generators are very commonly augmented by the distortion of the field, to an extent that is not always fully appreciated. One of the main causes of the stray losses occurring in machines is this increased iron loss due to the super-saturation of the teeth. The tapering of the air-gap has the effect of making the great iron loss occur at no-load instead of at full load; but in cases where the machine is not running for any length of time on no load this is not a serious drawback.

Causes of Excessive Iron Loss.

Another cause of excessive iron loss in electrical machinery is found in the ill-treatment of the iron during its passage through the factory. In the first place, sufficient care is not taken with the punching of the slots; certain limits of error are allowed to the punching department in—it is thought—the interest of economical production; but no proper tests are made to see whether the money thus saved in giving the punching department a certain limit of error is not spent several times over during the assembling of the punchings and in the work that is subsequently done upon the machine. Experience goes to show that where exact shaping is attempted it is practically as economical (in fact, sometimes more economical) to aim at the very highest accuracy as it is to allow the machinist a wide limit of error. Take the case of the punching of an odd number of slots in a blank stamping by means of a slot die. The accuracy of the work depends upon the care with which the slot die is mounted in relation to the index wheel and the stops by which the position of the blank is fixed. An examination of a large number of punchings will often show that all those that have been punched with the one setting of the die are exactly the same to an extraordinary degree of accuracy. Where the punching machine has had to be set up again in order to produce a set of punchings that are to break joint with the first set, a small error will have crept in, so that after the dynamo is built up there is perhaps 0·5 mm. or more overlap betweeen one set of punchings and the other. This makes an error in the size of the slot, which may call for undue filing, and the time paid to the man for filing up the machine is perhaps ten times as great as would have been paid to the man who set up the punch if he had taken greater care to get the slots in exactly the right position. Sometimes a drift is used and driven through the slots and bends the teeth until they are in the right position. This hardens the iron and perhaps costs the user £50 per annum for extra power. Another matter is the increased iron loss due to the burring over of the punchings. A burr on the punchings may be due to the die's being in bad order. Here again the question arises whether it is cheaper to keep the die in good order or to remove the burr after it has been made. In many cases the burr is not removed, and, as a consequence, after the laminations have been assembled the insulation between them is far from being effective; so that the iron loss is increased by the eddy-current in the whole core. There ought to be more co-ordination between the die maker, the die user, the machinist who machines the frame, the armature builder, the armature tester, and the designer, each of whom should be brought to realise the difficulties of the others; and a common effort should be made to produce cheaply a machine with a small iron loss.

In this connection it is important to consider the quality of iron that will give the most economical result from the point of view of first cost and running efficiency. Transformer designers have long ago adopted iron-silicon alloy for their cores; but this alloy is as yet little used in electrical machinery, partly on account of its mechanical qualities and partly because its permeability at high densities is not as good as that of ordinary dynamo iron. An iron-silicon alloy can now be obtained having very reliable mechanical qualities, and can be used for all classes of dynamos if the design is modified so as to give a little more room in the teeth. Notwithstanding the high cost of silicon alloy and the greater amount of it that would be necessary in order to work at lower tooth densities, the savings to be effected by reducing the losses are so great that the additional expenditure is well worth while. If we take a machine in which the iron, including scrap, costs in the raw state £48, and in which the iron loss is 14 kW, the interest on the cost of material comes to only £6 per annum, whereas the lost power at one halfpenny per unit comes to £145 per annum. If we use a larger quantity of silicon alloy, costing £108, the interest on the cost comes to £13, and the annual cost of power lost comes to only £63. It may be that in the future even better qualities of silicon steel will be put upon the market, at prices bringing them within the consideration of manufacturers of electrical machines. The fact that the silicon steel has not as good a permeability as ordinary steel at high densities does not preclude it from being used, if we are prepared to make the frames big enough.

Magnetic Properties of Iron Silicon Alloys.

Many readers of The Electrician are no doubt familiar with the researches by Trygve D. Yensen on the magnetic properties of iron and iron-silicon alloys melted *in vacuo*. Although there is no immediate prospect of our having on the market in substantial quantities iron as pure as that made by Yensen by a laboratory process, his experiments show that it is physically possible to make an iron having a hysteresis loss (at $B_{\text{max.}} = 15\,000$) of one-fifth of that found in Swedish charcoal iron, and an eddy-current loss also of one-fifth the value. The permeability of Yensen's iron, at flux-densities of about 7 000, reaches the sensational figure of 66 000. Fig. 2, which is reproduced from Bulletin No. 83 of the Engineering Experimental Station of the University of Illinois (November 22, 1915), is of interest in giving a comparison between the behaviour of the new iron and that of commercial steel. Although there are many difficulties to be overcome before one can hope to get such pure iron produced by the ton at a reasonable cost, one can never say what the developments of the future may bring.

Another important cause of loss in both direct current and alternating current machines lies in ripples in the wave form of electromotive force, caused by open slots. Apart from the pole-face losses due to movement of the teeth across the face of the pole, the ripples in the electromotive force give rise to ripples in the current, and these again to high-frequency eddy-currents in the brushes, which produce undue heating of the commutator. The proper shaping of the pole face, and the choice of a suitable number of slots per pole-pair, will go a long way towards eliminating some of these troubles. It is good to see that some manufacturers are skewing the armature slots through a full slot pitch; this helps to get rid of the ripples in the wave form.

In cutting down the cost of electrical machines manufacturers have been proceeding upon the wrong lines. They ask the designer to get more and more output out of his frame; whereas they ought to encourage the designer to make the best possible machine even at a greater cost for raw materials, and then apply themselves to cheapening the production notwithstanding the increase in material. The cost of the raw material is after all only a small part of the cost of electrical machines as they are sold to-day. A machine whose price to-day is £3 000 contains perhaps 1 ton of copper, 300 lbs. of insulation, $1\frac{1}{2}$ tons of sheet iron, 2 tons of mild steel and $2\frac{1}{2}$ tons of cast iron, costing in all under £300.

The Testing of Electrical Machinery.

By H. E. MELLOR, M.Sc., A.M.Inst.C.E., A.M.I.E.E.

FROM the beginnings of the electrical industry it has been customary to carry out tests, more or less thorough in nature, on completed machines or other gear, and also on component parts. At first there was little experience to guide the manufacturer, either in the design or the actual making, so that it was difficult to predict the performance of a machine. Methods of testing were naturally crude and guarantees of temperature rise, &c., in their present form were unknown. As time went on and experience and knowledge accumulated, it became possible to predict performances with a closer and closer approach to certainty; on the other hand, under the stress of competition, standards of performance became more stringent, so that there was no tendency to dispense with works tests.

The advantages of making thorough tests on electrical gear before despatch from the manufacturers' works are now generally recognised. It is easier and cheaper to carry out any adjustments before despatch than it is at the customer's premises, and there is less cause of annoyance to the customer. There is also the direct effect of thorough testing in tending to raise the standard of excellence in the works. There is a further point to be considered, which is that insulating materials such as are suitable for use in electrical machinery are not so strong mechanically as materials of construction proper, and even with the greatest care are liable to injury during the processes of manufacture. It is only by careful testing that weak spots can effectively be guarded against. From such considerations as these it follows that testing is an essential feature of production.

THE OBJECT OF TESTING.

In a modern works, tests are made with the following objects in view:—

(i) To make sure that a machine complies with the purchaser's specification (if any), that it is satisfactory mechanically and electrically, and such as to maintain, if not enhance, the maker's reputation.

(ii) If there are defects, to indicate how these would best be rectified, the discovery of faults being only the first part of the duties of the test-room staff.

(iii) To afford reliable information to the designer which will be of use in predicting the performance of future machines.

For the purpose of this article it will be convenient to divide electrical manufacture into the following classes: (1) Rotating machinery (generators, motors), (2) static machinery (transformers), and (3) switchgear, &c.

For the first class, comparatively elaborate equipment is required, since in addition to preliminary tests on component parts, &c., the completed machines are usually tested for some hours on their rated output, and other running tests may also be made. The second class requires somewhat similar treatment, except that conditions are altogether simpler as there are no moving parts. Tests under rated load are made although not necessarily in each individual case. In the third class the test routine may be still simpler and only in comparatively rare cases will it be necessary or even desirable to test under the rated conditions.

GENERATOR AND MOTOR TESTS.

The tests which are applied to generators and motors fall naturally into two classes: (*a*) *Static Tests.* (i) Tests made to ensure that the *arrangement* of the circuits is in order. (ii) Tests made to ensure that the *insulation* of the circuits is in order. (*b*) *Dynamic Tests, i.e.*, running tests on the completed machines. It is the second class of tests which requires the more elaborate equipment and should therefore receive prior consideration when arranging the layout.

LAYOUT ARRANGEMENTS.

The layout naturally depends on the size of the machinery which it is required to test. We may roughly set out the following classes, referring mainly to motors, as these are naturally more numerous than generators.

(1) *Very Small Machines—"Fractional Horse-power Motors," such as are used to drive Fans, Domestic Appliances, &c.*—Machines in this class are generally so liberally rated, the main object of the designer being to ensure that the work of manufacture shall be simple and easy, that heating hardly forms a serious consideration. While full-load tests from time to time are desirable, it should not in general be necessary to run each motor under full-load conditions, a short run light being quite sufficient, except in the case of series-wound direct-current motors where some load will have to be applied, as otherwise the speed will be excessive. There is no very sharp line of demarcation between this class and the next.

(2) *Small Motors, say,* 1/2 *h.p. to* 50 *h.p.*—It will, in the writer's opinion, be found a commercial proposition to test motors in this class—even the smallest—under full-load conditions; this, however, is not by any means the invariable practice of manufacturers. It would probably be correct to say that a majority of the motors which are made in this country have ratings between the above limits. There will, of course, be a number of different sizes of motor frames, but as we have to deal with a comparatively large number of machines, it is worth while setting aside a special equipment for motors of this class. One very convenient arrangement is to have a number of separate testing stands each complete with a load machine and a switchboard to control both load machine and test machine. The load machine should be a continuous-current machine to secure maximum flexibility, and the switchboard should have mounted on it the necessary ammeters, voltmeters and, for alternating-current test boards, wattmeters; and it should also have suitable shunt regulators and load resistances.

The test machine may be bolted on to a cast-iron pedestal suitably drilled and slotted so that any frame size of motor in this class can be mounted on it, and if the holes or the slots for the holding-down bolts are properly arranged, the centre line of the pulley on the test machine will, for each frame size, lie opposite the centre line of the pulley on the load machine. It will be necessary for separate stands to be set apart for alternating-current and continuous-current machines, since, of course, the switchgear and supply arrangements will have to be different in the two cases; in the direct-current boards arrangements should be made for the load machine to be run as a motor, as there is a certain demand for small continuous-current generators.

ARRANGEMENTS FOR MEDIUM-SIZED MACHINES.

(3) *Medium-sized Motors, say, up to* 150 H.P.—In some cases it may be worth while making similar arrangements to those outlined above for motors up to 150 H.P., but there will always be a number of machines which will not lend themselves to stereotyped arrangements. It will not always be possible to couple the test machine to the load machine by means of a belt drive, for example, where the motor speed is high. Again, practically all machines in the preceding class will be arranged to operate on voltages not higher than 600, whilst in the class now under consideration it will from time to time be necessary to test high-pressure machines. Greater flexibility will be necessary in the arrangements and it will not in general be practicable to arrange for pedestal stands as in the preceding class. It will be better for the floor space set aside for testing these machines to have a number of slotted rails—say, 3 ft. apart—running from end to end, and for the test machines to be mounted on movable cross rails spanning these.

As regards the supply cables to the motors, a very convenient arrangement is to have a number of terminal boxes sunk in the floor, to which comparatively short lengths of cables can be run from the test and load machines, the cables between terminal boxes and control boards being run in trenches.

(4) *Large Motors, say, up to* 500 H.P.—For large motors up to 500 H.P. the arrangements should be similar to those sug-

gested for the last class, except that they will necessarily be on a larger scale, and still greater flexibility will be required in the arrangements generally. Many of the machines to be tested will be intended for operation on high-pressure supplies. In some cases it may be necessary to erect the test machine over a pit.

(5) *Very Large Motors.*—Generally speaking with very large motors each machine will require its own special arrangement, and in the majority of cases the machine will have to be erected over a pit. It will not always, perhaps not often, be possible to test the machine under normal full-load conditions, although where two similar machines are ready for test at the same time this may be possible even when the full-load output is much greater than the capacity of the test supply available.

Testing arrangements for generators will generally fall into such classes as have been indicated above, except that there will be relatively fewer small machines. So much flexibility in the arrangements is required, in any case, for the larger motors that no special and distinct arrangements will in general be required for generators.

TEST BED LAY OUT.

Before passing on to consider other details of layout and equipment the situation of the test bed deserves some consideration. It is obvious that the test bed should be near to that part of the works where the machines are assembled, and it should be possible for a crane to pick up the machine and take it direct to its place on the test bed. This may, of course, necessitate the complete separation of the testing arrangements for the different sizes and types of machines. Very large machines will have to be assembled piecemeal on the test bed. It is best, of course, for the test bed to be situated at the end of a bay, unless arrangements are such that there is no occasion for traffic through or over the test bed. It is highly undesirable that unauthorised persons should have free access to the test bed, for considerations of safety as well as shop discipline.

DETAILS OF TESTING EQUIPMENT.

Owing to the variety of supply voltages and frequencies in this country, means must be provided to give variable voltage alternating current and direct-current supplies, and also to vary the frequency. The common frequencies in this country are 50, 40 and 25 cycles per second, and while it is possible to test 40-cycle induction motors on 50 cycles, and vice versa, the voltage being varied proportionally with the frequency, this cannot be regarded as satisfactory in all respects, since the motor speed changes, of course, with the frequency, and the change in speed alters the ventilation and cooling of the motor, so that a time run on a different frequency does not give definite information as to the temperature rise on the correct frequency. To get over the difficulty it is necessary to provide supplies at the above frequencies which is most easily done by providing a motor alternator set driven by a variable speed motor.

An additional complication in alternating current work arises from the fact that there are a number of public supplies which give two-phase current. If there is a three-phase supply available for testing, a two-phase supply can be obtained by a special ("Scott connected") transformer. Also if a motor alternator set is installed as suggested above, it is possible by suitable design of the alternator winding, for the machine to give a two-phase supply as well as a three-phase.

It is an easier matter to provide for different voltages. So far as alternating current is concerned, a suitably designed transformer with a number of tappings on each leg, can give a corresponding number of voltages at one and the same time. This is a convenient arrangement for the smaller machines. The maximum output the transformer can give at any one voltage is inversely proportional to the voltage; in general the test machines will have much lower ratings than the transformer so that this is not likely to be an inconvenience. For the larger machines it may be more convenient to arrange each leg of the transformer secondary in two or more separate sections, which can be put in series or parallel as may be desirsd. In this way full rated output of the transformer can be obtained at any of a number of different voltages, but in general only one voltage can be obtained from the transformer at the same time.

So far as continuous current is concerned, if a supply at any voltage is already available, then by means of a motor booster set the voltage can be varied at will from zero up to as high a voltage as may be required. For dealing with large quantities of small machines, it might be found best to arrange for a special booster set to give, say, a 3, 4 or 5 wire supply at convenient voltages; only rarely would such an arrangement fail to provide a suitable supply for a commercial motor.

SWITCHGEAR FOR TESTING PURPOSES.

It has been suggested above that the best method of testing the small machines is to have a number of testing stands, each with its own switchboard. As regards the general type of the gear it is difficult to lay down any hard and fast rules, but it may be said that the arrangement of such switchboards deserves very close consideration; a comparatively elaborate switchboard, provided it is not too elaborate, may well justify its enhanced cost if it saves time and trouble in the carrying out of the test. On the other hand, many of the complications of ordinary commercial switchgear, such as elaborate no-volt release arrangements, overload arrangements and interlocks are quite out of place in switchgear for testing purposes. There should, of course, be a switch or circuit breaker to enable the current to be cut off easily and quickly, and there should be some automatic protection to interrupt the current in case of an accidental short circuit.

For the larger machines it will not be found practicable to adopt any very elaborate arrangement of switchgear and in some cases with very large machines it will only be possible to test them on full load by adopting special and more or less makeshift arrangements. Even in such special cases there ought to be some means or other of isolating the machine promptly without risk to the operator. In this connection it is of special interest to point out, although the principle applies equally to all types of test machine, that any switch or circuit breaker that is intended for use as such, and not merely as a set of isolating links, should be capable of breaking any current that is likely to pass. This is specially of importance in the case of high-pressure machines.

In addition to switches, circuit-breakers, &c., a number of other items are required, such as field regulators, starters, load resistances, &c. The field regulators should be of various current carrying capacities, and the capacity should be clearly indicated on them, so as to cover a wide range individually and collectively; they should be graded so that they will be suitable for use on the highest continuous current voltage which is likely to occur (say 550–600 V), and their number should not be kept down to a minimum, as it may happen occasionally that more than one regulator will be required for each machine. The best form of starter for test purposes is undoubtedly the liquid type, since it affords the greatest flexibility of arrangement, and cannot be burnt out.

TEST RESISTANCES.

Resistances to absorb the output of machines operating as generators should, in the case of the small machines, consist of banks of resistance coils, and if these are suitably graded and each controlled by a suitable switch, the load can be adjusted very readily. Such resistances, however, are rather expensive if they are of a material which does not vary greatly in resistance with temperature; iron is cheap, but has a high temperature coefficient. This would not matter so much if it were simply a question of loading up the machine for a time run, but it makes it an awkward and lengthy matter to take a compounding characteristic on a generator or similar test.

For very large inputs, air-cooled resistances become prohibitively large and expensive, and it becomes necessary to adopt other means. As in the case of the starters, a liquid rheostat can be used, which will take the form of large electrodes dipping into a water tank. It is not very easy to keep the load steady with one of these rheostats, and water-cooled resistances are as simple, and in some respects form a better alternative; since the water prevents a high temperature rise iron strip can be used without the disadvantage of a high temperature coefficient; the iron strip can be wound round a suitable wooden framework, and it is quite a simple matter to make up such a resistance to suit any special case. In the case of continuous current and higher-pressure alternating-current tests, the strip has only a few hours of life, but in any case the arrangement is cheap and easily renewable.

Measuring Instruments.

While there is no more important item of the equipment than the measuring instruments, it is not essential, and in some respects not altogether desirable, that they should be of the most sensitive and accurate type. For many purposes, good commercial instruments, correct to within 0·5 per cent., are quite accurate enough for time runs and heating tests; in fact, provided that they are calibrated from time to time against more accurate instruments, they can be used for such tests as open circuit characteristics, &c. It is right that instruments of a more accurate type should be available, but as they are delicate and require careful handling, they should be reserved for such special tests where very exact measurements are required. For continuous-current work it is desirable that the instruments should be of the moving coil type, as otherwise the polarity will not be indicated.

There is a need, only in part satisfied, for a range of commercial multi-range ammeter shunts, and reasonably accurate multi-range current transformers. In the absence of these, arrangements are necessarily somewhat less convenient.

Before leaving the question of equipment, it is necessary to touch on the preliminary tests—*i.e.*, those which are applied at various stages in the manufacture of the machine. These preliminary tests consist of (i.) measurement of the resistances of individual circuits of the machine; that is to say, measurement of resistance per phase in alternating-current machines, between each pair of adjacent commutator bars in direct-current machines, and of each individual field coil. (ii.) Pressure tests on the machine or its components, to make sure that there are no points of weakness.

For the former set of tests a complete equipment for the measurement of resistance is required. For the measurement of high resistances, a Wheatstone bridge, with the usual accessories (galvanometer, &c.), will be required. The low resistances may be measured by the ammeter-low-reading voltmeter method, or more accurately by a Kelvin double bridge. A battery will be required in connection with the measurement of low resistances, and it is usual for the equipment to be located in some convenient position, to which any parts to be measured can be easily transported. Some large firms have a portable apparatus for the measurement of low resistances, but this is a somewhat more expensive arrangement.

For high-pressure tests at least one high-pressure transformer will be required. It is desirable that it should be possible to vary the test votages gradually over the whole range, and this is most conveniently done by providing a small motor alternator set (or induction regulator if an alternating-current supply is available) specially for the high-pressure transformer, so that the voltage can be adjusted to any desired degree of fineness by providing correspondingly fine regulation in the alternator field. It is not unusual to provide one or more portable transformers for testing large machines or their parts in the winding department, so making it unnecessary to move such heavy items to the test department. On the other hand, so many precautions will have to be taken to prevent danger to the workpeople that it is questionable how much is gained in the long run by this method of testing.

Test Routine.

Some indications of the test routine have already appeared, but no apology is necessary for going over old ground. At various stages during manufacture, high-pressure tests and sometimes resistance measurements are made to ensure that all is in order so far, and that no defects have developed. If there is any defect, the earlier it is discovered the less expense is involved in putting it right, and the less time is wasted in doing this. It is highly desirable that any defects should be remedied as soon as possible, not merely because they add to the expense of the particular machine in question, but because they tend to reduce the output of the works, and an output reduced to a small extent means a profit reduced to a great extent. Preliminary tests should, therefore, be made very carefully, and the high-pressure tests at this stage should be rigorous.

After the component parts have been passed by the test staff, they are assembled and the completed machine is ready for test. It is mounted in its position on the test bed, connected up to the test supply and run for a short time without load, after any minor adjustments have been made. It is then loaded up to its rated output and allowed to run at this for some time, which in the case of continuously rated machines should be four to six hours. Immediately after this run temperatures should be taken, usually by thermometer, on windings and core plates in the case of stators, rotors and direct-current armatures, on field coils in direct-current field frames and alternator rotors, on commutators in direct-current machines and slip-rings in alternating-current machines.

Following the time run, a reading of the light load losses should be taken; this reading is taken after the temperature test as the bearing friction will probably be less than it was before the time run owing to what may be called the initial stiffness in all new bearings. Any additional efficiency tests which may be required should also be made, as well as overload tests, and open circuit characteristics, compounding curves, &c. It is also desirable that a pressure test on the completed machine should be made, as the expansion of the windings due to the heating test may show up weak spots which otherwise might have been overlooked. Concurrently with the above electrical tests the lubrication of the machine should be noted. Wherever possible the load machine should be arranged to give its output back to the supply mains, thus reducing the total power expenditure for test purposes.

The Keeping of Records.

It is of the greatest importance that careful records should be taken of all tests made, and in such a manner that tests relating to components, as well as the completed machine, are either grouped together or connected together by cross references. Records should be as complete as possible, they should be clear and free from ambiguity, and there should be no possibility of misunderstanding what is meant. It is then an easy matter to collect together the whole history of the tests made on the machine and its parts during the manufacturing processes. It is not merely that care in this direction is of assistance should any question arise after the machine has left the works; as a matter of fact, one of the chief advantages of carefully kept records is that they provide an immediate and automatic check on the tests themselves, and render it unlikely that any of the necessary tests should be omitted or slurred over.

It is not safe to dogmatise as to the precise form in which the records should be kept; much depends on the number of machines dealt with, and the number of testers concerned. Where the output and the staff are small nothing beyond ordinary care is required to make almost any sort of system work reasonably well, but the larger the staff, the more thought must be given to the record system. Every system has its special advantage and special objections, and it is really impossible to lay down any hard and fast rules applicable to all cases.

Before passing on to the question of personnel, some reference should be made to other classes of electrical gear than motors and generators. Dealing first with transformers, it is to be noted that there are practically no tests to which they are subjected which have not their exact counterpart in the case of motors; on the other hand, as they are static, not rotary, machines, the testing of them is considerably simplified. In fact, except in special cases, it is hardly necessary for each transformer to have a time run, to test the temperature rise. The temperature rise of an electric motor depends (1) on its efficiency, which can be closely estimated without running the machine for any considerable length of time, (2) on the rate of cooling, which is slightly different for each machine ; consequently, it is in practice necessary to run each individual machine for some time to form a close idea of the temperature rise. In the case of the transformer the temperature rise depends on the same factors, but the efficiency can be estimated closely from test figures taken during a short test, and the cooling effect is sensibly the same for all transformers of the same size, type, and design. The equipment necessary for testing transformers is therefore a simplified version of that suggested above for alternating current motors.

As regards switchgear, the testing of this is at most chiefly a matter of measurement of the resistance of some circuits, of high tension tests, and last but not least, careful inspection. Tests under working conditions are practically never required except in the case of new designs, and in fact, are not in general desirable because of the slight wear and tear which is bound to occur, and which often detracts from the new appearance of the gear.

Personnel for Testing Purposes.

The question of the personnel is not the least of the problems to be faced by those who would organise a test department. Much of the testing work is purely routine in character, but the tester should always be on the *qui vive* lest he should overlook some defect or other, perhaps hardly noticeable. Human nature being what it is, it is not often that one comes across the ideal combination, patience and accuracy in performing routine work, combined with the initiative and activity of mind necessary to improvise test methods to meet special cases. There is in most works a class of young men—apprentices, improvers, &c., which often provides good material, but it is comparatively rare that a place on the test bed staff is regarded as an end in itself. The head of the test bed has a responsible position, and this should be recognised by his chiefs. In addition to the qualities required to make a good tester, he must be something of an organiser, and should also have his share of tact, otherwise in his position of official critic he runs the risk of controversies which a little diplomacy might avoid. It should be his duty to supervise generally all the work carried out by those under him, and any special cases should receive his personal attention. It goes without saying that he should be a technical man—in fact, a test bed is no place for anyone destitute of at least some technical training.

The question of personnel leads up to that of control. Is the test room to be controlled by the works staff, or the technical staff? It is the writer's opinion that no hard and fast lines can be laid down ; what is the best arrangement is inevitably linked up with what may be termed the internal politics of the particular organisation of which the test bed forms part, and the arrangement which might be a success in one firm might be a failure in another. This point, however, should always be kept in mind. The duty of the test bed is to make sure as far as possible that the machinery passed by it is as close as practicable to the ideal which the firm strives to attain, and no machine should be delivered unless it has been passed by the test room staff. There is no such thing as an ideal electrical machine, in the sense that there is no " best " electrical machine—there are several " best " motors. The work's staff's ideal motor is that which is easiest and cheapest to make, the designer's ideal motor is that which is most efficient, and in which the material is disposed to the best advantage. The salesman's ideal motor is that which has the largest number of " good selling points " as compared with its price, the management's ideal motor is that which yields the best profit for the capital outlay, and the user's best motor is that which is the most reliable. No one machine can be best from all these points of view, but that which comes closest to fulfilling the last two ideals, because it is an attempt to satisfy the customer on a sound economic basis, is the ideal which the test bed staff should keep before them; not because they can make of it a definite ideal, or a definite standard of comparison, but because they will thus keep before them the right point of view.

Electrical Manufacturing Tendencies in the United States of America.

By A. M. RANDOLPH.
(Virginia, U.S.A.)

MANUFACTURERS of electrical apparatus in the United States are daily becoming more alive to the importance of the electrical export trade. This is evidenced by the growing tendency among them to specialise in and concentrate their energies upon its requirements.

The foregoing statement is significant in view of the fact that prior to the war the interest of the United States in foreign trade was secondary. Manufacturers catered for the home requirements so long as these requirements created the necessary demand for their output. The foreign field was thus neglected or, if entered at all, was used as an outlet for surpluses of doubtful quality. The American business man of to-day has overcome the indifference towards foreign markets which characterised his pre-war activities. There is no element of disinterestedness in this. It is the evidence of a somewhat tardy awakening to the fact that a vast foreign field of activity is available and worthy of an organised effort to secure it.

Modern American Export Trade.

It is interesting to note in this connection that 10 per cent. of the electrical apparatus manufactured in the United States during 1919 was exported. The value of this volume was 90 million dollars, or 50 per cent. in excess of the value of this class of export for 1918. This high percentage of exports to total production is surprising in face of the unfavourable rates of exchange, and would seem to be a fair indication of the importance of apparatus for the generation and control of electric power in all countries. If this apparatus were not essential to the industrial rehabilitation of European countries it would hardly have been purchased in such an unfavourable market. At home this foreign business has, in recent years, served to maintain production in certain lines of electrical apparatus for which domestic demand has temporarily fallen off, and as the manufacture of electrical goods involves the use of many other manufactured products, the exploitation of foreign markets by American electrical manufacturers has greatly increased the business of allied home industries. "We should," says the " General Electric Review," " strive to maintain our present position in foreign trade by improving our knowledge of international business methods." This injunction has fallen on fertile soil, as there is little doubt but that the manufacturer of to-day is wide awake to his previous shortcomings in the foreign field and is determined, through the channels of system and organisation, to overcome them and in the future to devote a far greater proportion of his energies and resources to the development of that territory, in the direction of accommodating his product to its needs. This determination shows itself in the general tendencies outlined below, all of which are along the line of increased production.

The Development of New Markets Abroad.

One has only to peruse the advertising pages of the American trade journals to be impressed with the fact that this tendency is so marked as to be a practice, or part of a well defined policy. This is particularly emphasised in the electrical trade, where foreign connections are maintained either through factories in the countries in question, manufacturing under home administration, or through well-known agencies in the important foreign cities and towns. In this respect the writer, who for the past two years has travelled fairly extensively in the United States, has been struck with the great number of American manufacturers of electrical apparatus, large and small, who are vitally interested and active in the field available for their products in British territory. They all appear to be already well represented in England or laying plans for taking up connections there. On the other hand, there appears to be a singular lack of similar activity on the part of British manufacturers in this country. The answer to this, no doubt, is our tariff legislation.

Statistics show that where American-made electrical machinery has successfully entered foreign markets there has been widely sold allied American apparatus such as boilers, condensers, pumps, water wheels, hoists, mining machinery, sugar-mill machinery, &c., &c. A careful study of such statistics, which are periodically published for the benefit of those interested, has resulted in late years in developing the tendency amongst American manufacturers of various types of apparatus to co-operate more closely with electrical manufacturers in the supply of combined plant to the foreign field.

Growth from a Tendency to a Policy.

The tendency in this country to seek new markets abroad is not new. In the cases of several of the very large American engineering firms it was in evidence some 15 or 20 years ago. Since then, however, as has been already suggested, the tendency has grown into a fixed and definite policy by no means confined to the large concerns, but followed vigorously by the smaller ones as well.

In studying statistics and other data bearing on this point considerable growth is observed in connection with the supply apparatus, such as batteries, carbons for arc lamps and brushes for motors and generators, fans, heating and cooking apparatus, insulated wire and cables, interior wiring supplies, lamps, arc and incandescent (including the carbon and metal filament types), magnetos, spark plugs, meters and indicating instruments, motors (fractional horse-power), rheostats and controllers, switches and accessories, telegraph apparatus, telephones and small transformers. The developments in the smaller factories specialising in this class of product, due to the foreign trade campaign, is marked to a striking degree. The policy outlined above is carried out generally in four ways: through the establishment of manufacturing facilities in the country in which the product is to be marketed; through well-established native agencies in the same countries; through export and import agents, in the United States, with extensive foreign connections and through American salesmen travelling between the United States and the countries in which their activities lie.

The Creation of New Markets.

In the United States, advertising has been developed into an art and, as an educator of, and guide to, the taste of the American public its place is assured and its influence undisputed. It is exceptional to find an American firm manufacturing electrical apparatus and employing 500 or more employees without a publicity department. In order to survive, all must shout their wares through the medium of the publicity manager whose function it is to educate the public, first in the uses of electricity and then to shape its taste for what his principals have to sell.

The greater part of this educational work is effected through national advertising—that is, the journals selected for the purpose are those the circulation of which is truly national, and therefore reaches the greatest possible number of effective readers. In addition, the principal newspapers of the country are utilised for the same purpose.

"Movies" and Advertising.

One of the best, though one of the most expensive, means of moulding and educating public taste is the motion picture. Films are kept in stock by a number of the larger American firms, and are shown in picture houses, where educational films are recognised as a feature of the house. These films contain records of interesting electrical adaptations, processes of manufacture, features of factory life, "picturised" explanations of the uses of various electrical appliances, and, as far as possible, illustrations of electrical phenomena. In this connection it might be mentioned that this class of advertising has in some instances entered the realms of romance, as shown in a moving picture entitled "The Romance of Rails and Power," produced by one of the largest electrical firms in the United States. This has attracted most favourable mention from many sources.

There are also special merchandising shows arranged particularly for the dealers. These may be regarded as educational institutions for stimulating the minds of those who handle the "across-the-counter" trade, as well as the fancy of those who will ultimately use the product.

One of many effective methods used by electrical firms in this country for shaping public taste is the special article furnished to magazine and newspapers. These articles deal in a popular style with the news of the electrical world, and in the hands of a resourceful publicity writer can be made to attract wide-spread and useful attention, which the author does not allow to lag. Through interesting sequels the interest in the story is maintained. The propaganda turned out by these publicity organisations is excellent in quality, and, in the main gives evidence of unusual capacity on the part of those responsible for their literary productions. These, of course, are handled by experts, who, in addition to their knowledge of the product concerned, have a considerable knowledge of human nature and of what the public wants.

The personnel of the publicity organisations which have come to the writer's notice is of a high grade of intelligence, and appears to have been chosen and trained along sound lines. This is borne out by the attractiveness of the American publicity work, which seems to have approached as closely to being an art as commercial considerations permit. Specialisation seems to be the secret. Each man handling a publication is an expert on the particular subject dealt with, and his work is finally passed upon by a manager who is a veteran in the publicity business.

Standardisation of Selling and Production.

There are manufacturing firms in the United States who will make anything the customer wants, and will embody the customer's whims and fancies to the extent of ultimately destroying their own chances of financial prosperity. Such organisations, however, are few and far between, and occupy but a humble position in the commercial programme of the country. Standardisation in its fullest practical sense and application is the underlying principle of all electrical manufacturing in the United States. This principle applies alike to the large and small concerns.

Apart from the advantages accruing to firms employing standardised methods of dealing with customers and the handling of their outside problems, the necessity for systematised handling of their inside problems of manufacture, processes and the like, is so obvious as to make the creation and maintenance of well-organised standard departments an essential part of their organisations.

Such departments can be found in almost any American electrical manufacturing concern. They are usually regarded as part of the engineering and designing department, and are under the general supervision of the Director of Engineering. They are manned by employees who have an intimate knowledge of the components of the firm's products, and it is the business of these standard departments to universalise as nearly as possible the application of the parts of various apparatus to future designs. The principal object of this work is to minimise the number of parts carried by the firm, and thus reduce the cost of drafting, work pattern making, foundry work, machining, &c.

The attention and money expended in the matter of standardisation in this country largely accounts for the independent attitude of the American manufacturer in the marketing of his goods. He will not, except in exceptional cases, depart from his standard product to meet the fancy of a customer. He has spent money, often in considerable sums, in developing and standardising his product, he knows its possibilities, and is sure that it is the best of its kind. He is loth to upset his design by embodying suggestions of a layman, who has either to take it or leave it. The soundness of this principle seems obvious. This policy of standardising is carried through from the design end, into the manufacturing organisation where standardisation of machine tools, operations or methods of conducting them, hand tools, jigs, fixtures, &c., is carried out to the last detail.

PRODUCTION IN VOLUME.

Following logically on the practice of standardising in American engineering works comes the practice of producing in volume.

Owing to the varied nature of electrical apparatus it is regarded in this country as impracticable for any one manufacturer economically to produce more than a few lines of the following which, broadly, come under the general head of electrical apparatus: (1) Power, generating, distributing and consuming apparatus. (2) Signalling and communication apparatus. (3) Scientific and laboratory devices. (4) Primary and secondary batteries, dry cells. (5) Insulating materials. (6) Wires and cables, and (7) novelties, toys, &c.

The pre-war tendency in the United States was in some cases toward specialising in one of these lines, and quite often in one style of one line. This is particularly noticeable in the case of the fractional horse-power motor which, while being built by several of the larger manufacturing concerns as a means of contributing toward the economic production of their major line, is now being produced by several manufacturers as their sole line. The production of motor car lighting and ignition sets is another instance of apparatus handled in a similar manner. The large manufacturing concerns have of late years reorganised their systems of manufacturing this part of their output by segregating their operations either in separate fully-equipped departments in their main factories, or in factories located in other parts of the country where labour and other conditions are perhaps better adapted to bulk production.

THE AFTERMATH OF THE WAR.

The aftermath of the war brought with it some severe lessons to the specialist who concentrated on one line of specialised product for the disposition of which he depended on two or three outside firms. The demand for his product collapsed with the inevitable deflation which followed the war period, and he was left without resources in the way of other lines of apparatus to which to turn his energies and the resources of his factory. This has been the post-war history of the motor-car trade in the States. As a result of this the tendency now is for single factories to make one type of apparatus its major line, and, in conjunction with this, to take on, within reasonable limits, a diversified line of products to help pay the bill and keep the organisation together in times when the major line of product shows weakness.

Having reduced production costs and selling price through these tendencies to standardise and specialise, the American manufacturer invariably produces in volume in at least one or a few designs, as this tends further to reduce cost by lessening overhead charges. The theory underlying volume production is closely followed in this country, and, consequently, we find the most up-to-date tool rooms, manned by the most highly-skilled artisans, for tools are necessary in order to produce in volume, and volume is necessary to absorb the cost of the tools. Volume permits economical buying of materials and economical fabrication of same, as through it and the constant repetition work it entails, the quality and quantity of labour output is greatly increased.

Production in volume has placed its indelible stamp on all of the factories in this country that follow that policy. The practice spells a high grade of organisation and system carried through to the ends of it.

THE TENDENCY TOWARDS SCIENTIFIC MANAGEMENT.

In the United States, the virtual home of so-called scientific management, modern management methods scarcely constitute a tendency. The origin of scientific management is a disputed point, but it has so long been part and parcel of American manufacturing life that it may perhaps be fair to say that it is indigenous to the soil. Under this heading the sub-divisions of activity will be very briefly touched upon.

ORGANISATION.

The main departments into which electrical manufacturing concerns of five hundred or more employees are divided are: (1) Sales; (2) engineering; and (3) works.

Briefly the functions of each are:—

SALES.

The main functions of the sales department differ little from those of similar organisations in Europe. There is, however, one responsibility which the sales departments of electrical firms in America must shoulder in order to be considered successful, and that is the responsibility of satisfying the customer. The selling organisaton, being the factory's main guide as to future business and future needs for new designs or modifications in existing designs, is relied upon to bring these matters to the attention of the works organisation.

ENGINEERING.

In no branch of manufacture is the engineer regarded in this country as being more essential than in the production of electrical apparatus. The tendency in this direction in the United States is to increase rather than to decrease engineering staffs. The great expense due to large engineering staffs is another incentive to the manufacturer to obtain volume of production in order to minimize the engineering charges per piece.

WORKS.

The amount that could be written regarding the tendencies of American manufacturers in the direction of works organisation would far exceed the limits of this article which must be confined to a short reference to the salient points in present day factory administration in this country.

Broadly the factory organisation is divided as follows:—

(a) *Manufacturing*, including planning and time and rate setting.
(b) *Production*, including stores and shipping.
(c) *Inspection*, including testing.
(d) *Costs*, including time keeping, estimating and pay roll.
(e) *Maintenance* of apparatus as service to the customer.

It is in this field of factory administration that the American manufacturer seems to have gone to the front; it is here no doubt that his accomplishments in the direction of management have earned the adjective "Scientific." Little is left to the imagination in the works department after an order has been reduced to terms of engineering specifications and drawings. From the moment of receipt of manufacturing information in the manufacturing department the various steps in the manufacturing of an article are directed by practical experts whose business it is to see that the requirements of the respective departments through which an order may have to pass are fulfilled.

PLANNING AND RATEFIXING.

After an order has been converted into specifications and drawings these latter are sent to the manufacturing departments' planning section where the small tools, jigs, fixtures and machine tools required are determined. This section also sets the time in which each operation is to be performed and settles a piece rate for each operation. In American factories the planning section has, to a large extent, superseded the foreman and his clerks in the matter of ordering material, setting rates and making substitutions and changes.

Although the most efficiently equipped factories have highly trained staffs to administer this most important part of the work of manufacture and regard them as separate and distinct from the other works departments, they can, for the purpose of this article, be looked upon as a part of the general planning system.

The foreman in the best organised American shops is not now employed as a rate setter. The practice of fixing rates on a guessing basis, no matter how expert, is obsolete. This job is now done by the expert observer, who does not rely on opinion or hearsay of what was, but is governed by facts as revealed to him by a stop watch.

It is not the purpose of this article to present statistics—but the saving effected, since the tendency to find out beyond doubt how long it takes to do a job became a practice, must be staggering. The appearance of a stop watch in an American workshop, as an adjunct to taking a time study on a job has come to be recognised by the workman as a necesary part of the game and as an incentive rather than a deterrent because he knows that it means more production, less exertion in getting it, and bigger earnings for him.

Production.

The tendency in American electrical works is more and more toward concentration under central production departments. Working with the same engineering information, supplemented by the data prepared by the planning department, the production department under a supervisor of production, who reports to the manager of works, orders the materials, sees that it is delivered to the manufacturing departments, schedules and follows up the dates of delivery to assembly sections and shoulders the responsibility of seeing the completed apparatus on its way to the customer.

Inspection.

The same tendency to centralise is followed in inspection which is carried out both as part-inspection and finished apparatus inspection. The first being a machine to machine component part inspection and the second an inspection after assembly.

Inspectors are not responsible to foremen, but to their own superintendent, who, in turn, reports to the manager of works. An inspector, however, is required to initial all workmen's job tickets for *quantity*. The day is past in this country when a shop foreman can pass work out of his department because in his opinion "it is good enough." Nowadays the inspector is the judge of that, and he must be shown, when the element of doubt arises, and must take full responsibility for passing it.

One may naturally ask what the American shop foreman does in the way of assuming responsibility. The answer is that he is chosen for his practical experience, knowledge of what a good job is, and ability to handle workmen properly. He is not a desk man, and has little to do with paper work. He is on the shop floor amongst his men most of his time, and is responsible for having sufficient men to enable him to meet the delivery dates specified by the production department It is felt in American shops that if a foreman meets these requirements he is satisfactory. He has plenty of opportunities for exercising initiative and judgment so far as the work of his department is concerned, but his chances of showing favour in the way of special work, extra overtime, or pushing through doubtful products are non-existent.

Costs.

Other than stating that the centralised cost department is a feature of all American works, it is not proposed to deal at any length with this subject. The methods of obtaining factory costs are fundamentally the same in all establishments, and, so far as American practice is concerned, there is nothing of outstanding interest to English readers. There is a tendency toward the policy of establishing machine-tool-hour rates and of figuring cost on that basis. This, however, is not universally practised.

Service.

One of the strongest of recent tendencies in the electrical industry in the States is the rapid development of the "Service" system.

All manufacturers now recognise the importance of looking after their apparatus after it is sold. This is not only because they feel it necessary to keep the customer satisfied by promptly taking care of complaints and quickly supplying repair parts, but also because such service furnishes to their engineering departments the best and most direct information regarding the efficiency and reliability of designs, which often leads to immediate changes which save future expenditure and gives the customer the assurance that his interests are being cared for.

For the most part, the service stations are miniature factories stationed in the most important centres of the country, and generally in close touch with the district sales office in that centre. A fairly complete equipment is maintained in these stations, so that rapid repairs may be effected and the apparatus concerned may be promptly returned to its owner.

While this class of service is carried out to some extent in the case of motors and generators, it applies more particularly to such apparatus as storage batteries, magnetos and motor-car starting and lighting equipments.

Research.

The tendency toward recognition of the paramount importance of research work in the engineering industry, and particularly in the electrical branch of it, is assuming such proportions in the United States that in the near future an electrical manufacturing establishment without a research department will be considered ill-equipped. The leading electrical manufacturers are all efficiently equipped in this respect, but are ever reaching out into the research field and adding to their equipment in order to cope with the new problems met with. Great sums of money are being appropriated by the larger electrical firms for properly carrying on this work, and so completely successful have the efforts of some of them been that it is no longer necessary for them to submit any of their problems to the laboratories of our technical colleges for solution. Indeed, it is doubtful whether or not purely technical men could, in this stage of the development of manufacturing research departments, satisfactorily solve the infinite variety of problems that are daily referred to such departments. Manufacturing concerns recruit their research staff from those who have had a college technical training previous to a practical course of work in their shops, for in order to be thoroughly rounded men they must have their technical knowledge reinforced by experience in shop methods and processes. The tendency to widen the scope of this class of research work is beginning to manifest itself in the practice followed by some concerns of augmenting the technical staff with men who are experienced in the analysis of men as worker and of the application of their capabilities to the requirements of the shop methods and processes. This latter, however, is at present only a bare tendency, the greater part of this kind of research work being done jointly by the employment and rates and processes departments.

A summary of the present-day tendencies of American manufacturers of electrical apparatus may be stated thus: (1) Marked activity in seeking new markets abroad. (2) Development and maintenance of publicity organisations for the education and development of public taste. (3) Extensive policy of standardisation. (4) Specialisation in manufacture, particularly when volume is obtainable. (5) More complete planning and operating systems. (6) Improvement in quality of product and service to customers. And (7) Development of research work.

Waste Prevention in the Electrical Industry.

By E. V. Chambers.

During the present industrial crisis, some relief from the prevailing depression may be obtained by a careful investigation of the capacity and potential efficiency of the manufacturing plant in the works, so as to be ready for the next trade wave. A quiet period, in fact, provides a golden opportunity to carry out repairs and alterations, and also to effect improvements which will have a minimising effect upon production costs when the plant returns to normal working conditions. Finality in regard to efficiency has by no means been attained in the electrical industry, and the works staff will find profitable occupation in making a thorough and complete survey of their respective departments with the above object in view. In addition to the waste due to the deficiencies of manufacturing plant, there may also be considerable waste of materials—by-products of the process—and a close investigation of such waste materials may have very profitable results. A reference to the by-product waste in the electrical industry will be made later. In the meantime, a few observations upon the general processes may not be out of place.

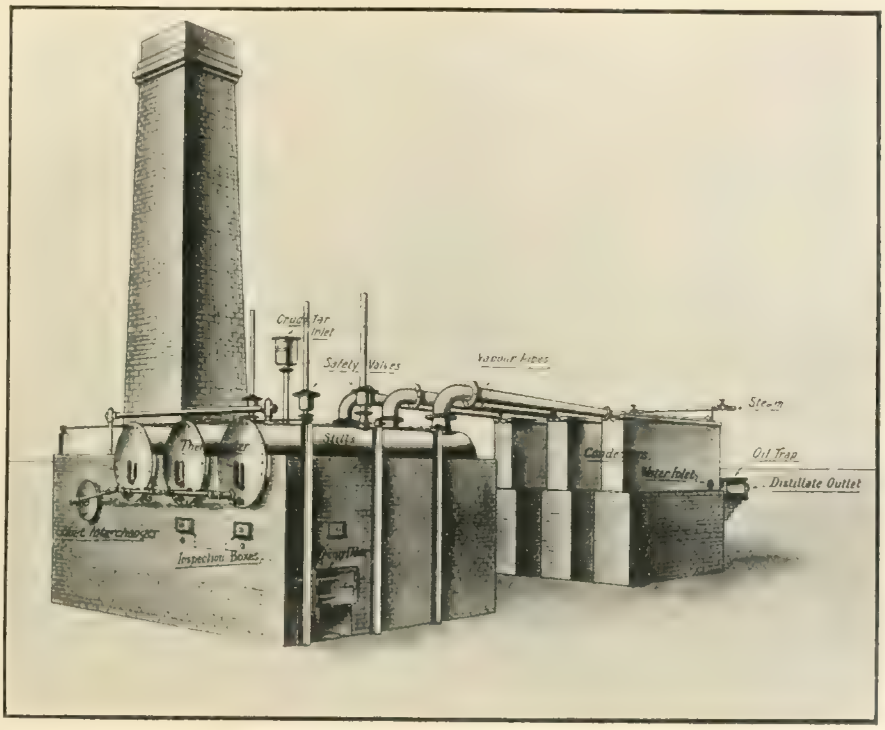


Fig. 1.—Continuous Tar Distillation Plant.
(Chambers & Hammond, Lightcliffe, Yorks.)

Steam Boiler Efficiency.

To-day, coal is four times its 1914 cost, therefore fuel efficiency is four times as important. On a moderate sized boiler installation—say, three Lancashire boilers—a saving of 10 per cent. in the fuel consumption means a saving of £600 per annum. Excessive fuel consumption at the boilers may be due to ignorant or indifferent stokers, leaky boiler settings, unsuitable fuel, defective air supply for combustion, or unsatisfactory feed water. The requirements of efficiency demand that the leading stoker should be intelligent and willing to learn. He should then be trained to understand the principles of combustion, and encouraged to take an intelligent interest in boiler control instruments, and he should benefit financially from any material improvement in the accomplishment of which he had played a part.

To ascertain the actual performance of the boilers, a complete boiler efficiency test should be carried out. Such a test would expose the particular defects in the system, when the remedy could be applied. Unsuitable feed water frequently causes an excessive consumption of fuel. In some cases, owing to rapid scale formation in the boilers, the working period is greatly curtailed for cleaning purposes, and the consequent cooling down and re-starting losses bring about an unnecessary wastage of fuel.

Scale-forming waters should be treated in an efficient water softener, of which many reliable types are available. The actual heat loss owing to non-conductivity of boiler scale, is frequently exaggerated in the statements of water softening plant manufacturers. It is true that boiler scale retards heat transference through the boiler plate, but in a Lancashire boiler the heating surfaces are so extensive that even when the fuel consumption is constant, varying thicknesses of scale have but a small effect upon the rate of evaporation, or upon the temperature of the flue gases entering the chimney. A reduction in fuel consumption of 10 per cent. has, however, frequently followed the installation of a water softener. It should not be forgotten that the life of a boiler depends almost entirely upon the nature of the feed water. The length of life of a steam boiler may be doubled by the use of a suitable feed water, in which case the depreciation will be halved. In this direction, therefore, it is an indisputable fact that a water softener amply justifies its cost.

Boiler Compositions.

Ordinary boiler compositions have practically no effect in the prevention of scale. Many which have been examined have contained more than 90 per cent. of water, and even those which exert a chemical effect merely change the nature of the boiler scale which still remains in the boiler. A lime and soda treatment in a water softening plant will remove the scale-forming salts before the water reaches the boiler, the operation being carried out at a minimum cost in labour and chemicals. It frequently happens that the boiler produces steam without undue waste, but that the fuel consumption is high owing to radiation losses in the steam pipes. As a rule the larger steam mains are suitably protected against steam loss by non-conducting coverings. Such protection is not always afforded to the branch pipes and smaller steam pipes. In a steam range, each one foot length of 1 in. diameter pipe will lose by condensation, heat equivalent to 2 lb. of coal per week. There are many factories where it would not be difficult to find 1 000 ft. of such piping causing a weekly loss of 4 000 lb. of coal, equivalent to 44 tons of coal per annum. A suitable steam pipe covering would almost entirely repay its initial cost.

Much steam is frequently wasted by the installation of small steam-driven units, such as pumps, small steam engines, air compressors, &c. Occasionally there may be no alternative, but, wherever possible, such units should be driven from the power shaft. Small units often require 40 lb. to 50 lb. of steam per horse-power, while the main driving shaft may develop 1 h.p. from 12 lb. to 15 lb. of steam. Making allowance for friction load, there is a heavy margin in favour of belt driving from the power shaft. There are, of course, many other means whereby steam consumption can be reduced, and it is certain that a careful inspection of each and every part of the steam system would amply repay the time thus spent. Faulty steam traps are frequently a cause of considerable steam loss.

By-Products from Producer Plant.

Many electrical manufacturing establishments are equipped with producer gas plant; some of these plants produce tar and sulphate of ammonia, while other plants produce tar only. The regular demand for sulphate of ammonia has led to the development of efficient and satisfactory sulphate production plant. There has not been an equally satisfactory demand for producer or Mond gas tar, and considerable difficulty has been experienced in its disposal. It is practically impossible to distil this tar in the ordinary intermittent or pot still. Producer tar contains a high proportion of water, which is emulsified with the tar, and which cannot be separated by the ordinary methods of settlement and decantation.

The following figures are obtained when Mond producer tar is distilled: Water 15·4, light oil 32·6, heavy oil 9·5, and pitch 42·5 parts per cent. It should be noted that some producer tars contain water to the extent of 50 or even 60 per cent., but even this high content of water presents no difficulty in the still to be described.

A New Form of Tar Still.

Some three years ago a new form of tar still was introduced, which is of the continuous type, and this type of plant has already dealt with large quantities of Mond and producer gas tar. Fig. 1 is an illustration of a plant which is capable of dealing with 15 to 20 tons of Mond tar per 24 hour day. Smaller installations deal satisfactorily with a weekly production of 5 tons of Mond tar. In larger producer tar plant it is usual to separate the tar into four fractions, namely, light oil, medium oil, heavy oil and pitch. The oils may be sold directly to refiners. The producer tar distillates are entirely unlike the distillate obtained from coal-tar produced in the horizontal gas retort. The products from the latter are of the aromatic or benzene series, while those obtained from producer tar are of the paraffin series. On refining, these oils produce motor spirit, light petroleum, fuel oil and burning or lamp oil; heavy oils suitable for the manufacture of disinfectants and sheep dips, also for wood preservation purposes. The pitch is used in the manufacture of briquettes, and owing to its low free carbon content, it is possible that it may be utilised as an insulator in the electrical industries.

It is quite possible that the products of distillation of producer tar particularly in the case of the smaller distillation plants, can be utilised in the same works as that which produces the tar. The pitch can be readily converted into a quick drying, hard black varnish, which is eminently suitable for painting castings, pipes, steel plates and other manufactured electrical products. As a general protective paint for the shops and buildings, it cannot be excelled. The oils can be utilised for cleaning purposes, particularly for the removal of grease. They also provide the fuel for oil-fired furnaces, and the heavier quality can be easily converted (without special plant) into disinfectant for use in the works.

Details of the Plant.

The following is a brief description of the working of the plant illustrated in Fig. 1: The crude tar enters the tar feed box, and thence passes through a heat interchanger, where it absorbs heat from the outgoing pitch produced in the stills. Leaving the heat interchanger it enters No. 1 still, in which it must pass down a cascade of steel plates. On the cascade the tar is spread out into a thin film, and it falls from one plate to another until it enters the still proper. The water which the tar contains is driven off during the passage down the cascade, the plates of which are heated by the hot vapours from the boiling tar underneath. This heat is practically sufficient to drive off the whole of the water before the tar enters the lower part of the still. The tar travels the length of the first still, and then enters and traverses the second still, and finally it passes through the third still. In this still the tar is converted into pitch, which, after leaving the still, passes through a heat interchanger when it gives up a portion of its heat to the ingoing crude tar. The working temperatures in the three stills are so graded that the first still has the lowest temperature and the third still the highest. The temperature difference in each still may be approximately 100°F. It follows that the products from the first still have a lower boiling point than those of the second still, which are again lower in boiling point than those of the third still. With a uniform feed and uniform heating the distilled products show no variation in boiling points, and the plants are of course, designed to maintain this essential uniformity.

The vapour discharged from each still is condensed in water-cooled condensers and the distillates flow into separate receiving tanks. The pitch flows into pitch beds constructed of concrete, and when cool it is removed by hand. A plant of this type requires no skilled attention, and men can be trained in three days to work the plant satisfactorily. Small plants do not require the whole attention of one man. They

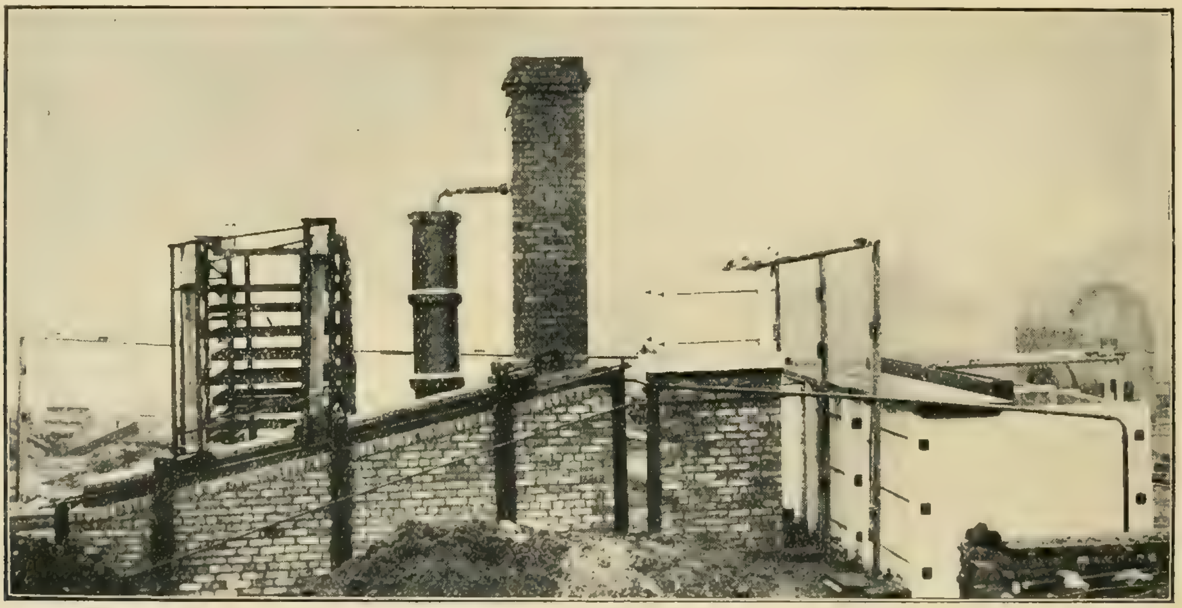


Fig. 2.—View of Plant for the Recovery of Ferrous Sulphate from Iron Pickling.

can be arranged to work in the day time only or continuously day and night. Mond tar and producer tar in the crude condition are difficult to dispose of, and usually their selling price is so low as to bring in no net return on the tar. When this tar is distilled at the point of production quite a different result is experienced. The prices obtained for the distilled products are such that the cost of the distillation plant is quickly recouped, and, of course, the difficulties of handling and disposing of the crude tar are eliminated.

Recovery of Valuable Products from Cleaning and Pickling Baths.

Many valuable products are wasted by the discharge of liquids used in the electrical and associated industries. In addition, it is frequently found that these discharges have a serious polluting action upon the water courses or channels into which they are delivered. Such solutions usually consist of metallic salts with or without the presence of free acid. The electrolytic methods of metal recovery, particularly copper, are, of course, well known. In many other cases, the evaporation of surplus water in waste liquor, will result in a liquor which, on cooling, deposits crystals which may be recovered for re-use. Care should be taken in regard to the selection of suitable apparatus, particularly where acids are concerned. Various silicon irons are manufactured for dealing with acids of certain strengths and quality. Before attempting to use any of these metals full information, together with samples, should be submitted to the maker, as otherwise disappointment and serious loss may be experienced. An excellent material for resisting acid solutions is fused silica, which is manufactured by fusing specially selected quartz in the electric furnace.

Recovery of Ferrous Sulphate.

As an example of the recovery of useful products from waste liquors, reference will now be made to an installation for recovering hydrochloric acid and ferrous sulphate (copperas) from iron wire cleaning or pickling.

The iron is coated with rust which consists of various oxides of iron. For the purpose of removing this rust the iron wire is dipped in dilute hydrochloric acid (spirits of salts). The wire after dipping is washed with water and treated with milk of lime. The rust dissolves in the hydrochloric acid and after a time the acid dipping bath becomes more or less concentrated with iron, and its hydrochloric-acid content is reduced to about 1 per cent., when it is discharged from the dipping vessel. Such a liquor gives the following results on analysis: Ferrous chloride, 18·4; free hydrochloric acid, 0·40; and water, 81·20 parts per cent.

Fig. 2 illustrates a plant which converts this waste pickle liquor into hydrochloric acid and ferrous sulphate. The waste liquor is led into large stoneware tanks, and to the liquor in these tanks sufficient sulphuric acid is added to convert the iron into ferrous sulphate, and to set free the hydrochloric acid. From these tanks the liquor is raised into another tank which feeds the silica basin cascade evaporator. The mixed liquid passes from the top of this cascade to the bottom, flowing from one basin into the next beneath, and so on. As the result of the heat which is applied the liquid boils and hydrochloric-acid vapour is evolved. This passes forward to condensers and the hydrochloric acid leaving the condensers flows into a store vessel. The liquor which flows from the bottom of the cascade consists of a saturated solution of ferrous sulphate, which is allowed to flow out into crystallising vessels, where ferrous sulphate crystals are removed after cooling. The plant will work with the attention of one man per shift. A plant treating 1 000 gals. of spent liquor per day will produce hydrochloric acid of 16°Tw., in quantities equal to 270 gals. of tower salts per day, and, in addition, there is produced 18 cwt. of sulphate of iron. The actual production and values of recovered material are, per annum:—

8 000 Carboys Hydrochloric Acid at 7s.	£2 800	0	0
275 tons Sulphate of Iron at £4	1 100	0	0
	£3 900	0	0

The working costs, including all overhead charges, do not exceed £2 000, and this recovery process therefore brings in a net return of £1 900 per annum.

Recovery of Lubricating Oil.

In the engineering shops large quantities of oil are consumed by the various cutting tools employed. These may either be homogeneous oils such as lard oil, colza or mineral oils, or mixtures of the same. These lubricants after a time become so saturated with impurities that they are discharged as waste. It is possible by a simple mechanical treatment to refine these oils and to remove therefrom suspended particles which the oils contain in an extremely fine state of division. By submitting these waste oils to the action of centrifugal force in a rotating centrifugal machine the suspended solids are almost instantaneously removed from the oils, which are discharged in a perfectly transparent condition, quite suitable for re-use. The machine employed is a solid-basket centrifugal which rotates at between 1 000 and 2 000 revs. per min. By a suitable baffle ring inside the basket the solids are held back while the oil overflows the baffle ring into the jacket of the machine. From this jacket it emerges by means of a small pipe outlet into casks ready for use. These machines are inexpensive and do not require continuous attention. A machine having a diameter of 2 ft. will deal comfortably with 50 gals. of oil per hour. Fig. 3 illustrates the type of machine utilised.

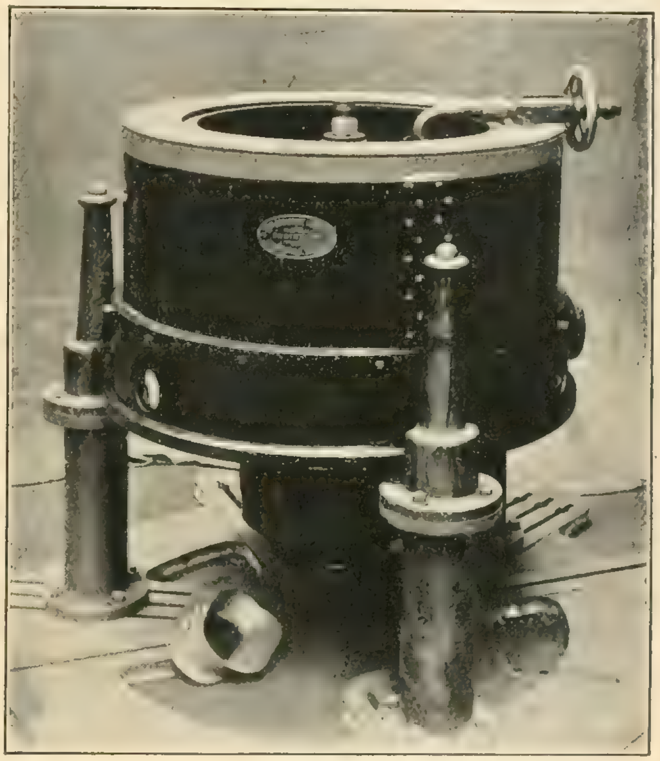


Fig. 3.—Machine for the Recovery or Dehydrolisation of Lubricating Oil.

Metal turnings, borings or cuttings from machines may contain oil to an extent varying from 10 to 30 per cent. of their weight. Apparatus is available for recovering this oil from the waste turnings, &c. In this case a perforated-basket high-speed centrifugal is utilised, when the turnings are submitted to centrifugal force equal to 1 000 times gravity. The centrifugal machine used is of the same design as that shown in Fig. 3, with the exception that for recovery of oil from turnings, &c., the revolving basket is perforated as previously stated.

The type of machine illustrated in Fig. 3 is also very effective in removing water from lubricating oils. It is often difficult by means of ordinary gravity to separate water from oils, when the two exist in the state of an emulsion, as the difference in specific gravity between the water and the oil is in many cases very slight. The application of centrifugal force increases the effect of gravity by hundreds and even thousands of times, and there is a proportional difference between the gravities of the substances under treatment, with the result that emulsions are almost instantly separated into two layers in the basket of the machine: an outer layer of water, and an inner layer of oil. The flow of these oils to the machine is continuous, and there is also a continuous delivery of water through the machine, while the oil is removed by means of an adjustable skimming pipe, which impinges on the surface of the rotating liquid, and the oil by its own momentum is delivered through the skimming pipe into barrels or other receptacles.

Recovery of Shellac and Mica from Waste Insulating Materials.

Quantities of waste mica cuttings are produced in the various sections of the electrical industry. Hitherto these materials have been treated as waste; these waste mica cuttings have been examined, and it has been found that on the average they contain the following: Mica, 70, shellac, 24, moisture, 6 per cent.

The moisture is due to the fact that the cuttings have been lying on a tip for several months. By submitting these cuttings to the ordinary solvent extraction process, it has been found that the whole of the shellac can be recovered, and that the small mica plates free from shellac can be used for building up large insulating sheets, by using the recovered shellac as the adhesive and paper as the carrying base. In several establishments proposals are under consideration for recovering these materials for re-use in the works. Samples of insulating paper cuttings have also been examined, giving the following results: Paper, 54, and shellac, 29 per cent. It is proposed that this paper shall also be extracted for the recovery of valuable shellac.

Mixed Waste.

A recent inspection of a dump on an electrical plant manufacturing works revealed the fact that the dump consisted of mica, various metals and other insulating mediums. There can be no question that if these materials, as they are produced in the works, were deposited in separate store bins, valuable materials could be recovered therefrom. The mica can be dealt with as has been previously described. The larger pieces of insulating mediums could be adapted for smaller work, and the metals could, of course, be disposed of readily.

There is much to be said for the institution of a special inspector whose duty it should be to prevent such waste as has been referred to. This waste department should investigate every process which could be applied to the recovery for re-use of what has hitherto been regarded as unavoidable waste. When one sees on a dump mixtures of copper, nickel, iron, bearing metals, solders and the like, it can only be assumed that such waste is the result of a lack of co-ordination in the various departments. It is a comparatively simple matter to have separate stores for each individual form of waste, but it is a difficult and expensive matter to separate the above materials from a heterogeneous mixture of all of the above. It should not be forgotten that since 1914 there has been a very great change in economic values. Materials which formerly had little or no value may possibly at the present time be very valuable, and it is essential, therefore, that there should be a corresponding increase in the conservation of such materials. It is not possible in the scope of this article to deal extensively with all the waste products in the electrical trades, but it is hoped that sufficient will have been said to direct attention to this all-important question.

Women in the Electrical Industry.

By the HON. LADY PARSONS.

THAT a new spirit is beginning to pervade the management of electrical and engineering works is another proof of the earnest effort to find a solution of the difficult and troublesome problems that are now holding up our industries.

Quite a number of girls who gained their principal knowledge of electrical work during the war were not willing to give up, without an effort, their four years of experience, and many of them continued their studies under varying conditions; in works, when possible, in colleges, by attending courses, and by home reading. As so many capable and educated women have gained experience in business and in the technical knowledge of electrical work, it is only to be expected that they should be seeking to develop their position on the management side of the works. Some few firms, electrical and engineering, have made posts for women in the administration of their factories; where such responsibility has been entrusted to qualified women good results have followed.

Where Woman Can Help the Buying Department.

In the buying departments it is noticeable that a considerable saving has been effected, in minor directions, while capable women are also making substantial reductions in wages and costing departments. Both these departments are being subjected to a very minute and detailed examination. Accustomed from childhood to a minute calculation of things in detail, it comes as a matter of course to women to order in such material as they can see an immediate use for. In the lay out of shops, too, much greater order and convenience is apparent; girls like to have all their tools ready to hand and neatly arranged near their work, thus saving a great deal of time in journeys to and from the store. And if, perhaps, women have not yet the vision to see out beyond their own experience, it has the advantage that they do not so readily fill up the works with mountains of stuff for which there may be a prospective but remote use. In the present zeal for economy no firm can afford to neglect any avenue that opens out a prospect of more economical methods.

Electrical firms employing capable women as company secretaries, or as assistant secretaries, may also see an expansion of business in unforeseen directions. A clever secretary who has also spent some time in the actual work of the shops, so as to have a reasonable knowledge of the processes she is sometimes asked to explain, will be a great asset to any firm; a girl having good business methods and a pleasant sympathetic manner will have many opportunities for extending business, and if she can add a conversational knowledge of French it will help her with the representatives of foreign firms who are expected to visit our electrical works as soon as conditions are more favourable to business.

Research and Experimental Work.

In chemical research work and in experimental work on metals and alloys women are in great demand as assistants, and are as a rule good, careful and reliable in such positions, working usually along already defined lines. Sometimes in experimental work women have been at a disadvantage in not being in possession of the complete knowledge of the experiments in which they are assisting, but as electrical works generally are establishing well-equipped research departments, the women who come with a good training from University and Colleges will soon learn to carry out efficiently the experimental work under their charge.

In the Drawing Office.

In the drawing office women have greatly improved their position and enlarged their scope. For years they were only employed as tracers, and never had the benefit of any shop experience or the chance of interesting work. They were found to be industrious and painstaking, continuing their patient efforts for years in the same work, doing dull jobs that men and boys would not undertake, and were consequently so useful that they were not given any encouragement to learn original drawing. But with the arrival of the more highly-educated women in the drawing offices much more initiative has been shown, both on the part of the firms and the girls. Girls have learnt to design parts of machinery, to enlarge or reduce parts from sketches, to assemble and complete drawings from sketches of parts; many of them are able to take responsible work. Not only in factories but in some technical colleges women are teaching drawing to students of both sexes.

As women have passed from the drawing office to the pattern shop and from the foundry to the shops and to mechanical processes, and so on through all the departments of a large works, a necessary and wholesome process of sifting has taken place, but the net result so far has been a small nucleus of clever girls with experience and initiative who are doing the valuable if somewhat thankless work of pioneers for their sex in learning to manage the business and the technical side of electrical and engineering works.

As travellers for electrical firms women have not yet made any serious bid. A few exceptional women have occasionally followed up work, but in general a constitutional fear of plunging into the unknown has made women hesitate at the thought of making commercial journeys to win custom out of the unknown. Commercial travelling is a very old business, and women cannot expect to succeed all at once without the necessary training and experience in commercial affairs. Hard work and many disappointments are certainly discouraging, but have to be faced in any business. Probably when women seriously attack the science of selling they will do so on somewhat original lines, and think out their own methods of market building, and as women are now students for the new commercial degree of the London University we may soon hope to see a number of well-instructed women applying themselves seriously to the commercial side of business and evolving a new race of travellers whose selling capacity will reach a high level.

The Influence of Women Generally.

Taking a general view of the influence that women are producing in the management side of the works a fresh point of view has been brought to bear on many problems. Women are untrammelled by tradition in engineering. In management they have their own way of overcoming troubles. In the supervision of shops the best results are certainly obtained where educated forewomen with a thorough practical knowledge of the technical work are placed in complete control of the work. They are good judges of the capacities of their own sex; knowing how susceptible women are to praise or blame, they are often able to avoid trouble among the workers by a personal interest and by words in season that is something of an innovation in large firms.

In general management some essentially feminine characteristics have become apparent. Women have proved to be extremely sensitive to their environment. The quality of their work, their keenness and happiness depend greatly on living in an agreeable locality. Factories pleasantly situated, easy of access, with good accommodation near at hand, and with opportunities for some social life, suit women far better than the immense factories in dingy localities, unattractive in aspect, uncompromising in social atmosphere, such as were the characteristics of important factories, at any rate before the war.

The Business Girl and the Housing Question.

The housing question looms up large in the difficult path of the business girl—very expensive and very difficult to get, girls constantly have to put up with the most wretched accommodation. They often make great efforts to do all the housekeeping, cooking, &c., as well as the day's work in the factory, and small wonder that many clever and well-educated girls have been driven out of business broken down in health by the impossibility of finding accommodation at reasonable terms.

Although combination and amalgamation are so much the tendency of the day in electrical and engineering works, yet there are possibilities of success in a return to a type of smaller factory. Having a lay out of machinery much less highly specialised, a small factory, when worked by a personnel directly interested in production, can deal economically with a great deal of the smaller work of the electrical trades. Such factories having resourceful and industrious women in charge would have a good chance of capturing every possible ounce of trade. In this way it has already been found possible to utilise to the best advantage the special qualities of women, qualities that are certainly very marked in the direction of industry, and of making economies, and of getting the best out of their female employees. And if women have not yet acquired an intimate knowledge of many processes and a broad grasp of wide principles, yet the capacity to manage small businesses economically and to build up a connection with small beginnings is an asset to the development of the business of the country that cannot be overlooked, at a time when all large enterprises are causing so much anxiety to the managers.

Machine Tools in Electrical Manufacture.

I.—Introduction.

By P. V. VERNON, O.B.E., M.I.Mech.E.

The design of electrical machinery and electrical appliances in the past has frequently been such as to necessitate somewhat difficult and expensive operations in machining, owing to the fact that many electrical designers have not been machine-shop men in the modern acceptance of the term.

The electrical machine, perhaps, more than than any other class of mechanism, is capable of design by mathematical formulæ, and a dynamo or motor, for example, can be manufactured to give a certain electrical efficiency from theoretical considerations alone, the assumption being that the mechanical side can be dealt with without much trouble, and that it is not by any means the most important thing to be considered. The result has been that the pure scientist has had, perhaps, rather too much to say in the design of electrical machinery, and the skill of the practical mechanical designer has not been fully utilised.

In recent years the effects of competition and the necessity for reducing costs and of improving methods of manufacture have led to much greater attention being paid to the design of electrical machines from the production point of view, and the development of the production engineer has not only caused methods of manufacture to be improved, but has resulted in great changes in design with a view to facilitating methods of manufacture.

In earlier years, before motors were made in this country in large quantities, the form of frame, end-shield or commutator sleeve did not affect the cost very materially, as such parts were not made in large numbers and the difference in cost when made by ordinary methods between one design and another was not serious, but now that quantities are increased and costs have to be reduced to the minimum, the form of the parts is nearly as important from a production point of view as the suitability of the machine tools which are used for producing them, and an examination of recent designs will show this to be the case.

The Electric Motor—Past and Present.

An example which occurs to the writer is in the design of the ordinary motor as made now and as made, say, 20 years ago. The early motors consisted of a bed-plate upon which was mounted the field magnets, and also two pedestals carrying the bearings. All these parts had to be separately attached to the bed-plate and lined up in addition to the machining of the parts themselves and of the bed-plate. It was therefore somewhat expensive. The modern motor frame, in which the machining consists of little else than boring and facing at one setting, is very much cheaper to machine than the older type; and the modern end plates which are centred in the frame of the motor are relatively simple to machine and centre themselves without any setting or lining up. All these points have resulted in cheapening production, and in facilitating the use of modern labour-saving tools—for example, the end-shields can now be machined complete with the bearings upon a turret lathe, although the turret lathe maker would very much like to see them of stronger design, so as to avoid the present tendency to distort owing to their extreme thinness.

Commutator sleeves, washers and nuts can be produced at a very low cost upon automatic turning machines, providing they are standardised so as to come along in suitable numbers. The same of course applies to armature spindles, which, if standardised, can be produced in a very economical manner upon bar turret lathes, and finished by grinding.

Motor Standardisation.

In a range of motors it is most important from the point of view of standardisation to keep down the numbers of frames and their accessories, and there is little doubt that the machine-shop man has had a good deal to do with the recent standardisation of such details.

The writer is not an electrical engineer, and naturally offers his views on these matters with some diffidence, but it does occur to him that the design of the switch and control gear frequently offered by electrical firms of repute is not such as would be tolerated by engineers for any other type of mechanism, and is only perhaps accepted at present owing to the fact that the general standard of such gear is very low from a mechanical point of view.

In many of these articles the quality of the fits, the proportions of the parts, and the amount of labour required to make and assemble, say, for example, a controller, appear to be such that the design would be radically altered if the shop man's views had more weight, and, judging by the success of some high-class productions of this nature which are offered by several of the best makers, the field for improvement from the mechanical and manufacturing point of view is doubtless very great.

A further matter from the machine tool makers' point of view that would be well worth attention by electrical manufacturers is the standardisation of motors with regard to those parts of them with which the machine toool maker has to deal when fitting a motor to the machine. Without interfering at all with the design of the motor itself, one would think it possible to adopt a standardised form of feet for the motor, and standardised shaft ends, together with uniform distances for different sizes of motors from the base to the centre. This would enable machine tools to be built so that any make of motor could be fitted to them without the need of special adapters and couplings. If the distance from the feet to the shaft end could also be standardised the work of the machine tool maker would be facilitated.

It is, perhaps, too much to hope that voltages and periodicities will be standardised, but it is, nevertheless, a fact that the application of direct connected motors to machine tools has been greatly hindered in the past by the great variations which exist.

II.—The Turret Lathe in the Electrical Industry.

By A. H. LLOYD, B.Sc., M.B.E.

The electrical industry is to-day of such huge proportions and covers such an extensive range of work that it would need a very large tome to illustrate and describe the whole of the machine tools and processes used. It is proposed in these notes, therefore, to restrict ourselves to that section covering the small or medium sized product. The electrical industry in particular is one which is in a position to take full advantage of the savings which can be effected by the installation of modern machine tools. Generally speaking, the quantities which are put in hand at one time are large, so that in many works automatic turning machines, or, as they are now called, auto-lathes, can be used, with consequent low labour costs.

The present article proposes to deal broadly with the various components of motors, dynamos and magnetos; indicating how they are being handled by the special methods arranged by Messrs. Alfred Herbert, Ltd., Coventry, for use on the Herbert line of turret lathes.

Capstan v. Auto Lathes.

As a foreword it may be stated that the advisability of installing capstan lathes and combination turret lathes in preference to auto lathes is determined entirely by the volume of work which can be put in hand at one time. The auto lathe is, in reality, a turret lathe in which, after chucking, all cutting operations are performed automatically, the machine stopping at the completion of the cycle. All the operator has to do, therefore, is to insert pieces in the chuck and take them out when finished. It is possible for one operator to attend from four to six machines, and the labour cost per piece is, therefore, lower than when produced on a hand-operated turret lathe, although the machining times may be the same. The auto lathe is consequently preferable when the quantities to be produced at one time are large.

Machining Small Articles.

Dealing first with small articles, Fig. 5 (1) shows the machining of a yoke of a motor-car lighting dynamo on a Herbert No. 4 capstan lathe. The material is a steel casting which is chucked in special jaws in the "Coventry" chuck. The machining operations are of a comparatively simple nature, being dealt with by two single point boring bars piloted in the chuck, and a sizing bar for finishing the bore. The sizing bar has adjustable floating cutters which produce a very accurate hole with the minimum of trouble. On the cross-slide is mounted a square turret in which are carried roughing and finishing facing tools. The machining time is about 10 minutes.

Fig. 8 (5) shows a special adaptation of the "Coventry" chuck, which is here fitted to a Herbert No. 4 capstan lathe. The chuck is holding an end-shield for magnetos. The "Coventry" chuck is a most versatile lathe accessory and can be adapted to hold many kinds of irregular objects by the employment of special jaws. In the example shown two of the jaws are removed and a fixed locating plate substituted, the gripping being done by a single jaw. The locating plate is provided with a little adjustment to facilitate setting the first casting true.

Fig. 5 (2) shows the same type of machine arranged for boring out the pole pieces of magnetos after they have been assembled with the magneto and the base. For this operation a special chucking fixture is employed, the magneto body being clamped on to an angle plate by means of a cam inside the horse-shoe portion. The base is located laterally by a hardened slot in the angle plate, this slot being formed in a removable adapter plate. Other adapter plates can be substituted for dealing with different types of magnetos. The tools consist of three single point boring bars for the "tunnel," which are piloted in a steady bush in the fixture, and facing tools on the cross slides. The machining time for boring 2⅛ in. diameter, 4⅞ in. long, counterbored and faced at both ends, is 16 minutes.

DETAILS OF A TYPICAL LAYOUT.

In the foregoing examples the tooling is fairly simple, and we will now consider a rather more elaborate layout on a No. 4 capstan lathe which deals with the machining of a gun-metal magneto cam case.

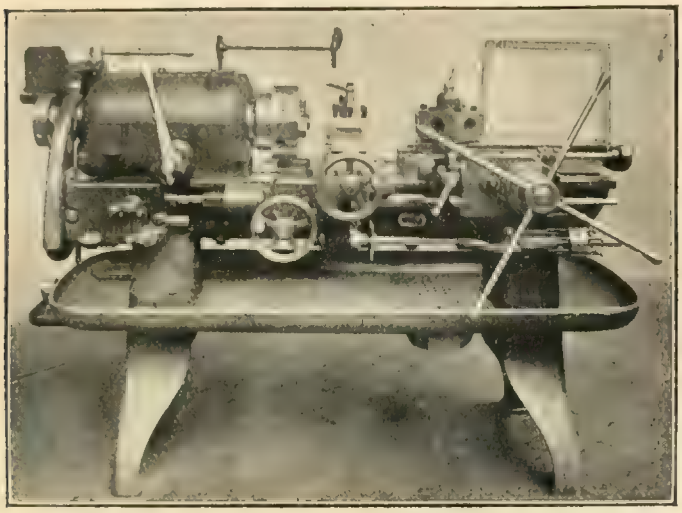


FIG. 1.—NO. 4 CAPSTAN LATHE ARRANGED FOR CHUCKING WORK.

Fig. 1 shows the No. 4 Capstan Lathe, general view, fitted with 9-in. "Coventry" chuck. The first operation is shown in Fig. 5 (3), the layout drawing of which is given in Fig. 2, which will be the key to the tooling. The casting is gripped in the "Coventry" chuck fitted with a special-shaped set of jaws, of which an end view is given in the layout. These jaws are made with a short shoulder so that they square up the flange and provide a definite end location. Tool No. 1 is a facing tool for the end. Tool No. 2 is a flat drill. Tool No. 3 is a standard knee-type turning tool for turning the outside diameter; this carries a boring bar with flat cutter for rough boring and facing the bottom of the large bore. Tool No. 4 is similar and finishes the surfaces corresponding to those machined by No. 3, but there is an additional cutter for grooving the bottom of the large bore. Tool No. 5 is a single-point boring bar for sizing the bore. Tool No. 6 is a boring bar carrying a cutter-head which finishes the small bore, forms the radius at the mouth of the small bore and forms the external radius on the end of the casting. At the second operation shown in Fig. 5 (4) and Fig. 3 the method of chucking is noteworthy. It shows how concentricity of the work done at the second operation is obtained in relation to the first. The chuck steady bush which is perfectly true is made a sliding fit in the large bore finished at the first operation, and on this the work locates. Gripping and driving are done by the soft jaws which are bored out true, but it is important to note that the concentricity is not dependent upon the truth of the soft jaws but on the locating plug. Tool No. 1 in the square turret faces the flange and the end. Tool No. 1A is used for the finishing operation on the same surfaces. Tool No. 2 is a standard knee-type turning tool carrying a rough turning cutter and a piloted 4-fluted reamer for rough boring and bottoming. No. 3 is a similar combination to No. 2 but takes a second cut. No. 4 is a boring bar carrying an under-cutting tool for grooving the bottom of the bore. No. 5 is a sizing boring tool. No. 6 is a knee-turning tool for sizing the spigot. No. 7 is a boring bar for forming the radius in the small bore and carries cutters for forming the internal and external radii. Although the tolerances on this class of work are very fine, the piece can be produced complete in about 4¾ minutes.

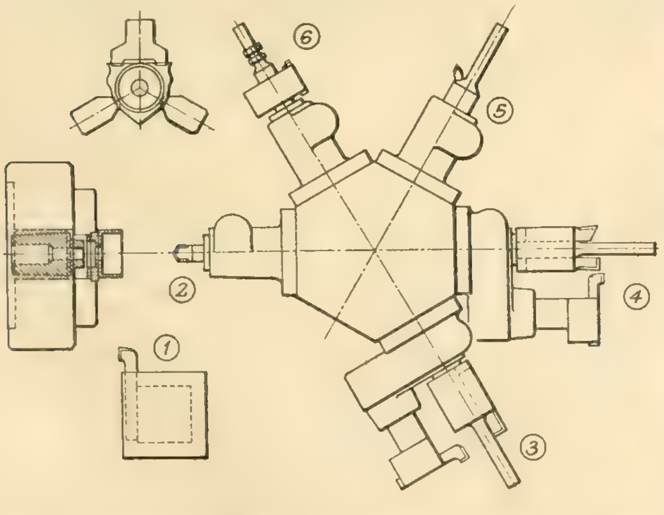


FIG. 2 LAY OUT FOR FIRST OPERATION ON MAGNETO CAM CASE.

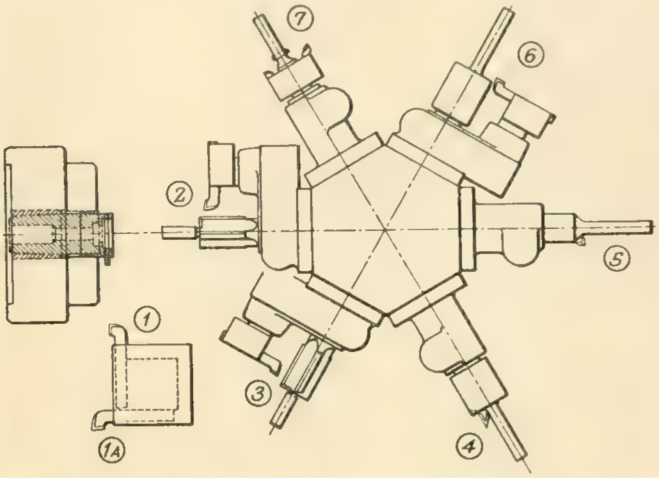


FIG. 3.—LAY OUT FOR SECOND OPERATION ON MAGNETO CAM CASE.

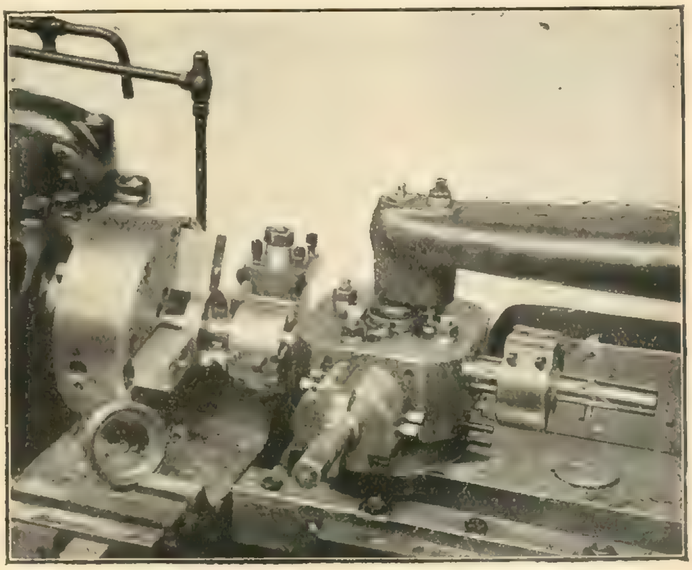


FIG. 4.—MACHINING COMMUTATOR RINGS ON NO. 2 HERBERT AUTO LATHE.

An Operation on a Small Auto Lathe.

Fig. 4 shows the machining operation on a small auto lathe —the No. 2 Herbert. This is the tool layout employed on the second operation for machining commutator rings. At the first operation the mild-steel stampings are gripped in the bore with the flat end outwards, whilst the outside diameter is turned and the end faced. At the second operation shown the work is gripped in soft jaws and the bore is finished.

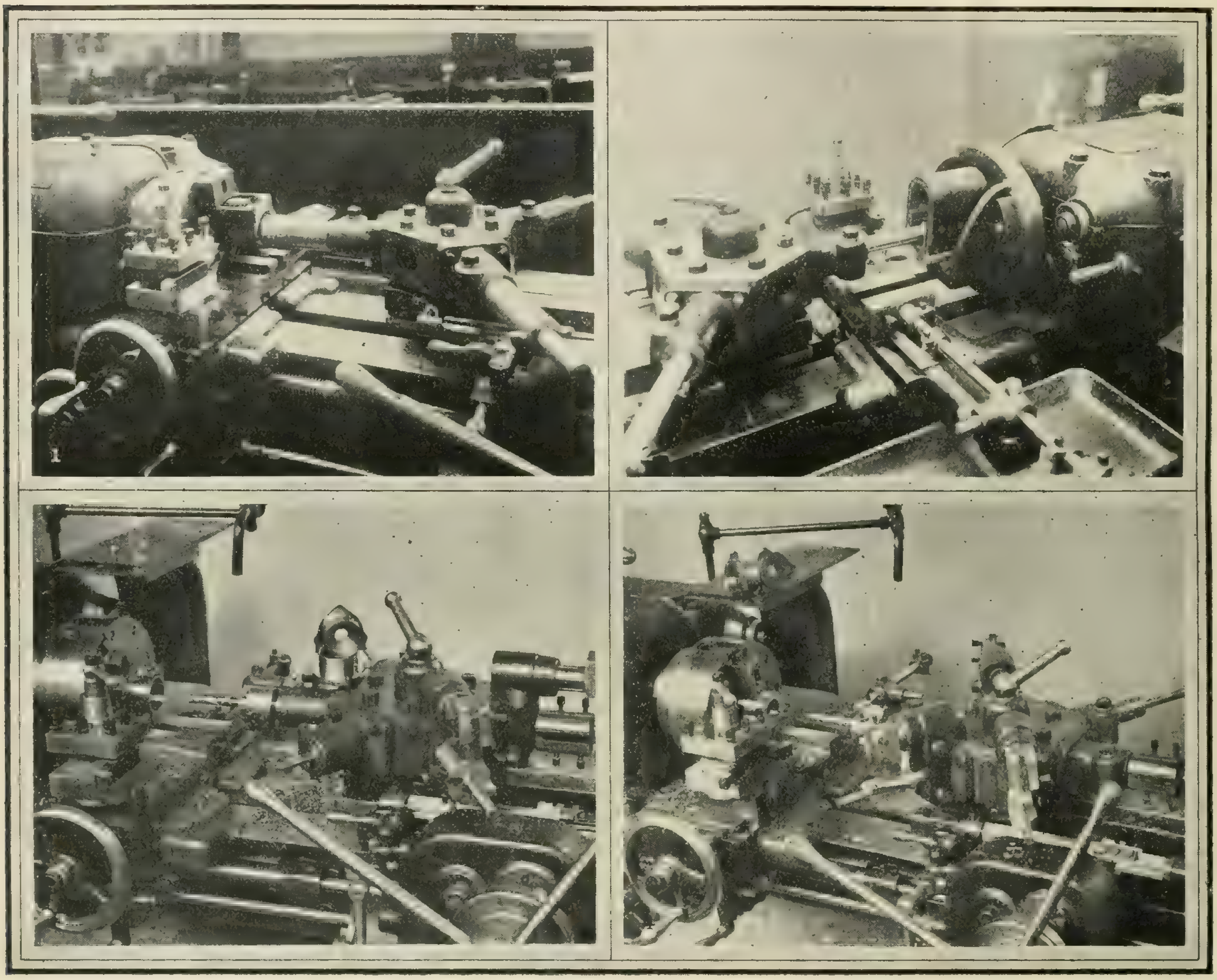


Fig. 5.

1. Machining Lighting Dynamo Yokes on Herbert No. 4 Capstan Lathe.
2. Boring Magneto Tunnels on Herbert No. 4 Capstan Lathe.
3. First Operation on Magneto Cam Case.
4. Second Operation on Magneto Cam Case.

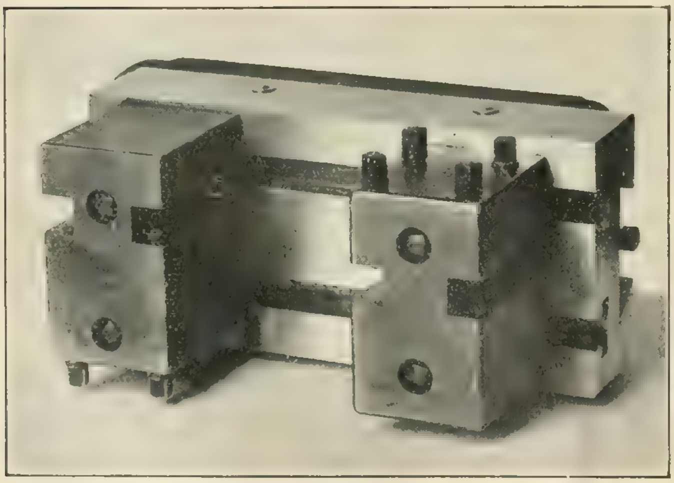


Fig. 6.—The Slide Facing Tool used for Machining Faces inaccessible from the Cross Slide.

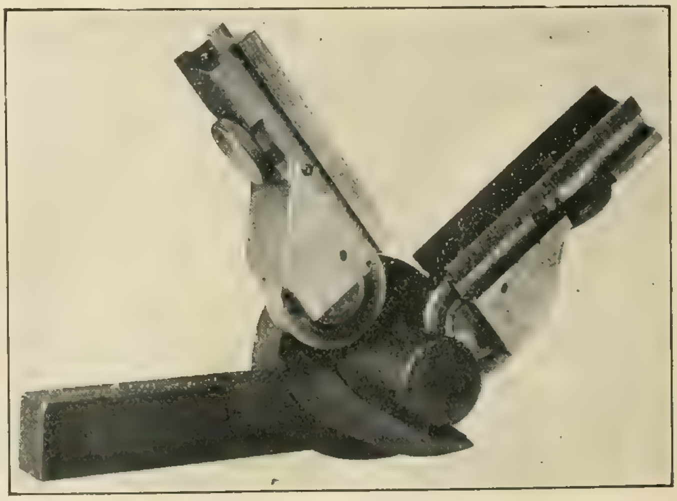


Fig. 7.—Arrangement of the Roller Steadies and Cutting Tool in the Herbert Patent Roller Steady Turners.

Three cutter heads are mounted on boring bars for forming the bevel and the various radii. The cross-slide carries a simple facing tool. The machining time on this piece is about 10 minutes.

AUTO LATHES FOR LARGE WORK.

We shall now consider some larger pieces of work machined on auto lathes. Fig. 8 (6) portrays the layout on a No. 6 auto lathe for machining the pulley end shield of an electric

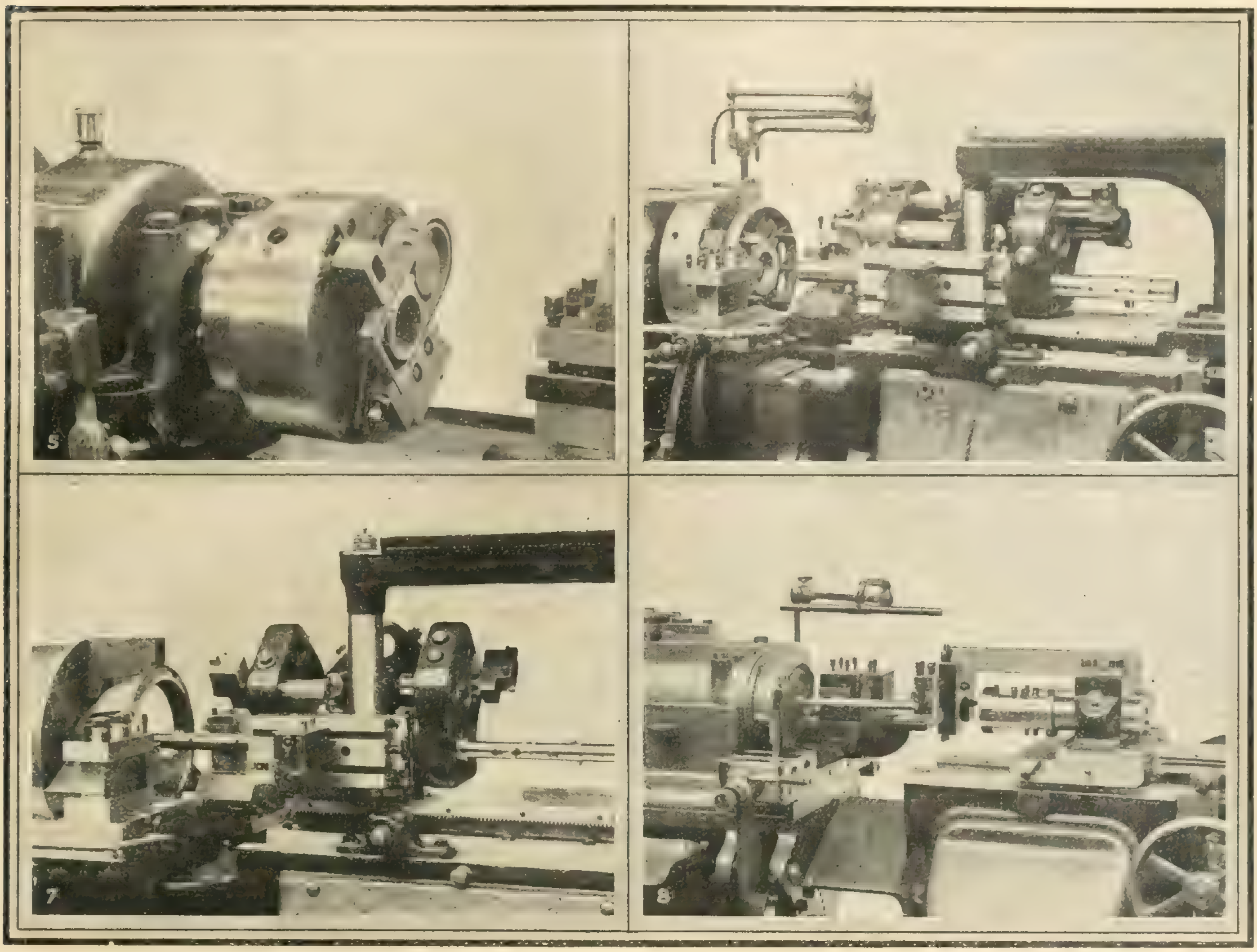


FIG. 8.

5. SPECIAL ADAPTATION OF THE "COVENTRY" CHUCK FOR HOLDING MAGNETO END PLATES.
6. MACHINING PULLEY END SHIELDS ON NO. 6 HERBERT AUTO LATHE.
7. MACHINING COMMUTATOR END SHIELDS ON NO. 6 HERBERT AUTO SLIDE.
8. NO. 2 HERBERT AUTOMATIC STUD AND BOLT MACHINE PRODUCING SPINDLES FOR LIGHTING DYNAMOS.

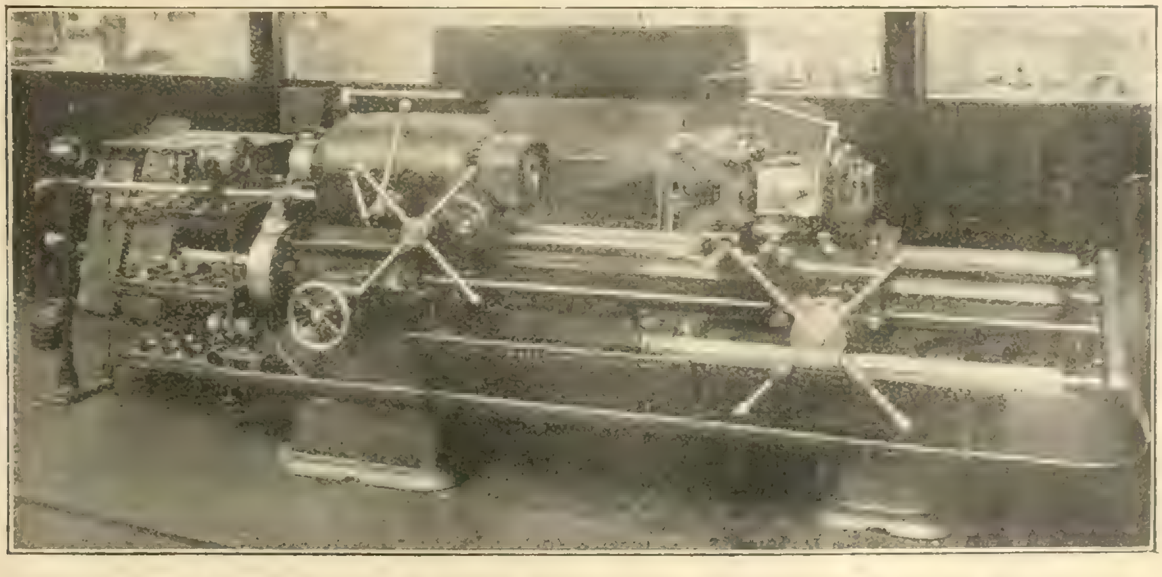


FIG. 9.—GENERAL VIEW OF NO. 13 HERBERT HEXAGON TURRET LATHE FOR BAR WORK.

motor. Fig. 8 (7) shows the layout for machinery the commutator end shield of an electric motor. In both the cases shown the operations consist of boring and facing with an accurate spigot to be sized in each case. In both of these layouts there appears a very useful tool known as the slide facing tool, which is to be seen in each case on the front face of the turret. This device is used for machining faces which are inaccessible from the cross-slide. Whilst it might appear at first sight that this kind of machining could be done with serrated flat cutters, it is much better to use a single-point traversing cut as the scale would rapidly destroy the cutting edge of a flat cutter.

Fig. 6 shows the slide facing tool which carries one or more toolholders; the tool is bolted to the turret, which is brought forward to the work and held stationary by a retaining cam. A block on the cross-slide of the lathe pushes over the slide and this traverses the face with a single-point cut. Roughing and finishing cutters can often be carried on the same slide, but in such case the roughing cutter is arranged to finish cutting before the finishing cutter starts.

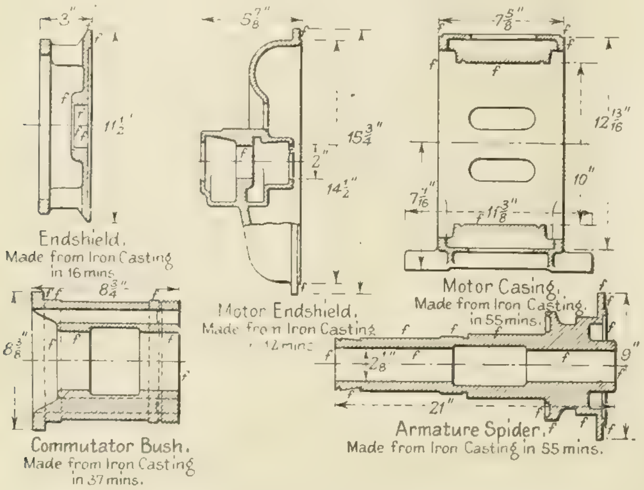

3"
11½"
Endshield.
Made from Iron Casting in 16 mins
5⅞"
15¾"
2"
14½"
Motor Endshield.
Made from Iron Casting in 12 mins
7⅝"
12 13/16"
10"
7 7/16"
11⅜"
Motor Casing.
Made from Iron Casting in 55 mins.
8¾"
8⅜"
Commutator Bush.
Made from Iron Casting in 37 mins.
2⅛"
9"
21"
Armature Spider.
Made from Iron Casting in 55 mins.
f

Fig. 10.—Electrical Details Machined on Herbert Combination Turret Lathes with Production Times.

In Fig. 8 (7) is shown a remarkably long set of chuck jaws which grip the casting on the large diameter. The very long bearing which the slides have in the "Coventry" chuck makes it possible to use much longer jaws than would be practicable with any other type of chuck. The machining time for the pulley-end shield, which is 10¾ in. diameter, is 14 minutes, and for the commutator-end shield, which is 14 in. diameter, 22 minutes. It will be noticed in the examples which have been given that the tooling is simple, and much of the prejudice which existed against capstan and turret lathes in their early days has now been removed by the provision of well-designed outfits of standard tools which can be used for a large variety of work.

Other Types of Turret Lathes.

The Herbert line of turret lathes comprises machines which are fitted with many refinements which facilitate rapid change-over from one piece to another of a different type. It is, therefore, a paying proposition to set up for comparatively small quantities. Fig. 10 shows a number of pieces which are being handled on Herbert combination turret lathes. Machining times are given. Whilst the combination turret lathe and auto lathes, illustrated in Fig. 11, show typical electrical parts machined on Herbert auto lathes, the times given are not in the nature of "stunt" performances, but rather average times taken from customers' practice, and where castings have been machined, the iron is the average British grey iron. We mention this fact as, occasionally, production times from American sources may appear better. It should be borne in mind that much depends on the conditions and the material which is being operated upon, and it is a well-known fact that American cast-iron is softer than the British variety.

While the combination turret lathe and auto lathe deal with the parts made from castings, dynamo and motor spindles are made from bar on a different type of machine known as the hexagon turret lathe. Messrs. Alfred Herbert, Ltd., make this class of machine in three sizes, viz.: the No. 1, which has a capacity of 1⅝ in. by 27 in.; No. 13, 2¾ in. by 36 in.; and No. 4, 3½ in. by 42 in. Fig. 9 illustrates the No. 13 hexagon turret lathe, which is typical of the Herbert line of turret lathes. On this type of lathe a standard tool equipment is regularly fitted which enables it to deal with all ordinary work without the necessity of resorting to special tools. It will be readily appreciated that it is much easier to do this in the case of a bar lathe, as all bar work of necessity consists of a combination of a number of different diameters varying within a small range. On the hexagon turret lathe there are three patent roller steady turners, which finish diameters at one cut.

The Herbert Bar Lathe.

Fig. 7 shows the principle of the roller-steady turner in action, the patented disposition of the rollers enabling the Herbert bar lathe to take very large reductions at high speeds and coarse feeds. The equipment is completed by the "Coventry" Patent self-opening diehead for threading; a slide for forming, grooving, and cutting-off; a triple tool holder, comprising (1) a roller steady ending tool for finishing work accurately to length, (2) a roller-steady centring tool for centring the work for subsequent grinding operations, and (3) an adjustable stop which determines the length of bar feed.

As the layout on this type of machine is practically always the same it is possibly not quite so spectacular from a tooling-up point of view, and the interest, therefore, in an article of this kind lies more in its productive capacity. "Rapid production" has been the keynote in designing the lathe, and with this end in view there have been fitted such labour-saving devices as power rotation to the turret; quick power traverse to the turret up or down the bed; large pilot wheels; single pulley headstocks with one lever for start, stop and reverse, there being no countershaft and changing of belts on step pulleys; dial feeds for quickly obtaining the feed required, &c.; gear boxes forming oil baths which obviate the operator locating small oil holes with an oil can; rapidly revolving members are amply guarded; the whole scheme being to enable the operator to concentrate on operation, and the attainment of large output in the minimum time.

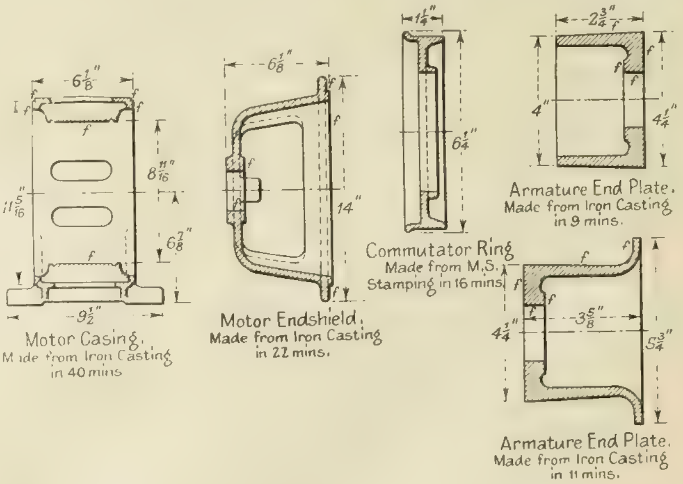

6⅛"
11 5/16"
8 11/16"
6⅞"
9½"
Motor Casing.
Made from Iron Casting in 40 mins
6⅛"
14"
Motor Endshield.
Made from Iron Casting in 22 mins.
1¼"
6¼"
Commutator Ring
Made from M.S. Stamping in 16 mins
2¾"
4"
4¼"
Armature End Plate.
Made from Iron Casting in 9 mins.
3⅝"
4¼"
5¾"
Armature End Plate.
Made from Iron Casting in 11 mins.
f

Fig. 11.—Electrical Details Machined on Herbert Auto Lathes with Production Times.

Spindles for motor-car lighting dynamos are being successfully manufactured from the bar on full automatic machines. Fig. 8 (8) shows a "Herbert" No. 2 Automatic Stud and Bolt Machine, tooled up for producing spindles 9½ in. long, made, from 13/16 in. bright bar. The first face of the turret carries a patent inverted roller steady box tool, together with a special tool-holder, carrying three cutters and fitted at the front with a ball-bearing steady bush. With this combination three diameters are turned simultaneously, and the shaft ended. In the second turret hole another ball-bearing steady bush holder is brought on to the work, while the end nearest the chuck is formed, and all shoulders recessed for grinding by means of a gang of form tools carried in a wide tool-holder on the back of the cross slide. The production time is remarkably good, a spindle being completed every 70 seconds.

We believe sufficient has been written to emphasise the necessity for production engineers in these days to consider carefully the adoption of modern machine-tools where such are not already in operation, as the prevailing high labour costs make it imperative that labour-saving machinery of the highest class be installed.

The Design of Grinding Machines.

By H. H. ASBRIDGE.

ENGINEERS generally, and in particular those who are in constant contact with current machine tool practice, now accept it as an established fact that grinding constitutes the most accurate and efficient method of finishing practically all metallic surfaces, whether the ultimate shape be round or flat. To those who took a long view of the future, as well as of the present developments of machining methods, the possibilities of precision grinding machines were by no means obscure, and the confidence of these engineers has been amply justified in almost every case by the results obtained.

Along with the rapid improvement of the grinding machine, the wheel makers have necessarily kept pace, and specialist companies have developed the artificial abrasive up to a very high pitch. The bonding, grading and sizing of the finished wheels is now carried out so uniformly that it is possible to duplicate within very close limits any wheel which has once been supplied. What this has involved in the way of expense and patient research only the wheel manufacturers themselves can say. It is enough to add, however, that their efforts, combined with those of the machine builders, have culminated in placing the grinding machine in an unassailable position as the most efficient medium for the "final sizing" operation in all classes of work.

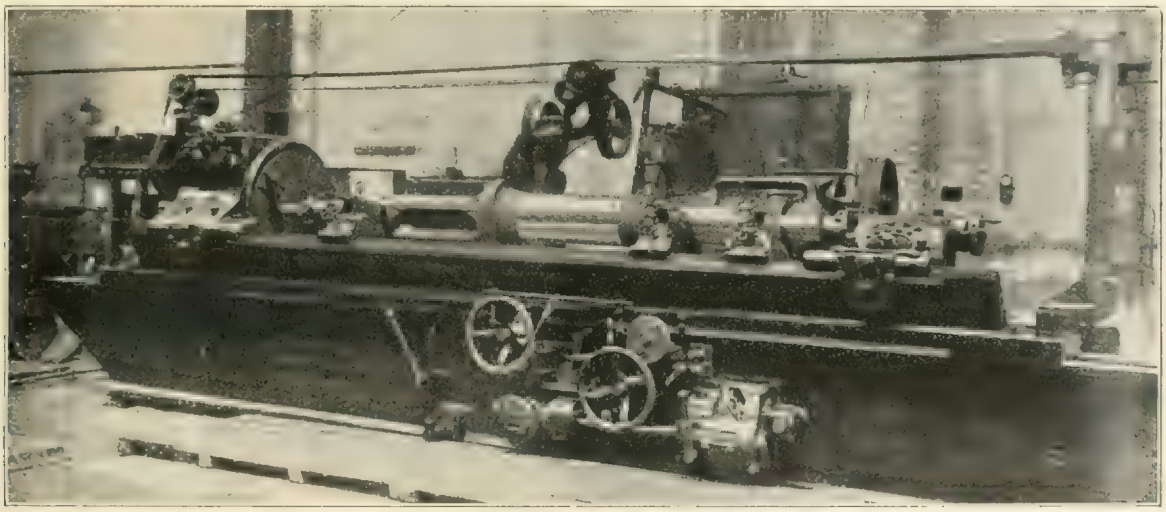


Fig. 1.—30 in. Plain Grinding Machine with Self-contained Motor Drive for Large Turbine Shafts.

Importance of Final Sizing.

It will be noted that stress is laid on the term "final sizing." With the exception of a few outstanding cases, the grinding machine does not come into direct competition with the lathe or planing machine or milling machine as a stock remover. It is in the removal of the last 0·020 to 0·030 in. down to the correct size, and in the working up of the finished surface, that the grinding method establishes its superiority. Examples of cases in which the grinding machine is quicker than the lathe are in the grinding of plain parallel shafts up to 2 in. or $2\frac{1}{2}$ in. in diameter, where the grinding machine will grind direct from the black bar, removing either $\frac{1}{16}$ in. or $\frac{1}{8}$ in. in diameter; the grinding of motor-car crankshafts direct from the stampings, where the stampings have been designed for the purpose. Also in rolling mill practice, chilled rolls are now being ground direct from the casting in much less time than previously occupied by the roll turning lathe. Another instance is in the grinding of the castings of armatures for drum-type controllers, where the grinding machine has overcome the difficult and time consuming lathe operation.

There are also many cases where the surface grinding machine, either with the vertical spindle or the horizontal spindle carrying a cup wheel, will grind direct from the casting or drop stamping in much less time than the milling or planing machine. Surface grinding machines are now in use carrying grinding wheels 30 in. to 50 in. diameter, which will surface up the feet of stator cases and similar work in much less time than the milling or planing operation which it supplants; and the use of this type of grinding machine is extending in all branches of the engineering trade.

Co-operation and Grinding Machine Development.

Progress in any industry is only made by constant striving after improvements in methods of manipulation and co-operation between the parties concerned. The development of the modern grinding machine is a typical instance of co-operation between grinding machine makers and other branches of engineering work, and the evolution of some of the more commonly known types of grinding machines is directly traceable to this source.

At the present period of high wages and high manufacturing costs it is essential that the skill of our workmen be supplemented by modern methods of machining and the elimination of hand work. Wonderful results have been obtained in the past solely by the skill of our workmen, but the cost of such methods in times like the present precludes any possibility of progress being made on the old lines and it is to the modern grinding machine more than any other machine tool that manufacturers must look for the elimination of expensive hand work for the finishing of any type of surface.

The various types of grinding machines which are regularly being put forward for everyday manufacturing purposes are as follows :—

Plain Cylindrical Grinding Machines.

The plain cylindrical grinding machine is made in a range of sizes with varying capacities for handling shafts and spindles of the smallest dimensions up to rolls of 30 tons weight and 40 in. diameter. Machines of this type (*see* Fig. 1) can be made to handle work of any length, and will grind either parallel or taper. Robustness of construction is essentially the first consideration with a manufacturing machine of this type, also high finish, accuracy and the ability to produce work to the finest limits when working under maximum output conditions.

Universal Grinding Machines.

The universal grinding machine is essentially a finishing machine. Its range of work covers shafts, spindles, gauges, cutters, reamers, bushes, saws, and includes external and internal, either parallel or taper, and face grinding.

Internal Grinding Machines.

Internal grinding machines are of two types. With the first the work is rotated and traversed past the grinding wheel either mounted on a face plate or gripped in a chuck. These machines are specially built for the rapid grinding of holes in bushes, cylinders, rings and similar classes of work, either parallel or taper. Essentially manufacturing machines, they combine the greatest accuracy with every convenience of rapid manipulation, consequently they are of great productive capacity, and will produce work of the highest class.

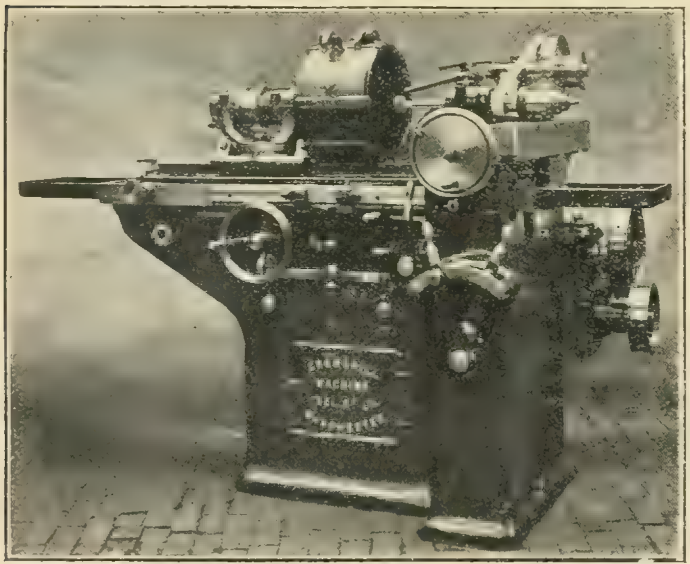


Fig. 2. –12-in. Internal Grinding Machine, Grinding Holes up to 18 in. deep.

Cylinder Grinding Machines.

The second type of machine has been designed for the internal grinding of cylinders, liners, &c., and holes in machine parts which, owing to their external shape, cannot be conveniently rotated. The design of the machine admits of the widest range of work to be dealt with. The table on which the work is carried is stationary, whilst grinding is proceeding, and is provided with cross adjustment, so that articles with a number of holes may be ground without disturbing the setting of the piece on the table. The grinding spindle is arranged with eccentric or planetary motion, and is designed so that the eccentricity can be varied whilst the machine is operating. Within the capacity of the machine, there is no limitation to the external shape of work which may be dealt with. Holes are being ground on this type of machine up to 32 in. bore by 7 ft. long.

Surface Grinding Machines.

Machines of this type can be classified under two main headings, the first of which is the vertical spindle type which makes use of the cup or segmental wheel, the second type being equipped with a horizontal spindle which may carry either a cup or segmental wheel, or alternatively a disc wheel. Reverting now to the first type—that is, the vertical spindle machines—these can be further subdivided under the following headings :

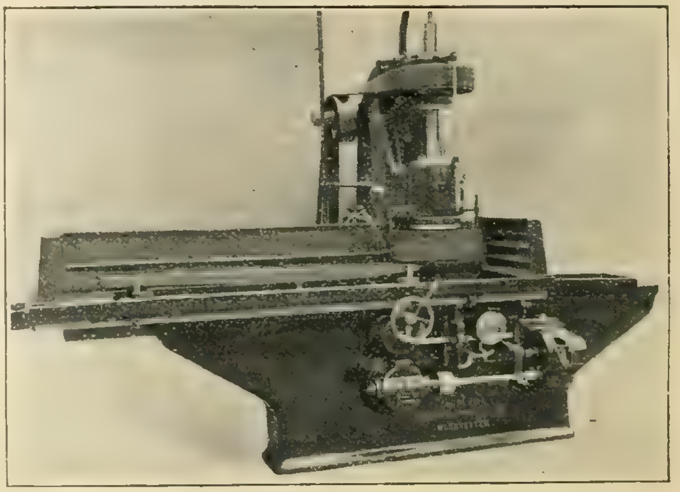


Fig. 3.—Vertical Surface Grinding Machine for Grinding Locomotive Motion Bars.

Vertical Surface Grinder.

In the vertical surface machine (*see* Fig. 3) the work is mounted on a reciprocating table and is operated on by practically the full diameter of the grinding wheel. These wheels are regularly made up to 18 in. in diameter and will grind work 16½ in. in width. In comparing this method of machining flat surfaces with other methods, this type of grinding machine possesses great advantages on certain classes of work, particularly when used in conjunction with the magnetic chuck. Used in this way, the machine will give a much greater production than either milling, planing or other methods of grinding.

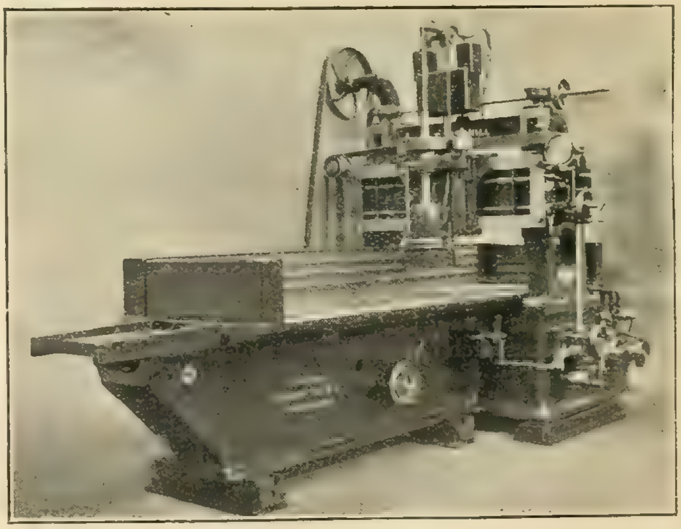


Fig. 4.—Plano-type Surface Grinding Machine. Capacity 120 in. × 27 in. × 24 in. high.

Plano-Type Vertical Surface Grinder.

As its name implies, the plano-type vertical surface grinder operates on the planing machine principle. The work is mounted as above, but is operated on by only a comparatively small sector of the wheel, this usually amounting to about 1½ in. in width, the method of operation being automatically to traverse the wheel head on the cross rail a definite amount at each reversal of the work table. In this way large areas can be covered quickly and economically, the action of the wheel on the work is in effect a shearing one, thus a minimum of heat is generated and accuracy of ground surface ensured. This type of machine is eminently adapted to locomotive work for the grinding of motion bars, slide valves, steam chest covers, &c., and as it is generally equipped with a horizontal grinding spindle using a disc wheel for work having upstanding ledges, which cannot be ground using the cup wheel on vertical spindle, it covers a very large range of work, particularly the surfacing of worn parts, eliminating more than possible with any other machine the necessity for hand work. A view of one of these machines is given in Fig. 4.

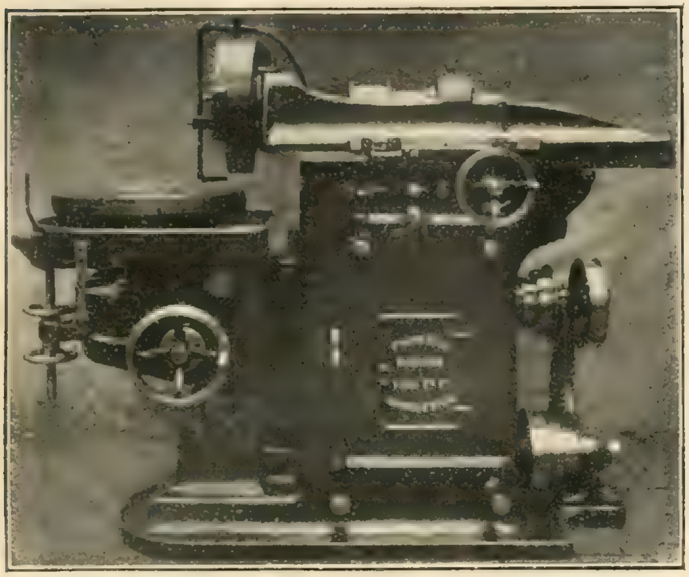


Fig. 5.—24-in. Piston Ring Grinding Machine.

Vertical Spindle Ring Grinder.

In the vertical spindle ring grinder (*see* Fig. 5) the work is mounted on a rotary table usually in a magnetic chuck, the method of operation being to feed the full diameter of the cup wheel down to the work. This type of machine possesses a very large productive capacity particularly in the larger sizes, and on the group grinding of stampings or castings is much quicker than corresponding milling or other machining operation. At the same time, as costs are reduced, the accuracy of the work ground is easily maintained and ensures better interchangeability.

Horizontal Spindle Surface Grinder.

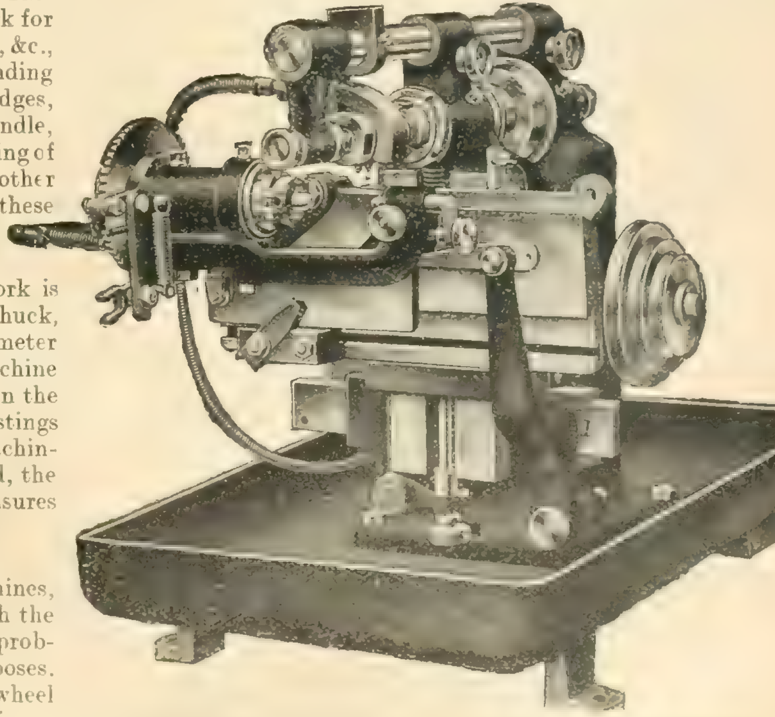
Adverting now to the second type of surface grinding machines, in which the horizontal spindle is used for grinding with the periphery of the wheel. This method of surface grinding is probably the oldest and is used principally for finishing purposes. Its output is limited owing to the line contact which the wheel makes with the work, and if forced beyond the cutting efficiency of the wheel much heat is generated and the consequent distortion of the work defeats the object in view. A recent development of the horizontal spindle type of surface grinder carries a cup wheel, either of the ring or segmental type. Machines fitted with grinding wheels up to 50 in. in diameter are being put forward and are providing some truly remarkable figures with regard to their capacity for quick and accurate production. Economies are effected in the setting up time and the operating time, &c. The finish obtained on the work is extremely good, and the elimination of the cost of expensive cutters and their upkeep is another important advantage. Altogether the possibilities of this machine are enormous, and it is rapidly coming to the front as offering the most efficient means of surfacing up any flat surface within the range of the machine. As in the case of the petrol engine manufacturers, where crankshafts are specially designed with plenty of web clearance to facilitate grinding the pins and journals, so other machine manufacturers are, wherever possible, designing their components without projecting ledges and lugs to enable the work to be dealt with on the face grinding machine.

Magnetic Chucks.

As in the case of the grinding wheels, the development of magnetic chucks has also played considerable part in enhancing the value of the grinding machine. The magnetic chuck method of holding work offers great advantages as compared with the clamping method. Its action is instantaneous, and it holds the work without the distortion or marking, which often results from the use of jaws or clamps. Further, it provides a means of gripping a number of small parts by simply throwing over a switch, these parts being released by a similar action. Another great advantage lies in the fact that the top surface of the work is left absolutely free. It is probably true that if it were not for the extensive use made of the magnetic chucking method, a large number of operations now carried out on surface grinding machines would be quite impracticable.

Small Gear-Cutting Machines.

We are glad to learn that the question of designing and making small machine tools for the accurate and rapid production of parts such as are employed in sewing machines, clocks, &c., is now receiving the attention of British manufacturers. Among those who have been most successful in this direction are Messrs. S. Ratcliffe, Ltd., of Manchester, for whom Messrs. H. V. Carrington are the sole selling representatives. This firm have recently produced an entirely new series of machines suitable for this class of work, an example of which we illustrate herewith. The machine in question is designed for cutting small gears and can be operated either by power or by hand. Two cams are supplied with the machine, one giving an effective length of feed of ½ in. for cutting bevels, crown wheels and pinions, while the other has an effective feeding length of 2 in. for machining spur and similar wheels. Some idea of the output of these machines may be obtained from the following figures which have been selected from actual practice: Brass spur wheels, 56 teeth, 1½ pitch diameter, 1/16 in. thick, 1⅜ in. hole, production 360 per hour. Ratchet wheels for clocks, &c., 14 teeth, 1⅜ in. diameter by ⅛ in. thick, production 140 per hour.



Automatic Machine for Cutting Small Spur and Bevel Gears.

Gear-Cutting Machines.

By V. GARTSIDE.

GEAR-cutting machinery, as used in the electrical engineering industry, in most cases chiefly consists of machinery for the production of reduction gears of some description. These are required owing to the high speeds at which the generators, or motors, run, and the gears dealt with range from the smallest, such as used for meter work, to some of the largest.

The smaller makers of electric motors generally do not employ gear-cutting machines themselves, but rely on the gear-cutting firms who specialise in this work for the supply of spur, helical and worm reduction gears, but, where firms have sufficient of this class of work to warrant the installation of special plant, a description of some typical machines will be of interest.

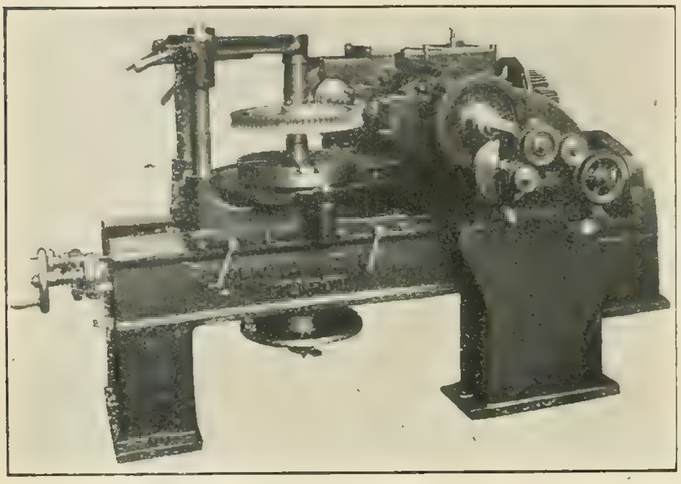


Fig. 1.—Worm Wheel Generating Machine.

Manufacture of Worm Reduction Gears.

For the manufacture of worm reduction gears, three types of machines are used—one for cutting the worm wheels, one for milling the threads of the worms, and a third for grinding the worms after they have been hardened to take out all inaccuracies owing to distortion due to hardening.

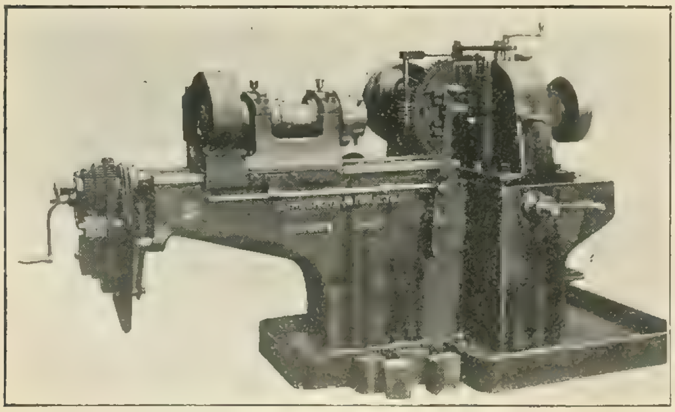


Fig. 2.—Worm Milling Machine.

Fig. 1 shows the worm wheel generating machine. This machine cuts the wheels by means of a hob, or fly cutter. When a large reduction is necessary and single-thread worms gear with the wheel, it is generally sufficiently accurate if the wheels are cut by what is known as the sinking-in process where the hob is fed into the wheel at right angles to the radial line, the hob and table being geared together at the same ratio as the worm and wheel being made.

In cases where the worm has a large lead angle with multiple starts, the above process is not always suitable owing to interferences which would take place if the hob was sunk into the periphery of the wheel. Consequently, the hob is made with a taper similar to a taper tap, and is fed tangentially to the wheel, the axis of the hob being set at the correct centre distance before the feed is set in motion. As the hob feeds along the horizontal slide, it gradually generates the teeth in the wheel as it passes along. In this case, a special motion is brought into play by means of differential gears, which give an added-on motion to the table to compensate for the travel of the hob, in addition to the motions of the hob and wheel, to give the right ratio between the two. In the particular machine illustrated, there are two sets of change wheels—one which gives the correct ratio between the wheel and the hob to suit the number of starts in the worm and teeth in the wheel, while the other set governs the pitch. The feed motion is effected by a silent ratchet gear which gives an infinite number of changes up to a maximum.

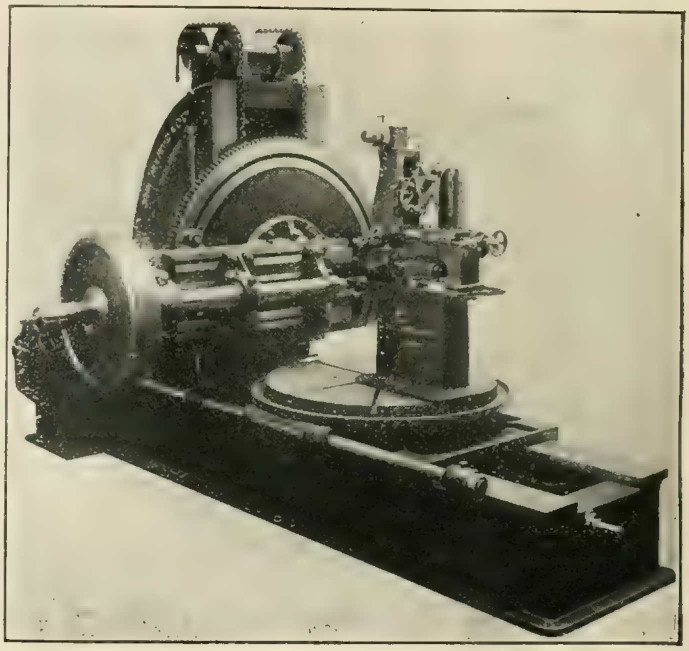


Fig. 3.—Hobbing Machine for Spur, Spiral and Worm Wheels.

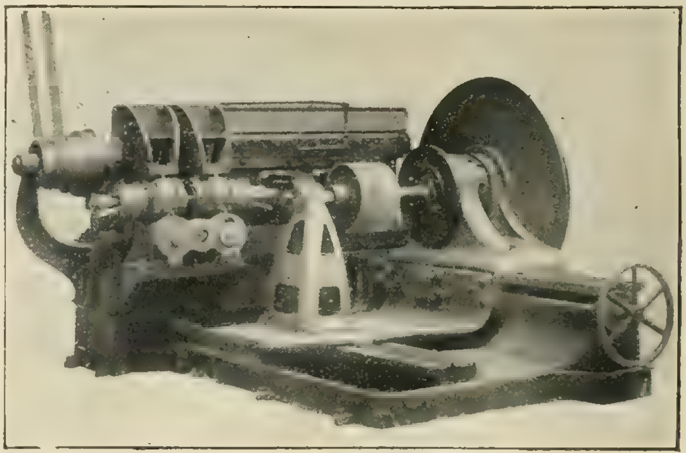


Fig. 4.—"Sykes" Gear Cutting Machine.

Another process is to use a fly cutter. The operation in this instance is similar to the sliding taper hob process. The fly cutter is a single tooth cutter which is mostly easily described as a single tooth of a hob. This process is used where only a few wheels have to be cut, and where the outlay on a hob is not warranted.

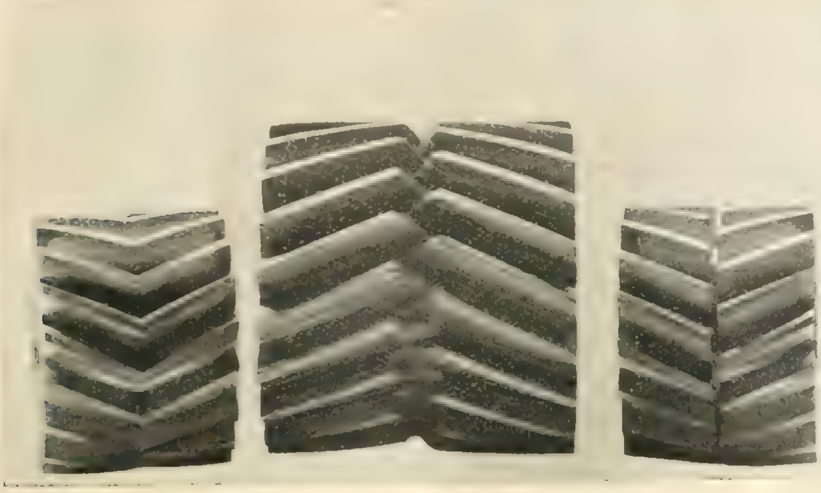


Fig. 7.—Gears Cut on the "Sykes" Machine.

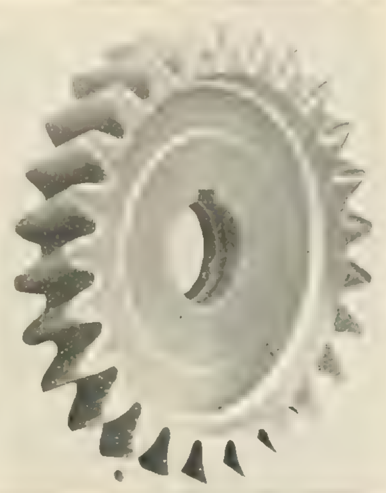


Fig. 5.—Cutter Used on the "Sykes" Machine for Helical Gears.

Thread Milling Machines.

For cutting worms, a thread milling machine is generally used, where a firm has sufficient to keep it occupied, and is invariably employed by gear specialists. A machine of this type is shown in Fig. 2. The machine operates in a similar way to a screw-cutting lathe, with the exception that, in place of a turning tool, a milling cutter is employed. The work is geared to a guide-screw by suitable change wheels, and revolves and is fed past the cutter by suitable feed motion. The whole depth of thread is generally milled out at one cut when this is within the capacity of the machine. This is a simple process where single start worms are concerned, but, for multiple starts and long lead worms, difficulties are encountered with regard to the shape of the cutters, and gear experts are generally consulted on these points. The details in connection with these difficulties are too involved to be dealt with in this article.

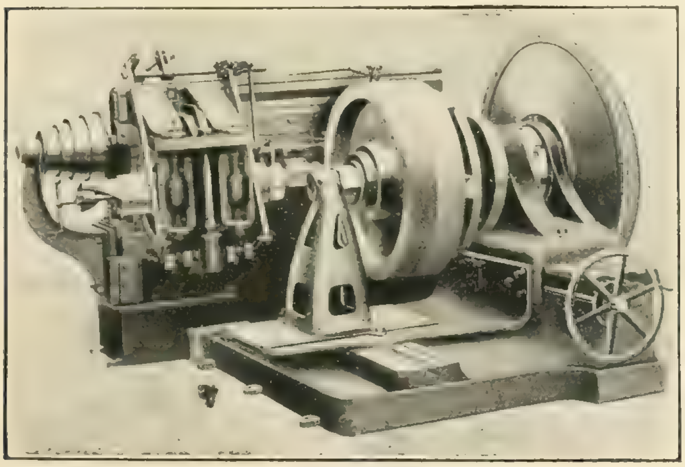


Fig. 6.—Another View of Same Machine.

When great accuracy is required, hardened worms are used. It is then necessary to finish the threads of the worms by grinding them after hardening to take out all inaccuracies, owing to distortion in hardening. The work is geared up, and revolves and traverses past the wheel as in a lathe and in the thread miller, but in this case an emery wheel takes the place of the tool or cutter. The machine has an automatic dividing arrangement for multiple-thread worms, and is generally supplied with a special arrangement for generating and truing up the emery wheel. The machine is also suitable for sharpening hobs automatically.

In addition to worm-reduction gears, the above plant is of interest to makers of turbo-generators, as it is used for the production of the gears which are generally used for the governor drives.

Disc Cutter Machines.

With regard to ordinary spur reduction gears, the ordinary gear-cutting machines using the disc cutter are often used. There are also machines which use a cutter in the form of a gear which slots out the teeth. This type of machine is made by the Fellows Gear Shaper Company in America. Another type often employed is the Sunderland machine made by Parkinson's at Shipley which uses a rack-shaped cutter and also shapes and generates the teeth.

Fig. 3 shows machines for hobbing the spur gears. These machines are arranged specially for general use, as they are arranged to hob spur or spiral gears. They will also cut spur or spiral gears with a disc cutter where the making of a hob is not warranted. In addition, they will cut worm wheels with a fly cutter or a taper hob, using the tangential feed,

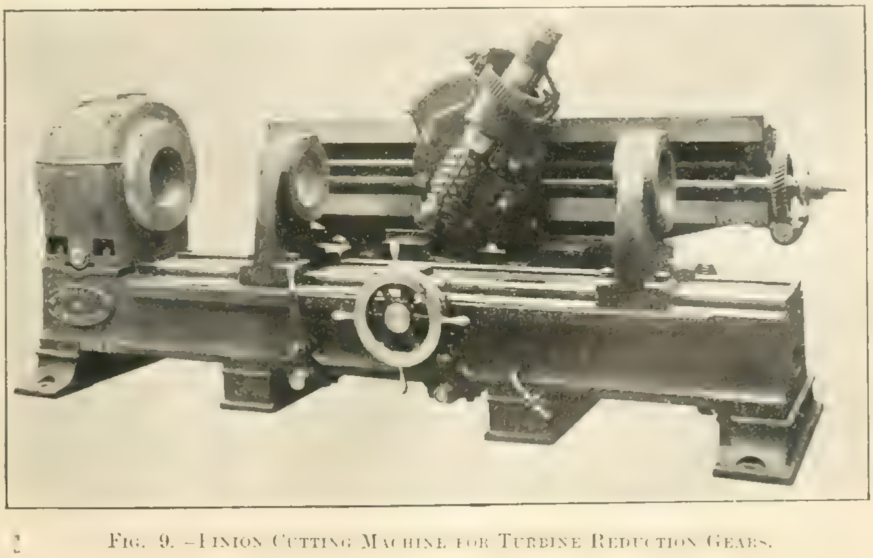


Fig. 9.—Pinion Cutting Machine for Turbine Reduction Gears.

and they will also cut worm wheels with parallel hobs by the sinking-in process. In fact, the machine will do all that the special machine shown in Fig. 1 will do, and in addition will cut spur and spiral gears with hobs or disc cutters.

Cutting Double Helical Gears.

Within recent years, double helical gearing has been made great use of for reduction gears, and great strides have been made in the production of these gears by different processes. About the year 1904, Wust, of Zurich, patented the application of the hobbing system for the generation of double helical gears. This process subsequently became very popular especially in England, and at a later date in the United States of America. It was quickly recognised, however, by well-informed students of gears that the hobbing system of generating double helical gears possessed certain fundamental disadvantages. The greatest of these was the fact that the teeth could not be produced continuously, that is to say, they had to have a gap at the centre—the right and left hand portions of the teeth could not be joined. This gap, besides weakening the teeth, also had the effect of taking away a certain proportion of the bearing surface, making it necessary to compensate for this by increasing the width of the face.

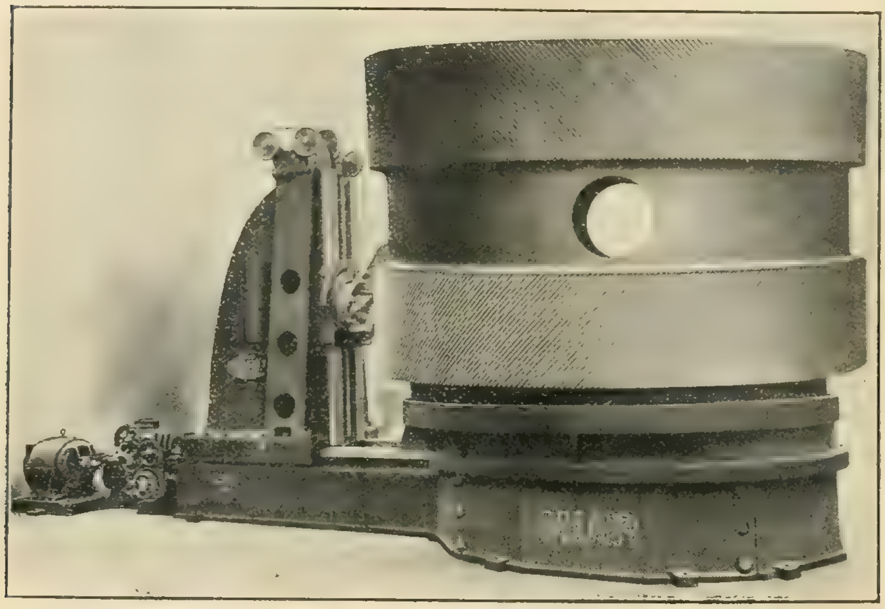


Fig. 8.—Turbine Gear Cutting Machine.

Mr. Sykes, of the Power Plant Company, West Drayton, who specialise in double helical reduction gears, brought out a machine for cutting these gears as shown in Fig. 4. It will be seen from this illustration that two cutters are employed, each of which is in the form of a single helical pinion (*see* Fig. 5). These cutters possess the advantage that they can be accurately generated by a grinding process. This generating grinding process is a fundamentally simple operation, and its accuracy can be relied upon. A further advantage is the fact that the cutters are of circular formation, and to employ them as generating tools the only motion necessary is a rotary one, which it is acknowledged is the easiest mechanical motion to obtain. The outstanding feature of the Sykes' double helical machine is the fact that it cuts continuous double helical teeth having sharp apices where the right- and left-hand portions join. The next feature of the machine is the rapidity of operation. This advantage is due to two tools being employed, one of which cuts on each stroke. There is, therefore, no lost motion (that is no return stroke). Further, the generating motion is a constant rotary one—there is no intermittent mechanism. From the commencement of cutting a gear the cutting motion is constant until completion of the work.

Cutting Large Wheels.

Fig. 6 shows the Sykes' machine for cutting wheels up to 53 in. diameter, and the present designs cover a whole range of machines, the largest of which cuts wheels up to 15 ft. diameter with a 30-in. face. The manufacture of the cutters forms a speciality. Mr. Sykes has designed and developed special machines for the manufacture of these cutters. By the use of these machines, the cutters can be produced very economically and with mathematical precision.

The double helical machines will produce in addition to continuous teeth any other known type of double helical spur wheel teeth. For instance, staggered teeth, Wust type, or staggered teeth with narrow gap, as shown in Fig. 7, can be produced quite easily when preferred.

Messrs. Muir & Company, Ltd., of Manchester, also make a range of special machines for double helical reduction gear. These machines however, were originally designed for the production of reducing gear for turbine-driven steamships to obtain the reduction of speed from the turbine to the propellor shafts, but there is no reason why they should not be used for other applications of reduction gear of large dimensions.

The machine illustrated in Fig. 8 is the machine principally used for turbine reduction gearing. This machine will cut wheels from 12 ft. diameter down to pinions 5 in. diameter. The patented features of the machine are, first, the interchangeable tables. When cutting a large wheel the machine carries a large table, as shown in the photograph ; when cutting a medium size wheel this table is removed and a smaller one substituted. When cutting pinions this table is again removed and the pinion is mounted direct in the spindle carried in the bed of the machine, which is driven from underneath. This construction enables the upright always to be close up against the work without any excessive

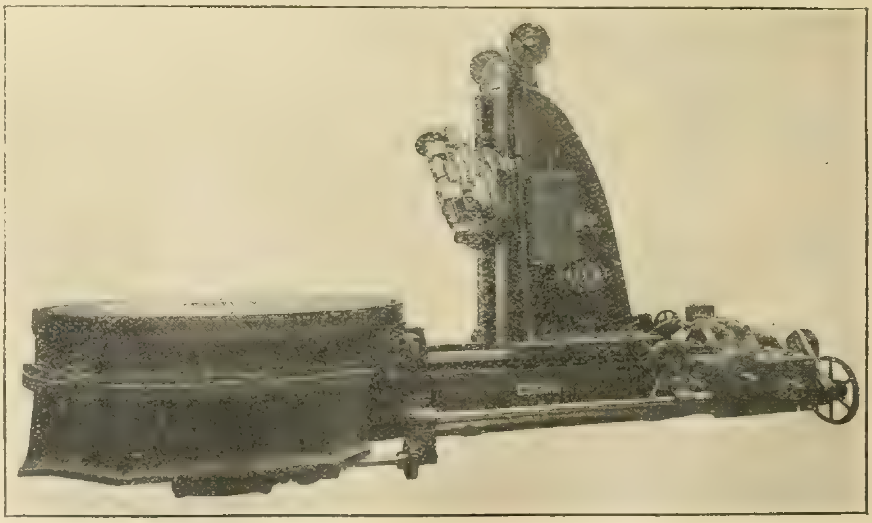


Fig. 10.— Another Turbine Gear Cutting Machine.

overhang of the hob slide. Another patented feature of this machine is that it will produce gears with any number of teeth up to 1 000 including prime numbers—without any special change wheels. Great accuracy is required in the spiral lead of this type of gearing, consequently the machine is arranged to produce absolutely the same angle on mating wheels.

In shops where there is enough large gear cutting to be done to keep the No. 2 size occupied, it is customary to install the No. 1 size machine, illustrated in Fig. 9. This machine will cut pinions from 2 in. diameter up to 2 ft. 6 in. diameter, and a width of face 5 ft. This machine can cope with all pinions for the entire output of three No. 2 machines when the latter are fully occupied upon wheels. The hob illustrated in this photograph is Muir's patent "all ground" hob. The feature of this hob is that, after hardening, the hob is ground all over to remove whatever distortion may have been set up in hardening.

The machine illustrated in Fig. 10 is the No. 3 size machine for dealing with gears from 2 ft. 6 in. diameter up to 15 ft. diameter. The features of the No. 2 machine already mentioned are embodied in this machine, everything merely being made much larger and much heavier.

The Application of Modern Semi-Automatics to Electrical Manufacture.

By HENRY ASHTON.

The term "semi-automatic lathe" is probably capable of misinterpretation, but it is a description which came into use to distinguish an automatic machine which has to be fed with work after each cycle of operations from one which, over a given period, is self-feeding. The chucking automatic owes its inception to the requirements of the textile machinery manufacturers and its rapid development is due to the growth of the automobile industry.

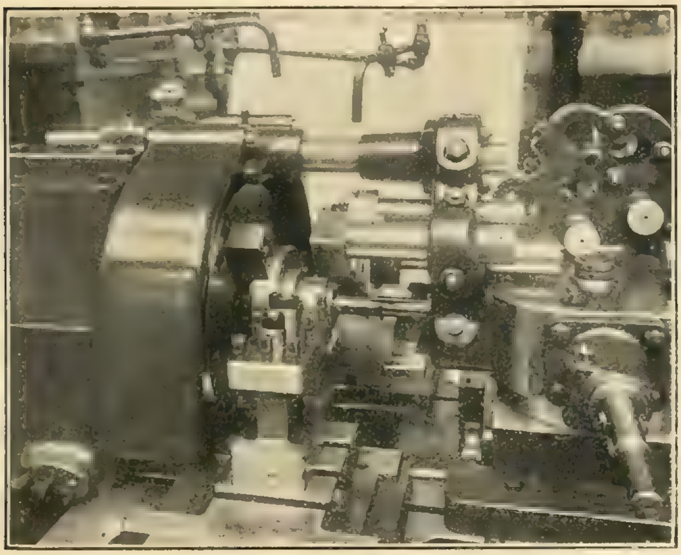


Fig. 1.—Overhead Pilot Arrangement on Herbert No. 5 Chucking Automatic.

A Limited Field.

The field for the semi-automatic is a limited one, but where repetition parts are required in quantities, its extended use is only a matter of time. A much-debated question is how many pieces it pays to set up an automatic machine for. Like most general questions, no general answer can be given, though it would perhaps be advisable to analyse the conditions governing two particular cases.

Take the case of an operator running three semi-automatics, each machine having a cycle time of 20 minutes. The setting up time for any of the jobs being machined may be taken at four hours' continuous work. Owing to the necessity of feeding the other two machines, the setting-up time would actually probably occupy five hours. Assuming that the operator were continually engaged on setting up and feeding, a machine once set up should run for at least 10 hours (30 pieces) or two machines would require setting up at the same time and production would be greatly reduced. The question of minimum number of pieces is therefore governed by the length of the operation, the setting-up time, and the number of machines to be run, and may be expressed in a formula :—

$$\text{Minimum number of pieces} = \frac{\text{setting-up time} + (25 \text{ per cent}) \times \text{number of machines} - 1}{\text{average length of operations}}.$$

Where large batches of machines are in use which are fed by operators whilst the setting up is done by special setters-up entirely employed on the work, the minimum number of pieces would be :—

$$\text{Minimum number of pieces} = \frac{\text{setting-up time} \times \text{number of machines}}{\text{average length of operations}}.$$

Good Equipment and Efficient Setting Up.

The successful running of semi-automatics is dependent absolutely on good tool equipment and efficient setting up. Unless foremen take a personal interest in the machines they are certain to be starved of equipment, for, in the average machine shop, there is always a crying demand for tool equipment from every section, but makeshift equipment is of no use whatever on a semi-automatic machine.

When once it has been decided to machine a certain part on the semi-automatic, suitable tool equipment should be got out. The points to be watched are :—

First Operation.—(1) Arrange to chuck the part in an absolutely firm grip, every other consideration to be subordinate to this. Economy in special jaws or fixtures will lead to trouble in the long run through parts slipping and in their being wrenched out of the chuck, resulting in broken tool equipment.

(2) See that, whatever happens, the hole in part is bored and reamed absolutely true, or all the operation will be a failure. Piloted boring bars with a single-point tooling operation previous to reaming are absolutely essential.

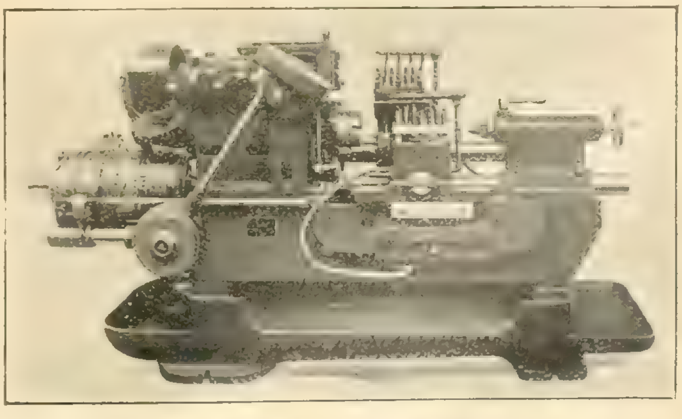


Fig. 2.—Standard Fay Automatic Lathe.
(Front view with chip guards removed. 14 in. swing. 11 in over cross slide. 6 in. feed.)

(3) Where there is no hole in the part to be machined, some means of piloting the turret would well repay any extra trouble entailed, and external piloting should be a standard equipment on all semi-automatics. (*See* Fig. 1.)

Second Operation.—Many failures with semi-automatics are due to mismanagement of second operations. It is practically impossible to chuck dead true continuously in a self-centring chuck, though if great care is taken, any error in concentricity may be kept within 0·002 in. Where greater accuracy than this is necessary, special spigots or spigot plates should be used. There is a semi-automatic machine, the "Fay" automatic, which finishes work from an arbor between centres and is worth your consideration as a second-operation machine. (*See* Fig. 2.)

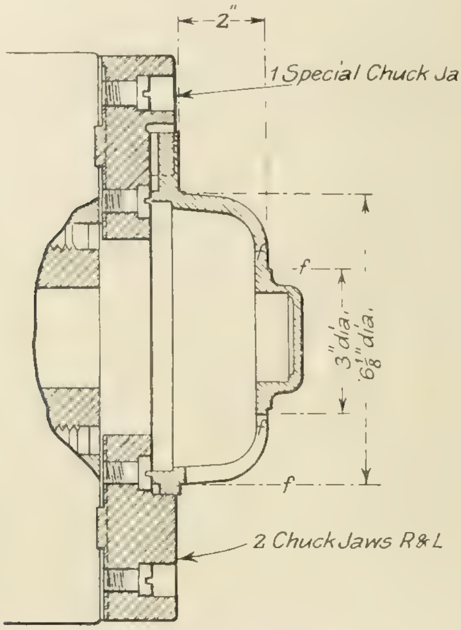


Fig. 3.—End Casing Gripped with one Special Jaw and Two Standard Jaws in Three-Jaw Chuck.

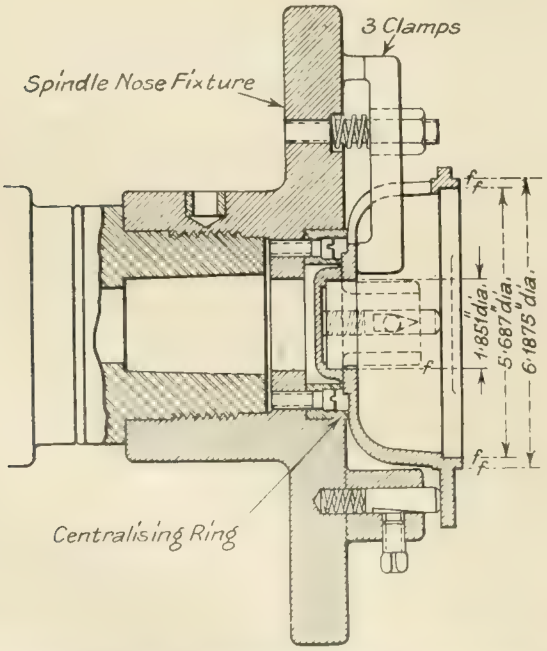
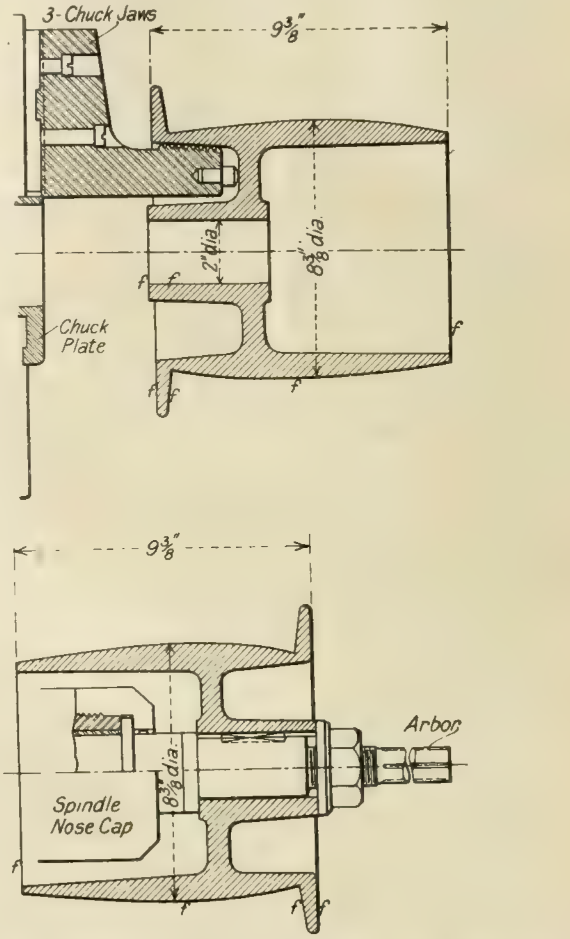


Fig. 4. Same End Plate Spigoted for Second Operation on Special Face Plate.

It will, no doubt, be appreciated that the tooling up of semi-automatics should be more complete than that for capstan or turret machines, as in the latter the tools may be humoured or nursed by the operator, whereas, in the former, they must plough through the work without fear of failure.

All broad forming of rough faces should be avoided. Special turret face slides for single pointing, though apparently cumbersome, prove much more satisfactory in the long run. Finish forming on faces previously roughed out with single-point tools is quite in order and saves a considerable amount of time.



Figs. 5 and 6.—Method of Chucking Large Pulley, First and Second Operations Respectively.

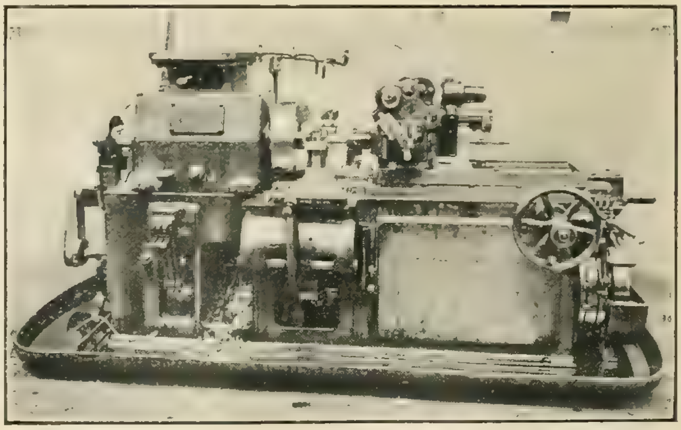


Fig. 7.—Herbert No. 5 Auto Lathe. 16 in. Chuck.

Details of Setting Up.

In setting up it is usually most convenient to machine the first piece as though the semi-automatic were a hand-operated machine with automatic feed, and not to attempt to set the various dogs governing the automatic motions until the piece is completely machined. Any slight mistake which might be made in the setting of the dogs cannot then cause any damage. The dogs on the average semi-automatic can be easily set in five minutes.

Where parts have been machined previously, it is usual to keep a part previously machined to assist in the rough setting of the tools for subsequent settings up. Where small batches of parts are put through, quick setting up by the operator should be aided and encouraged or the production will appear unaccountably low. A well-designed safety clutch is indispensable to a semi-automatic, particularly in the initial stages of introduction where the machines are imperfectly understood, and where the correct methods of tooling up have not been developed. Illustrations of methods of chucking are given in Figs. 3 to 6 and Figs. 14 and 15 and of machines in which these methods are employed in Figs. 7, 8 and 13.

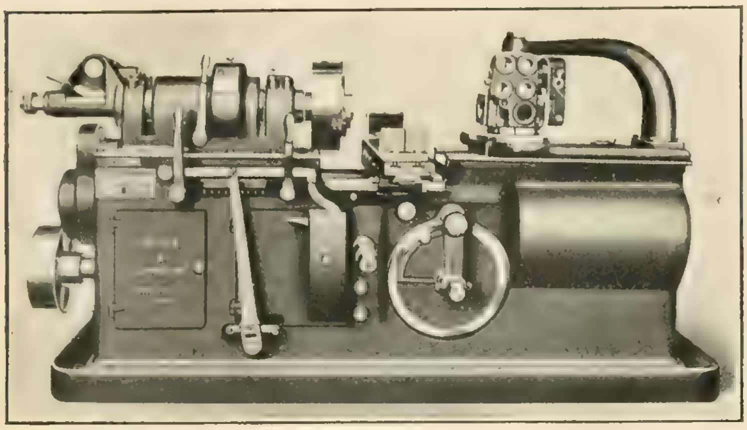


Fig. 8.—6 A Manufacturing Automatic Chucking and Turning Machine.

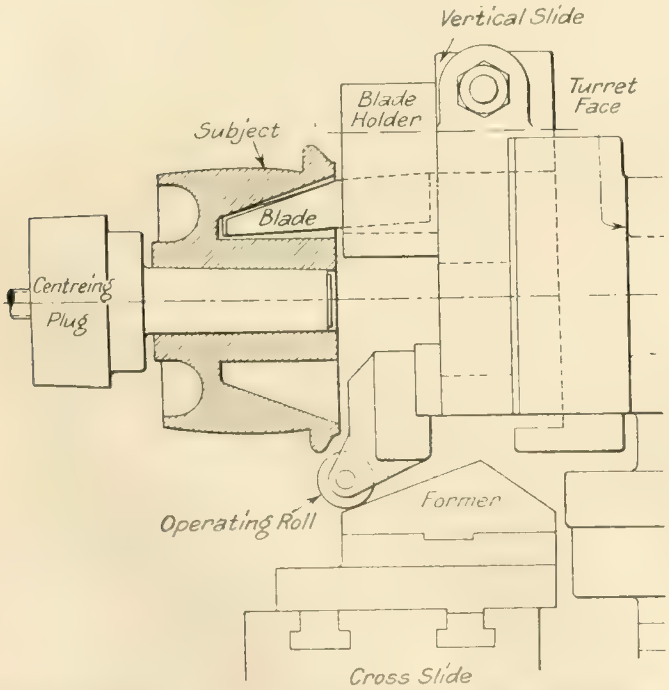


Fig. 9. -Special Taper Turning Slide Used for Machining Commutator Bushes or Rings.

Speaking from years of experience, the sooner a manager or foreman gets to grips with the machine, and its equipment, the more quickly are good results obtained. To be afraid of the machines as being something fearful and complicated, which they are not, and to think the maker's demonstrator can so leave the machines that all will work happily without attention, is very often only inviting trouble.

Semi-Automatic v. Other Types.

The answer to the question whether semi-automatic machines will pay as against centre lathe, capstan or combination lathes, depends on many factors, some of which it might be well to analyse. Interest, depreciation, floor space and overhead charges are generally ascertainable in a modern engineering works, and can be stated as a fixed sum per working hour for any machine installed or for a machine whose installation is being considered. The estimated or guaranteed production per hour from the different machines under consideration can then be considered as against the fixed charges mentioned above plus the direct labour cost per machine per hour.

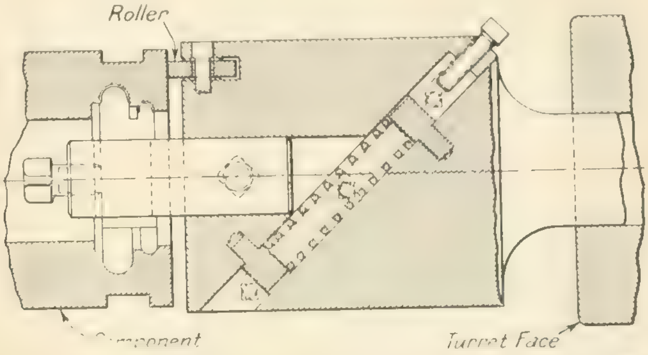


Fig. 10. Special Grooving Tool suitable for Machining on Grooves in End-Shield Bearings.

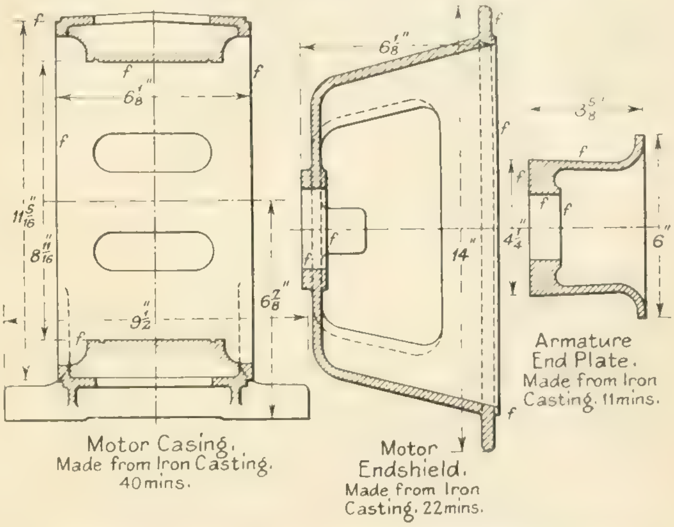


Fig. 11. —Typical Sample of Work suitable for Semi-Automatics.

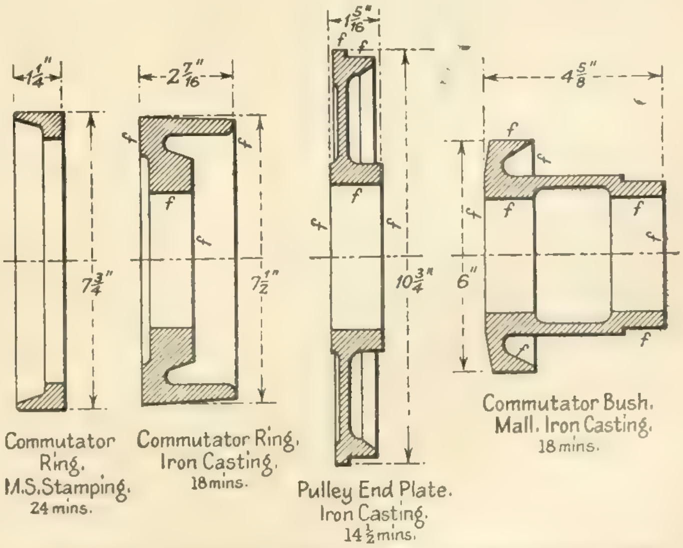


Fig. 12.—Typical Sample of Work suitable for Semi-Automatics.

The main advantage of the semi-automatic is due to the saving in direct labour cost, as one operator can run two to six machines, the labour cost per machine being correspondingly reduced. Where guaranteed outputs are taken as a basis, however, these should be over a reasonably long period, and not from stunt performances for one piece only. Chucking time and setting up time should also be considered, particularly where it is the intention to put through small batches of work.

Semi-automatics were extensively used in American electrical engineering shops 16 years ago, and at the present time, one large electrical concern has close on 500 machines of this type in their different works. The capacity of the modern chucking automatic covers a wide range, from the smallest parts produced from castings or forgings up to parts 36 in. in diameter, and 20 in. in length.

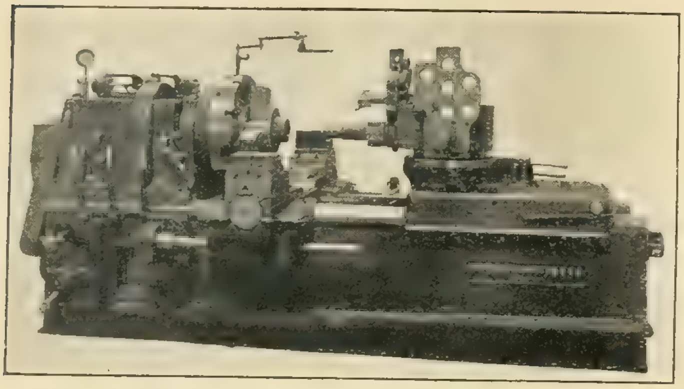


Fig. 13.—Front View of Potter and Johnston 8B-Manufacturing Automatic Chucking and Turning Machine—24 in. Chuck.

It is not possible within the scope of this article to give more than a few typical examples of work suitable for production on semi-automatic lathes, but these illustrations together with others showing special tools for grooving and taper turning, &c., will no doubt demonstrate the adaptability of this type of machine tool.

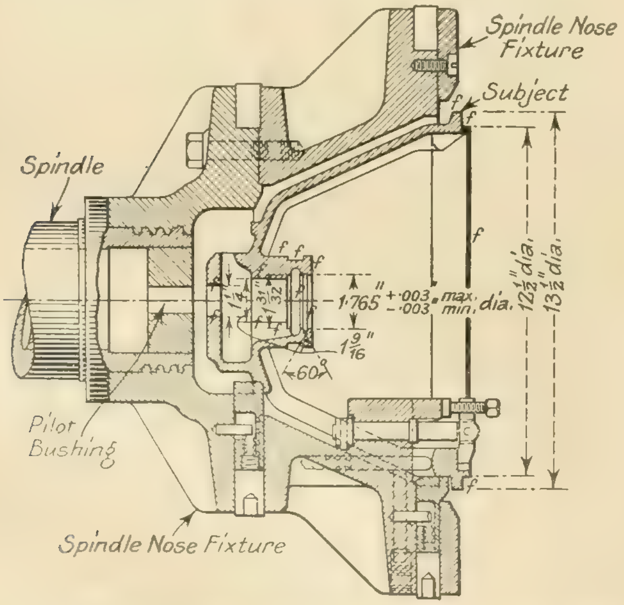


Fig. 14.—Showing Special Chuck for Commutator End Shield.

Many motor parts are very unwieldy from a chucking point of view, but when once this difficulty is got over the machining is fairly straightforward. All examples shown in the illustrations are of parts actually being machined on semi-automatics. Accessories suitable for use on semi-automatic employed for electrical work are illustrated in Figs. 9 and 10, while typical samples of work that can be performed on these machines are shown in Figs. 11 and 12.

Guarantees of Production.

Unlike most machine tools the semi-automatic when once set up is not entirely dependent on the human element. The speeds and feeds being constant for any particular setting, the production to be expected over a given period is a matter of simple arithmetic. This being so, it is possible for makers of semi-automatics to give very accurate guarantees of production provided the material being operated upon is fairly uniform in character. The extensive application of automatic and semi-automatic machinery in the United States has been due to the high cost of labour in that country. The present moment is favourable for a similar development in this country and manufacturers would be well advised in looking into the possibilities of semi-automatics.

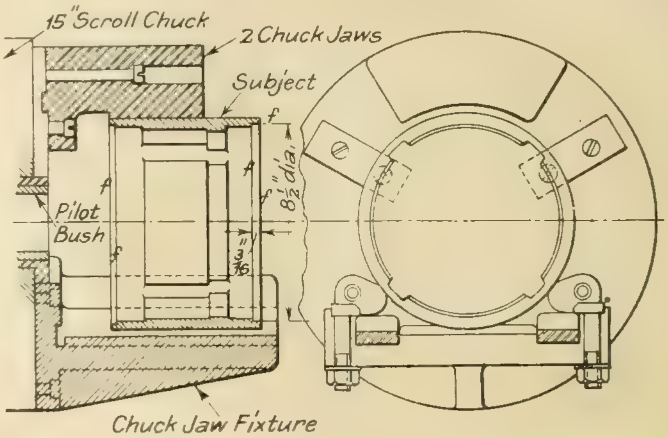


Fig. 15.—A Method for Chucking a Motor Casing.

The semi-automatic has almost as wide an application as the capstan or combination lathe, and it is a mistake to consider its economic use as being confined to the production of parts in huge quantities. Where huge quantities of the same standard article are required, specially designed machines should give equally good or better results as against the semi-automatics. Where changes in design are of frequent occurrence or where large or moderately large batches of work are put through the semi-automatic should prove a paying proposition.

Correspondence.

SYNTHETIC RESINS AND VARNISHES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The Electrical Research Association is actively interested in furthering the manufacture and use of electrical insulating materials made from synthetic resins and varnishes, and having the well-known heat resisting characteristics associated with some of these materials.

Leading manufacturers and users of the raw materials and finished products are already co-operating, and it is hoped that you will be so good as to insert this letter in your journal so that persons not already in touch with the work may have the opportunity of communicating with the undersigned.—I am, &c., E. B. Wedmore.

Director and Secretary, British Eelctrical and
Allied Industries Research Association.

London, May 10, 1921.

HIGH-TENSION SWITCHGEAR.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to Mr. Coates' criticism of my book on "High-tension Switchgear," the chief point mentioned is the adoption of V. D. E. standards. As mentioned on p. 2 of the Primer, the difficulty is to get other definite figures. If, for instance, the dimensions employed by any individual firm had been given, these would have no official backing, quite apart from the breach of confidence involved. The proper course would have been to collect and tabulate all available data, and to tabulate and analyse the figures; but this would take up many times the space available in the volume in question. Perhaps Mr. Coates could give me some official British figures published before October, 1920, giving clearances under oil, &c. I am not aware of any dimensions having been given by the I.E.E., B.E.S.A., B.O.T., or other recognised authority.

With regard to the detailed criticisms, some of the points seem to arise from hurried reading rather than from any defect in the text itself. For instance, the use of horn break switches on overhead lines is specifically mentioned, and it is only for indoor use that the type is described as obsolete. Other points occur owing to my endeavour to put both sides of controversial points before the reader, such as types of contact, &c.

I think that you will agree with me that the question of engineering nomenclature is a very difficult one, but surely some of the terms I have used are in more general use than the alternatives given by Mr. Coates.—I am, &c.,

HENRY E. POOLE.

London, N.W.

S.K.F. Bearings Applied to Electrical Machinery.

It is impossible in the course of a short article to explain thoroughly all the advantages that accrue from the use of ball bearings in electrical machinery, but we have endeavoured to summarise the outstanding features below, making special reference to the well-known S.K.F. bearing, manufactured by the SKEFKO BALL BEARING COMPANY.

In the first place, the substitution of S.K.F. ball or roller bearings for plain bearings effects great economies by reducing the friction losses to an absolute minimum. This enables a mechanical efficiency of upwards of 99 per cent. to be obtained, both under starting and running conditions. It also slightly increases the rating of the machine.

Since ball and roller bearings are not subject to appreciable wear during their lives the concentricity of the rotor and stator of an electrical machine is maintained. This enables the designer to employ a far smaller air gap than is possible with plain ring oiled bearings. The advantages of this in the case of alternating current machinery are considerable, since the increased power factor is obtained with induction motors, and better regulation is obtained with generators. Another point in this connection is that in the case of gear-driven machines the liability to noisy chattering gears is greatly reduced and only occurs when the gears themselves are worn.

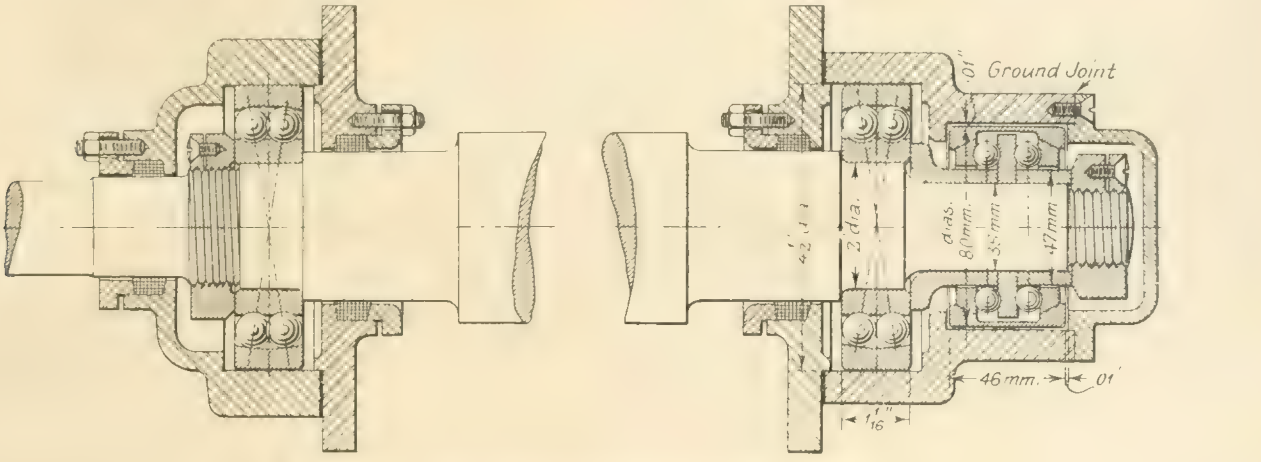


FIG. 1. S.K.F. BALL BEARINGS APPLIED TO ELECTRIC MOTORS.

ECONOMIES OF BALL BEARINGS.

The maintenance and lubrication bill for the machine is also greatly reduced (by as much as 65 to 90 per cent.), and the depreciation charges are cut considerably since the life of the machine is increased by 75 per cent., due, of course, to the absence of bearing trouble and the fact that the risk of the rotor coming in contact with the starter is eliminated. The cost of the actual machine, if designed for ball bearings, is in most cases slightly less than in the case of plain bearings, as the bearing brackets are greatly reduced in size and the bearings are fitted with the minimum of labour. This is also of importance where replacements have to be considered, as a ball bearing can be replaced (in the unlikely circumstance of this being required) in a very much shorter time than a plain bearing can be put again into commission.

BETTER RUNNING CONDITIONS.

Owing to the fact that the machine only requires lubrication every 3 to 6 months and requires practically no other bearing attention, the use of ball bearings has become almost imperative where machines are liable to be overlooked or neglected, and entirely so in the case of lighting sets, charging sets, &c., where skilled attention is not usually met with. Even in factories and in industrial applications this is of great importance, as it reduces the staff necessary for caring for the motors, and reduces the risk of the machines being out for repairs, which are caused usually by bearing troubles.

An end bracket fitted with S.K.F. bearings is protected by felt packing rings and does not leak; the consequence is that no trouble is experienced owing to leakage of oil on to the commutators and windings, and its usual deteriorating effects. This is a point of great importance for motors running in places where there is the liability of explosions or fires, as one of the main causes of sparking at the commutator is done away with.

TYPE OF BALL BEARINGS.

S.K.F. bearings of three kinds are used generally in electrical machinery, namely, the S.K.F. self-aligning ball bearing; the S.K.F. cylindrical roller bearing; and the S.K.F. self-aligning roller bearing. Ball bearings are recommended for the majority of machines where a steady load is encountered, and for practically all machines up to about 30 H.P., having proved themselves to be efficient—under these circumstances. A typical arrangement is shown in Fig. 1, which shows a motor mounted on S.K.F. ball bearings. In this case a double thrust bearing is shown for locating the shaft in an endwise direction, but experience has proved that this is only necessary in cases where the motor is subjected to heavy loads in an endwise direction, as when driving a fan; worm shaft, &c. The more usual method is to fix the outer race on one bearing in its housing, thus providing for the location of the shaft. Where heavy shock loads are met with, as in the case of motors driving gears, &c., our recommendation is that shown in Fig. 2, which illustrates the driving end of the shaft mounted on S.K.F. cylindrical roller bearings, and the other end on an extra wide type ball bearing. This roller bearing is capable of taking a heavier load than its corresponding ball bearing, and owing to the shape of its outer race, will take up whip and deflection of the shaft without any detrimental effects. The shaft is located in an endwise direction by the extra wide type ball bearing.

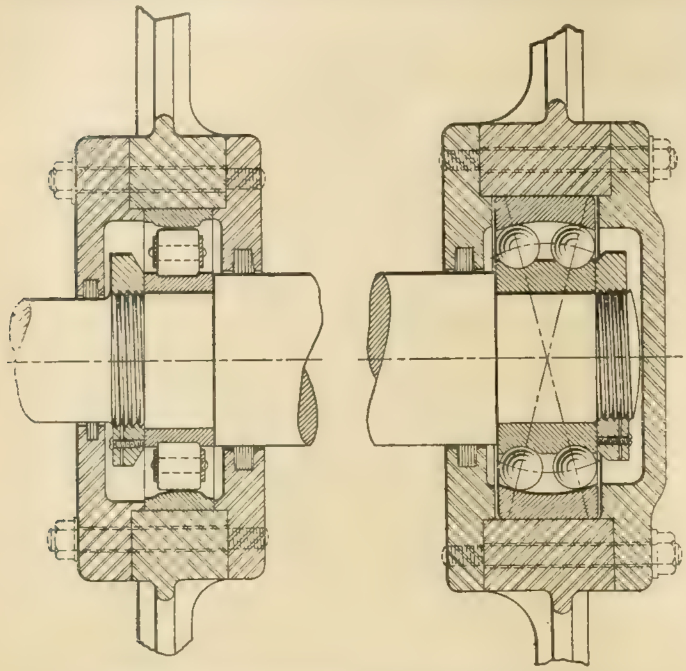


Fig. 2.—A Bearing Arrangement where Shocks are Severe.

Roller Bearings for Heavy Work.

The S.K.F. self-aligning roller bearing is only used in very heavy applications and where very exceptional loads are encountered. It is a development of the self-aligning ball bearing and possesses all its characteristics with the added advantage of being able to carry loads up to 75 to 100 per cent. greater than the corresponding ball bearing. In electrical machinery its use is confined to heavy generators, rolling mill motors, and, in some cases, traction motors.

It is often thought that ball bearings are only used for small units, but this is not the case; instances could be given where they have been applied to machines up to 1 500 kW., one case in particular being that of a water-wheel generator with a rotor weighing 44 000 lb., mounted on S.K.F. bearings. They have been standardised on motors up to, and above, 300 h.p. on the Continent and in Amercia.

The use of ball and roller bearings in electrical engineering is mainly confined to motors and generators, but they are also greatly in favour for machines such as electrical drills, hoists, conveyors, &c., and have been used for the wheels of transformer tanks, the spindles of induction regulators, and in numerous other applications.

In general, it may be said, that such bearings can be applied wherever rotating parts require a bearing, and when the bearing is selected with due regard to the conditions under which it will have to work, it will invariably be found to give satisfaction during the whole life of the machine, and, indeed, will often be found to be in perfect condition when the machine itself has to be scrapped. The principal reason of this reliability is stated to be the self-aligning feature, which is in exclusive feature of S.K.F. bearings. Deflections of shafts, &c., are taken up on these types of S.K.F. bearings without any detrimental effect. In fact, it is claimed that the S.K.F. self-aligning ball bearing or roller bearing will run as efficiently when considerably deflected from its central position as when under normal conditions. This is not only important where deflection of the shaft is concerned, but also eliminates any possibility of harm due to faulty fitting, &c., when assembling.

Quantity Production of Insulating Varnish.

The requirements of the electrical industry are so varied that it has been found necessary to employ a number of different insulating varnishes in order to obtain the best material for insulating coils and treating fibrous materials, and their large-scale production calls for considerable care in selecting raw material for continuous tests during manufacture and on the finished product. The varnishes used fall naturally into three main classes, baking oil varnishes, air-drying oil varnishes and air-drying spirit varnishes, each type having its appropriate applications in the industry.

Baking Oil Varnishes.

A varnish suitable for use on the coils of armatures or any rotating parts of electrical machinery must have great flexibility, even after it has been heated for a long period at the operating temperature of the machine (about 70° to 80°C.). The varnish must also have high dielectric strength and be capable of preventing moisture from penetrating into the coils and insulating material. As a result of years of experience in the use of all types of varnishes it has been found that the most suitable insulating varnish for the purpose outlined above are those composed of linseed oil used in combination with certain gums. Linseed oil used with the best proportions of these gums would produce a varnish that would require a considerable period to dry when baked at the usual temperatures, namely, 80° to 100°C. The time of drying can be readily accelerated by the introduction of one of the many dryers used in the paint and varnish industry. In hastening the drying of insulating varnishes, however, it is most essential that the materials employed as dryers should not affect either the dielectric strength of the varnish or the tendency of the varnish to become brittle after heating (technically termed ageing). On account of their influence on the dielectric strength, metallic dryers cannot be used, and in order not to spoil the good ageing properties of the baking oil varnishes, many other well-known types of dryers are also prohibited. This renders it extremely difficult to obtain a suitable dryer for an insulating varnish and, until recently, most of the varnishes on the market have either required an exceptionally long time for baking or have had bad electrical and bad ageing properties due to the employment of the usual dryers.

Quick Drying Baking Oil Varnish.

Messrs. Docker Bros., of Birmingham, after devoting several years of research work to the requirements of a first-class insulating varnish have recently put on the market a range of baking oil varnishes in which special attention has been given to the question of obtaining a baking oil varnish which will dry in a reasonable period and yet will have a high dielectric strength and exceptionally good ageing properties.

Air Drying Oil Varnishes.

For varnishing the coils and insulation of stationary parts of electrical machinery, the liability of the varnish to disintegrate with vibration after being heated is not as great as in the case of varnishes used on rotary parts. For this purpose it has been found possible to dispense with the necessity for baking, using an air-drying varnish, and to accelerate considerably the time of drying and yet produce a varnish that will be satisfactory under these service conditions. As in the baking oil varnishes, the whole secret of success lies in the proper combination of the most suitable oils and gums, together with the selection of a dryer which will accelerate the drying without interfering with the dielectric strength or ageing properties of the varnish.

Air Drying Spirit Varnishes.

These varnishes consist almost entirely of gums usually dissolved in methylated spirit. Although the dielectric strength is extremely good, it is not as high as the dielectric strength of the oil varnishes, and due to the brittle nature of all gums these varnishes are always liable to become brittle when heated continuously at 80°C. For solenoid coils, for mica building, and for many other purposes where the varnish is not subjected to any bending or excessive vibration, these varnishes have proved very satisfactory, and as they dry much more quickly than any of the oil varnishes their use is to be recommended wherever their characteristics will render their application suitable for the purpose intended.

Tests to Determine Suitability.

With a small sample of insulating varnish it is a difficult matter to devise any tests from the results of which it can be definitely stated that the varnish is suitable for use as an insulating varnish. After carrying out large numbers of tests Messrs. Docker Bros. have standardised on those mentioned below, to which all new mixtures are subjected before they are tried on a semi-commercial scale.

Dielectric Strength Test.—In the past the dielectric strength has sometimes been determined by dipping pieces of copper-foil in the varnish and afterwards obtaining the breakdown voltage of the varnish film. This method was first used by Messrs. Docker Bros., but it has now been found that far more consistent results are obtained by using paper having a thickness of 0·001 in. instead of copper-foil. These sheets of paper are given two dips in the varnish to be tested, being drained in the opposite direction between each dip so as to produce a uniform film across the whole surface.

If the varnish is a baking varnish it is baked between the dips for the required periods in an electrically heated oven, in which great care is taken to provide an adequate supply of hot air for the complete oxidation of the varnish film. When dry the dielectric strength is ascertained by means of a testing transformer, and this latter test is usually repeated after the sheets have been heated for a number of hours at a temperature of 80°C. It has been found that varnishes which show a high dielectric strength when tested immediately after their application, sometimes depreciate considerably after being subjected to the heat treatment mentioned above. As the varnish will always be subjected to heat when used in electrical apparatus, it is most essential that it should be judged after it has been subjected to some tests which will imitate as closely as possible the conditions likely to occur in service.

Ageing Test.—Pieces of the varnished paper prepared for Test 1, are left in an oven at 80°C. until they become so brittle that when bent flat upon themselves they crack and separate into two pieces. The number of hours required to accomplish this is called the ageing time of the varnish.

Tests on Coils.—If the varnish is intended for use on coils small solenoid coils are dipped into a sample of varnish, and the following facts ascertained:—

(*a*) Time to dry at various temperatures.

(*b*) The insulation resistance between parallel conductors under various conditions.

(*c*) The penetration and internal drying properties of the varnish.

(*d*) The tendency of the varnish to produce any discolouration when the coils are subjected to both heat and moisture.

Manufacture of Insulating Varnishes.

It was only after devoting many years to laborious research work on the lines indicated above that Messrs. Docker Bros. felt justified in putting down plant for the production of insulating varnishes in large quantities. When once the foundation of a new industry has been successfully laid on a scientific basis, the mass production of that commodity becomes not only a practicable, but also sound commercial venture.

In the manufacture of insulating varnishes it has been found that in addition to having the mixtures and processes accurately settled by scientific research, it is also necessary to keep a very careful check on all the raw materials used in the manufacture of these varnishes. Natural oils and gums vary considerably in quality, and unless the materials used are specially selected in accordance with the properties desired, no consistent results can be expected in the insulating varnish produced from them.

The actual manufacturing processes for the manufacture of insulating varnishes are comparatively simple in principle. The gums have to be heated in specially adapted pots and when they reach what is called their critical temperature the oil is added. This mixture is then boiled and the whole thinned down with turpentine or other suitable solvent. The addition of the gums to the oil and the suitable mixing of the same calls for considerable practical skill and knowledge on the part of the varnish maker, and in this connection extended experience in the manufacture of high-class finishing varnishes has enabled Messrs. Docker Bros. to produce on a large scale insulating varnishes having the required purity and consistency.

The fifth International Exhibition of Rubber, other Tropical Products and Allied Industries, of which the King is patron, will be held at the Royal Agricultural Hall, Islington, N., from June 3rd to June 17th. Already 40 British and Foreign countries and over 50 associations and firms have secured space. The exhibits include rubber-manufactured articles, reclaimed rubber, compounding ingredients, machinery and appliances, tropical raw materials, &c. Important international congresses will be held and while the principal subject for consideration will be the rubber industry, for the first time an International Congress will discuss matters relating to other tropical products, such as vegetable oils &c. The Organising Manager is Mr. H. Greville Montgomery, J.P.

Electric Power Supply in South Africa.

A preliminary report on the general question of electric power supply in South Africa has been prepared by Mr. C. H. Merz, of Messrs. Merz & McLellan. In a covering letter to the Prime Minister it is pointed out that the importance of developing the supply of electric power in the Union arises from the need of encouraging its existing manufacturers and attracting new industries as rapidly as possible. The report shows that in order to obtain electric power cheaply its production must be, as far as possible, concentrated in large plants, and the distribution network must be extended as widely as possible. The uncertainty of water powers and the abundance and cheapness of coal point to the latter as the main source of power production. In connection with this and the allied problem of by-product production and electrochemical work a definite scheme of investigation and research into the extent and nature of the coals and iron ore and other base mineral resources of the Union is desirable. Being a preliminary report, no detailed estimates are given, and no attempt is made to define the districts in which power networks should first be established. The latter will depend largely upon railway electrification and other factors.

Recommendations.

The Report recommends that steps be immediately taken to unify the electrical legislation of the Union and to set up a controlling authority with power to lay certain standards for all future work. The system of control should be sufficiently elastic to take advantage of different forms of enterprise and various sources of power, so as to permit the most rapid development to take place. Three reasons are given for the urgency of the question: (1) Power supply should be dealt with immediately the electrification of the railways has been decided upon, as considerable economies would result from the two schemes being undertaken simultaneously; (2) a definite policy and a technically sound system should be adopted before industrial development proceeds further, as vested interests and other obstacles will thus be avoided: (3) the existing generating stations at Cape Town, Durban and elsewhere are in urgent need of extensions, which can be most economically made in relation to a general scheme of power supply and railway electrification.

Industrial Future of the Union.

The Report points out that South Africa possesses most of the requirements needed for developing manufactures; it has wonderful natural resources, a splendid climate and both internal and external markets for its goods. Apart from precious minerals, the quantity and variety of raw materials in the country are remarkable, but the most important are coal and iron. The amount of iron ore is almost unlimited, and there are considerable supplies of high-class hæmatite ores. Deposits of coal exceed 56 000 million tons; the cost of production is low and the calorific value of the Natal coals high. In addition to coal and iron, there are considerable quantities of tin, copper, asbestos, corundum and lead. In 1918 there were 5 907 factories, compared with 3 973 in 1914, employing 133 783 hands and with an output valued at 62 millions sterling. The total value of engineering products from South African works has already reached nearly £10 000 000. The products include steel shoes and dies for mine batteries, locomotive wheels, cast steel pistons, sugar mill rollers, farm implements, &c. Although for some years to come the bulk of the plant for the railways, mines, irrigation and electricity works will probably have to be imported the establishment of such undertakings always leads to the starting of subsidiary industries to supply their requirements. It is pointed out that a cheap supply of power, and especially of electric power, not only assists the development of existing industries, but also causes new classes of industry to spring up. There is no reason why, given cheap electric power, electro-chemical industries, including the manufacture of fertilisers and other chemicals, as well as the products of the electric furnace, should not flourish in South Africa. After dealing with the important subject of the recovery of by-products in the distillation of coal it is stated that the cost of living in South Africa has risen less than in most large countries since 1914, and is now probably not much higher than in any other big manufacturing country.

Power Production and Distribution.

In dealing with the increasing dependence of industry upon power, Mr. Merz points out that in the United States the amount of power employed and the output per worker is probably higher than in any other country, being about double that in Great Britain. The best way to raise wages is to use more power, and thereby increase output, and these considerations will apply to the special labour conditions in South Africa. The spread of electric power has been due as much to its adaptability as to the ease with which it can be transmitted. Electric driving is becoming more or less general in modern factories, and 95 per cent. of the munition factories erected in England during the war were electrically equipped. There is a limit to the distance over which electric power can be economically transmitted, but it is being so transmitted over 200 miles at pressures up to 150 000 V. The economies effected from concentrating power production and from the use of large turbo-generators are clearly shown, and it is pointed out that electric power is being produced in the large Rand generating stations at from one-quarter to one-third of the cost in the average small local plant. Not only in the generation but also in the transmission and distribution of power economies can be effected, and by means of a wide network of mains advantage may also be taken of utilising waste power and water power.

Demands for Electric Power.

Three main reasons are given for developing the supply of electric power in South Africa on broader lines and extending electric mains on a larger scale than is possible under existing legislative conditions, viz., (1) In order to furnish bulk supplies to existing public and private undertakings in place of extending their present plants, thus reducing the cost of electric power to consumers and inducing others to adopt it; (2) to meet a much greater demand arising from the future need of industries, especially coal and iron; and (3) the need for attracting and developing entirely new industries, especially electro-chemical ones, including the production of fertilisers, the refinement of steel, &c.

A list of the existing undertakings is given in an appendix, but most of them are too small to produce power efficiently, and many are in need of extensions postponed owing to the war. If instead of spending further capital on comparatively small units of plant they could put down much larger units or obtain bulk supplies from a larger undertaking economy of capital and operating costs would in many cases result, profits would be increased, and the price of current could be reduced. Already in the neighbourhood of Cape Town a number of the smaller stations have been shut down in favour of a bulk supply from the main municipal station, and on the Rand several municipalities obtain their current in bulk from the Power Company. Taking a bulk supply need not interfere with the business of an undertaking; it merely substitutes the wholesale purchase of electric current for the purchase of fuel and generating machinery. It is also pointed out that many industries, such as collieries, cotton, oil, paper and others, would use power if a cheaper supply were available.

Existing Legislation.

After setting out the legislation governing electricity supply in the Cape Province, the Orange Free State, Natal and the Transvaal, it is mentioned that under the Transvaal Power Act, 1910, which constituted the Power Undertakings Board, no bodies in the Transvaal but municipalities were allowed to establish electrical undertakings exceeding 20 000 000 units a year output unless specially sanctioned by the Minister. This Act lays down the duties of licensees, and undertakings can be purchased after 37 years on payment of the fair value. The most important licence under the Act is that granted in 1910 to the Victoria Falls and Transvaal Power Co., but a separate licence was also granted to the affiliated Rand Mines Power Supply Co.

Excepting the four or five largest undertakings the total capacity of the generating plant of the remaining 70 to 80 undertakings in South Africa is under 40 000 kW, or about equivalent to the capacity of two large modern turbo-generators. Fortunately, the electrical and industrial development is at an early stage, and advantage can be taken of the experience of Great Britain and other countries to avoid their mistakes in initiating a new policy. Except the Rand, Cape Town and Durban no very large areas are covered by electric supply undertakings. The time therefore seems opportune for laying down on broad lines a progressive policy sufficiently flexible to encourage progress and conservative enough to protect the interests of existing undertakings, the consumer and the general public. If this is done with a view to having a comprehensive system of power supply throughout the industrial and more populous districts of South Africa, the first essentials are uniformity of type of current and frequency and standard voltage for transmission and, eventually, for distribution. A frequency of 50 cycles is suitable for general purposes and should be standardised and steps should be taken gradually to standardise distribution pressures also. Some details are given of the municipal undertakings at Cape Town, Durban, Johannesburg and Pretoria, as well as the Rand stations, and some suggestions are made as to the alterations and extensions required to make them fit into a general power scheme for the Union.

Policy to be Adopted.

In the portion of the Report devoted to the consideration of the policy to be adopted a sketch is given of the methods adopted in Great Britain and other countries. In a new country like South Africa, while there will be cases where the State may have to do things because other people will not, and many cases where municipalities can well do them, it is certain that neither of these bodies can or ought to attempt to deal with the whole question of the generation, distribution and supply of electricity. If private enterprise is also to be used, as it must if the country is to be rapidly developed, it is essential to give it security of tenure and the opportunity of making adequate profits, so that the necessary capital may be raised. It is equally necessary to protect the community by reasonable though not meticulous control of the capitalisation of the undertakings and the prices charged, and recent developments in Great Britain, France, Germany, Sweden and America are cited in support.

Mr. Merz states that his firm's experience leads him to suggest that the generation of power, apart from its distribution, should in future be subject to more central control than in the past. This does not necessarily involve government purchase or operation of power stations, but in any arrangement there should be complete freedom for the development of new industries, *e.g.*, electro-chemical works and by-product industries, which can be carried out more successfully by private enterprise.

In connection with the transmission system, as with generation, each case should be considered on its merits as it arises, and thus make provision for meeting local conditions. The distribution system should, as far as possible, be left to private enterprise and local municipal bodies.

Legislation Required.

One of the first steps to be taken should be the passing of a general Act unifying and regulating the present supply of electric power and the establishment of new undertakings. The Act should apply to the whole Union and should cover the powers granted to undertakers as regards their relations with the general public and the consumer; also powers to co-operate to issue capital, to regulate conditions of supply, tariffs, standards of pressure, frequency, &c.

The districts to be first dealt with will depend upon the decision as to railway electrification and the arrangements to be made with the existing undertakings. It is also suggested that the State should take the initiative in the establishment of means of research in connection with the various processes intimately associated with the production and use of electricity, such as a survey of the existing natural resources, testing the various classes of coal and iron, &c. In conclusion, reasons are given why the subject should be dealt with without further delay.

In a number of appendices statistics are given of the mineral and coal resources, the progress of manufactures, the present use of power and its cost in various industries, the existing electricity and tramway undertakings of South Africa, together with the text of the British Electricity Supply Act, 1919, &c.

Women in Lead Works.

The Home Secretary recently prepared draft Orders in pursuance of the powers conferred on him by the Women and Young Persons (Employment in Lead Processes) Act, 1920, Sec. 2 of which forbids the employment of women and young persons in any process involving the use of lead compounds if dust or fume from a lead compound is produced in the process or the persons employed are liable to be splashed with a lead compound, unless the regulations set out in the Section are complied with. These regulations include the following requirements:—

(*b*) The persons employed must undergo the prescribed medical examination at the prescribed intervals, and the prescribed record must be kept with respect to their health;

(*e*) Such suitable cloakroom, messroom and washing accommodation as may be prescribed shall be provided for the use of the persons employed.

The first two Orders prescribe respectively the periodic medical examination required under paragraph (*b*), and the cloakroom, messroom and washing accommodation to be provided under paragraph (*e*). They are based on the requirements in existing regulations and orders for other processes.

The third Order, which is made under Sec. 6 of the Act, declares what is a lead compound for the purposes of the Act and prescribes the method of ascertaining whether any compound is a lead compound within the definition.

Legal Intelligence.

An Apprenticeship Dispute.

At the Sutton Police Court on the 12th inst., Mr. E. E. Newbald, electrical engineer, applied for the cancellation of the apprenticeship deeds of three of his apprentices. On applying for the summons, Mr. Newbald explained that the boys were employed on terms of apprenticeship for five years. After two years had expired, the Electrical Trade Union, thinking that boys were not sufficiently paid, demanded that their wages should be increased to 31s. per week in the case of boys under 18, and to 39s. in the case of those over 18, threatening the master that, unless he paid the increase, his men and boys would be called out. He declined to pay, his employees came out, and he was further threatened that, in the event of his getting any work done, the Union would prevent the local supply company (the South Metropolitan Electric Tramways & Lighting Company) from connecting up any house at which he did work. In those circumstances, he gave notice to the boys to return to work, but they had not done so.

As the result of a conference between the parties it was arranged that the indentures of the three youths should be transferred by Mr. Newbald to some other employer. It was felt by the Union and Mr. Newbald that it was better they should go to some other employer. In order that there might be no reflection upon the apprentices, Mr. Newbald would pay their wages for a period, not exceeding one month, until the indentures were transferred. The Union were using their best efforts to find another employer to take them. The apprentices were to be put upon pre-war indentures and they would receive, in addition to pre-war wages the war increase given by the various orders of the Industrial Court and the Committee of Production, about which there was no dispute. The result of that would be some increase of wages to the apprentices. The figure which would have been paid if the agreement had been reached earlier would be fixed and half the difference would be paid to the apprentices. The men in the employment of Mr. Newbald would return and all hostile acts on either side would cease.

The magistrates allowed the summons to be withdrawn on the conditions stated.

The Conference on Wages between the Engineering Employers' Federation and the Trade Unions connected with the engineering trades has broken down. The men declined to accept the employers' proposals on the ground that they were too drastic, and they asked the employers to agree to arbitration. This the employers refused, and the men may now request the Minister of Labour to put into operation his powers under the Industrial Courts Act.

Electricity Supply.

The Urban Council of Cheadle and Gatley has applied for a Special Order to enable it to purchase and distribute electricity in its district.

Lyme Regis Corporation has entered a provisional agreement for the purchase of the undertaking of the local electric light and power company on Oct. 1 next.

The Worksop Urban Council, which has entered into an arrangement for a bulk supply of electricity from the Manton Colliery in preference to extending its generating plant, has let contracts amounting to £23 966 for a transmission cable, mains extensions, &c.

Aylesbury Corporation has applied for a loan of £27 632 for the installation of new plant at the electricity works. A grant of £370 has been made to the borough electrical engineer (Mr. W. A. Turnbull) for work done in connection with the extension of the electric supply undertaking.

As Paignton Urban Council will shortly be able to exercise the option to purchase the undertaking of the Paignton Electric Light and Power Company, a sub-committee has been appointed to consider the question. At Newton Abbot there is also a movement in favour of the acquisition of the electricity undertaking by the Urban Council.

An agreement was recently entered into between the War Office and Aldershot Urban Council for a supply of electric current in bulk to the town from the Camp generating station. The arrangement will obviate outlay of £24 000 or £25 000 on extensions of plant at the electricity works of the Council.

Though Accrington Council has now obtained the terms upon which Blackburn Corporation will supply electricity in bulk, it has been decided to urge the Electricity Commissioners to sanction the proposal granted to extend the Accrington generating station as the conditions are not considered sufficiently attractive.

At the last meeting of the Lincoln City Council it was agreed to withdraw the application to the Electricity Commissioners for sanction to borrow the sum of £62 745 for further contracts in connection with the electricity scheme with a view to another application being made at a later date for sanction to borrow an increased amount.

Despite the strenuous opposition of some obstructionists the Newark Corporation has decided to proceed with the electric supply scheme prepared by Mr. C. H. Wordingham, particulars of which we gave in a recent issue. A Special Order is to be applied for and a site for a generating station has been provisionally acquired.

The cost of the Electricity Commission for the period from the 23rd January, 1920, the date when the Commission was established, to 31st March, 1921, amounted to £39 900. This sum covers advances by the Treasury and interest, and the whole amount is repayable under Sec. 29 (2) of the Electricity (Supply) Act, 1919.

At Torquay Corporation meeting last week a recommendation to reduce the charge for electric current for cooking and heating to 2d. per unit was referred back. It is proposed to ask Mr. E. T. Ruthven Murray to advise the Council as to the possibility of installing steam-raising plant on the present site of the electricity station. One of the economisers is to be renewed at a cost of £1 250.

The surveyor of the Consett Urban Council (Mr. Fred Hargreaves) reported last week that the Cleveland and Durham Electric Company were under agreement to supply free current for 21 years from 1911, for lighting the town, up to 1 098 000 units. During the eight years ending April last, the Council had consumed 181 301 units only, while during the season just closed they had used 44 000 units. They had therefore 916 699 units available, which on last season's basis of consumption would be sufficient to light the district for 21 years yet.

An example of the confusion arising out of the contrary decisions of the National and District Joint Boards was given at the meeting of the Swansea Electricity Committee last week, when a letter was read from the secretary of the District Joint Board containing a resolution recommending that the constituent bodies should reduce the salaries in the area to correspond with the fall in the cost of living. The chairman (Ald. Sinclair) said that was a case in which the District Board was in disagreement with the National Board, who claimed there should be no revision. They in Swansea followed the District Board's schedule, and the reduction in Swansea came into operation on April 1. A letter was read from the Electrical Power Engineers' Association protesting against the reduction of salaries.

To celebrate the starting up of a new 5 000 kW Metropolitan-Vickers turbo-alternator at the Frederick-road Station of Salford Corporation on the 9th inst. a dinner was given in the evening at the Town Hall, the chairman of the Electricity Committee (Councillor Billington) presiding. Among those present were the Lord Mayor of Manchester (Ald. Kay), and the Mayors of Salford and Eccles. Councillor Billington, responding to the toast of the evening, gave an outline of the history of the electricity undertaking, and referred to its increasing prosperity since 1906, but said their profits had not grown by charging higher prices. This year, although the prices of current were 10 per cent. below those in the surrounding area, they made a record profit of nearly £27 000. They expected to increase their profits greatly by the new generating station. He attributed the success of the undertaking very largely to the borough electrical engineer, Mr. J. A. Robertson.

The Corporation electricity department made a profit of £27 000 in the past year, or £4 000 more than in the preceding year. It is proposed to place £15 000 to rate relief and the remainder to the renewals fund.

In a report by the engineer and manager of the Redditch Electricity Department (Mr. R. N. Mayne) a deficit of £5 385 is anticipated in the ensuing half-year. The Clerk also reported to the Urban Council that the £3 000 provided for in the previous half-year's estimate, for repayment of principal on extension accounts Nos. 1 and 2, had not been paid, and that (including unpresented cheques amounting to £2 370) the bank overdraft on the revenue account was £8 032. The district auditor declined to allow the suspension account, amounting to £6 657, to be continued, and had ordered the account to be transferred to the revenue account. The consequence was, taken in conjunction with the heavy expenditure on fuel and stores, increased wages and salaries, which had been enforced upon the Council, and the necessity of providing for the repayment of extension loans to date, liabilities had arisen of £17 651. This could only be met out of the rates, and by increased charges for current if sanctioned by the Electricity Commissioners.

After a long discussion it was decided to include in the estimate of the general district rate a sum equal to 2s. 6d. in the pound, in aid of the undertaking during the half-year.

At the meeting of Barnsley Corporation last week the chairman of the Electricity and Lighting Committee (Councillor Foulstone) reported that for the past year there was a profit of £4 265 on the electricity undertaking after meeting expenses and providing £10 489 for instalment of principal and interest, sinking fund and bank interest. There were 123 new consumers, making a total of 1 602. Five high-tension sub-stations had been completed, making 11 in all, and five more were in course of election. The change over of several consumers from D.C. to A.C. had reduced their conversion losses. The units sold amounted to 3 503 000, or 40 per cent. increase, and revenue rose from £33 000 to £48 000, or 43 per cent., by far the greatest advance in any one year. Their coal consumption of 3·98 lb. per unit generated was the lowest on their records, and that was due to new machinery. In 1912 the average price of coal was 6s. 3d. per ton, so that for the year just closed coal, which was one of their greatest items of expenditure, had increased 425 per cent. since 1912. By the small saving of, say, 4 oz. of coal per unit generated, they had saved 519 tons, which (at 32s. 9d. per ton) amounted to £850. Since 1914 wages had increased about 180 per cent., and other items, such as rents, rates, taxes, insurance and interest by quite 100 per cent. In view of those increases the wonder was that electricity could be sold at double the pre-war prices. The Committee intended as soon as possible to give the consumers of electricity the advantage of any decrease in the cost of production.

The Hammersmith (London) Borough Council recently decided to "discontinue its association with any and all of the several Joint Industrial Councils concerned with conditions of employment and rates of remuneration for the several sections of the Council's staff and employees." In a letter of protest to the Town Clerk the Executive Council of the Electrical Power Engineers' Association express regret "at the retrograde and ill-advised step" taken by the Council, as only in so far as agreements arrived at by the regularly constituted machinery in the industry are honoured, can there be any reasonable possibility of industrial peace being maintained. The Borough Council is reminded that the effect of Whitley Councils in the electricity supply industry has undoubtedly been to effect a diminution in the number of disputes, and as more experience is acquired, these good results will become more apparent. The inevitable outcome of a secession such as the Council contemplates must be to cause moral damage to the whole scheme, and will tend to bring about the return of the chaotic conditions which existed before the war. The fact that up to the present Whitley Councils have been concerned with the question of wages has been inevitable under the circumstances; but it is the desire and intention of the E.P.E.A. that Whitley Councils in the supply industry should devote their attention to larger questions, such as the efficiency of the industry as a whole, and that they should be a means whereby those engaged in it should make their definite contribution to its more efficient administration. The breaking up of the Councils by such action as the Borough Council proposes to take will effectively prevent this, to the grave detriment of the industry. It is, therefore, hoped that the matter will be given favourable reconsideration.

Electric Traction.

The Salford Tramways Committee report a profit of £17 000 on the past year's working of the Corporation tramways, and of this sum £10 000 is to be placed to renewals account, and the balance (£7 000) will be applied to the relief of the rates.

The Darwen Tramways Department made a net profit of £1 025 18s. 8d. during the past year. The total revenue was £29 384 against £27 961; the passengers carried were 4 362 404, against 4 106 196. On the renewal of the track £5 287 was spent.

Edinburgh Corporation has approved recommendations of the Tramway Committee that certain portions of the work in connection with the electrification of the Pilrig to Liberton section of the cable system be executed by the Tramways Department, and that the section between Goldenacre and Leith-street be electrified.

On Saturday about 300 men, who were employed at the Greenwich Power Station of the London County Council, struck work on account of the use of foreign coal. Volunteer labour was obtained and the tramway cars were kept running. Later a party of naval ratings arrived and took over the duty of maintaining power for the tramways. The executive committee of the tramways section of the Vehicle Workers' Union are taking a ballot of their members in London on the question of a strike.

Imperial and Foreign Notes.

According to a telegram from Melbourne the partial electrification of the Suburban Railways has proved a marked financial success and a saving of £191 000 per annum will be effected.

The construction of the new Sydney City Railway, which was commenced in 1916 and suspended in 1918, will be shortly resumed. The present central Sydney railway station is a mile from the business portion of the city. The existing suburban railways are to be electrified and extended to and around the city, and the Milson's Point-Hornsby railway, now terminating on the north side of the harbour, will be carried over the harbour by the North Shore bridge (which will have a clear span of 1 600 ft.) and connected to the city loop at Wynyard-square. The city railway will be partly in tunnels, partly on the surface and partly on viaducts. It is calculated that the new central station for suburban electric trains only will have a capacity of 210 trains per hour. The estimated cost of the railway works, exclusive of the harbour bridge, is £3 750 000.

The "Industrial Australian & Mining Standard" states that there is considerable activity in towns in the northern portion of New South Wales in regard to obtaining electricity supply. *Casino* Council is consulting with Mr. Bradshaw on the subject, and the cost of the proposed works is estimated at £16 000. *Ballina* Council wishes the Provincial Electric Supply Company to extend its system or sell it to the Council. Mr. Wm. Corin states that energy could be obtained from the Killen's Waterfalls for generating current for Ballina. *Lismore* Council is adopting electric street lighting, and contemplates extending the supply to private consumers. Mr. I. W. Bridger has prepared a report for *Tintenbar* Shire Council on the feasibility of utilising water power for generating electrical energy for use in the district. *Murwillumbah* Municipality intends to increase its generating plant by installing a 150 kW set and proposes to borrow £16 000 for this purpose.

At a recent meeting of Sydney Council Mr. Forbes McKay, the electrical engineer, recommended the purchase of a site for a new power house. He stated that it would be necessary to have at least one generating set in operation by 1925. It was suggested that the matter should be postponed until the Council had decided on the question of the purchase of a coal mine, but Mr. McKay said the plant would be required urgently whether a coal mine were purchased or not. The matter was postponed to a special meeting. With reference to the proposal to have a 16 000 KW turbo-alternator made in Australia, it was reported that Mort's Dock & Engineering Company had intimated that, owing to the pressure of work on hand and the scarcity of suitable skilled labour, it would be at least 18 months before they would be in a position to consider the Council's requirements. Messrs. L. Hinks & Company were prepared to carry out the whole of the boiler-house equipment, but were not able at present to quote for the turbo-alternator. It should however be pointed out that in July, 1920, the English Electric Company, of Australia, were informed by the Council that its next order for main generating plant would be placed with that company.

It is reported that the concession recently given to Marconi's Wireless Telegraph Company for operating the Peruvian wireless and land line telegraph services for 25 years has been made the subject of representations by the United States Government.

Institution Notes.

Supporters of the Engineers' Club, in London, are urgently invited to attend the general meeting which is to be held at the Hotel Cecil on Thursday, June 2, at 2.30 p.m.

The Institution offices were moved from Albemarle-street to its own building on Victoria Embankment on Tuesday last, May 17. All communications to the Institution should therefore now be sent to Savoy-place, Victoria Embankment, London, W.C.2. The telephone number will continue to be Gerrard 764 and the telegraphic address Voltampere, Phone, London.

At the second annual meeting of the Warrington Electrical Society last week the hon. treasurer (Mr. H. Rogers) presented the accounts. The average attendance at the meetings throughout the year was 22, whereas the total membership was 79. The officials were reappointed as follows: *Chairman*, Mr. F. V. L. Mathias; *vice-chairman*, Mr. Smith; *hon. treasurer*, Mr. H. Rogers; *hon. secretary*, Mr. J. B. Robertson. The Council include Messrs. Brooking, Seymore, Baird Senior, Leggatt, Sykes, Bishop and Barton.

At the annual general meeting of The Institution of Civil Engineers held on the 26th April, the following officers for 1921-22 were elected:—

President: Mr. W. B. Worthington; *Vice-Presidents*: Dr. W. H. Maw, Mr. Charles L. Morgan, C.B.E., Mr. Basil Mott, C.B., Sir William H. Ellis, C.B.E., D. Eng; *Other Members of Council*: Dr. C. C. Carpenter, C.B.E., Mr. G. M. Clark, M.A. (South Africa), Dr. P. C. Cowan, Colonel R. E. B. Crompton, C.B., R.E. (T.), Mr. Maurice Deacon, Sir Archibald Denny, Bart., Mr. W. W. Grierson, C.B.E., Sir Robert A. Hadfield, Bart., D.Sc., D.Met., F.R.S., Mr. Kenneth P. Hawksley, Sir Brodie H. Henderson, K.C.M.G., C.B., Mr. E. P. Hill, Mr. G. W. Humphreys, C.B.E., Mr. Summers Hunter, C.B.E., Mr. H. G. Kelley, Mr. C. R. S. Kirkpatrick, Mr. F. W. MacLean, Mr. H. H. G. Mitchell, O.B.E., Engr. Vice-Admiral Sir Henry J. Oram, K.C.B., F.R.S., Mr. Frederick Palmer, C.I.E., Mr. George Richards, F.C.H., B.A., Captain H. Riall Sankey, C.B., C.B.E., R.E. (ret.), Sir John F. C. Snell, Mr. W. A. P. Tait, Mr. E. F. C. Trench, C.B.E., H.A., Prof. W. H. Warren, LL.D., Sir Alfred F. Yarrow, Bart.

Miscellaneous.

The open competitive examination for assistant examiners in the Patent Office will begin on Tuesday, July 26, instead of on July 12, 1921, as originally announced, and will last until July 30. Candidates must be between 20 and 25 years.

We regret to record the death of Mr. E. F. Vesey Knox, K.C., a leading member of the Parliamentary Bar. During his career he appeared before Parliamentary Committees and the Light Railway Commissioners in connection with many electricity supply and electric traction schemes.

A magnetic storm of exceptional severity was experienced on Saturday evening last causing considerable disturbance of telegraph and telephone instruments throughout the world. In the United States practically all telegraphic communication was interrupted for over an hour, and in Sweden many wires were short-circuited, while at the Karlstad telephone exchange a fire was caused which destroyed the exchange. The disturbance was also felt in Australia, France, Italy and other countries. Mr. N. Carlton, President of t e Western Union Telegraph Company, states that the damage done may necessitate the lifting of some of the transatlantic cables for repairs.

On Monday, May 9, the Royal Commission on Awards to Inventors concluded the hearing of the application of Messrs. G. H. Nash (chief engineer and a director of the Western Electric Company), E. R. G. Penny, R. A. Mack and B. B. Grace for an award in respect of the user by the Admiralty of hydrophone equipment devised by them and incorporating the Nash "Fish."

A report of the arguments and evidence in support of the claim appeared in our issues of April 22 and May 6. Further evidence was given by Admiralty witnesses in opposition to the scheme, and, at the conclusion, Counsel for the respective parties addressed the Commission. The Commissioners reserved their decision.

The connection of golf with the electrical industry does not at first sight seem very close. Nevertheless, there are such things as Engineering Golfing Societies, and we know of a good many pleasant hours having been spent on golf courses during such functions as I.M.E.A. Conventions. A little booklet containing the Revised Rules of Golf, and issued by the Royal Insurance Company, is not, therefore, unlikely to be of interest to certain readers of The Electrician. A useful feature is an inset showing the difference between the old rules and the new, together with a few facts relating to the rubber-cored ball and the controversy on the limitation of the sizes and weight of the ball. A copy of this booklet will be forwarded to any of our readers who care to apply to the head office or any of the branches of the Royal Insurance Company, Ltd.

Seventy delegates attended a special conference of the Electrical Trades Union at Blackpool this week. Mr. J. W. Ball, of Manchester, the president, occupied the chair. The meetings were private. Following the presidential address, the conference approved of the principle of amalgamating with other trades unions.

It was also decided to instruct the Executive Council to open negotiations at once with the employers with a view to securing a settlement of the wages dispute. The Executive met on Tuesday and agreed to take the necessary steps to fulfil the instructions of the conference. We learn that about 50 per cent. of the men employed by members of the Masters' Association are out, and non-association firms have also issued notices of reductions in wages.

An unofficial conference of the secretaries of the various International Standardisation Organisations was recently held in London under the presidency of Sir Archibald Denny, Bart., the Chairman of the British Engineering Standards Association. Those present included:—Dr. P. G. Agnew, Mr. A. Eriksen, Mr. E. Hijmans, Mr. J. R. Durley, M.G. Gerard, M. Zollinger and Mr. C. le Maistre.

The object of the conference was the exchange of ideas with a view to the establishment of closer relationship, and we are glad to hear that from this point of view it was eminently successful. Each secretary gave a brief report of the general organisation of the work in his own country, the methods adopted in arriving at the standards and the principles followed to ensure their adoption when issued. One point which arose from the information thus brought to light was that industrial standardisation to be really useful must be obtained through a process of unifying the needs of the industry rather than by attempting to set up an ideal.

The Prevention of Strikes is a most desirable object from every point of view, and any method of attaining industrial peace is worthy of consideration. In this connection the plan adopted by an American firm is worthy of attention. In welcoming the delegation of American and Canadian dry goods merchants to Walsall last week, Mr. John C. Shannon, head of a large wholesale clothing factory, explained how he had succeeded in preventing strikes for the past eight years. "The whole secret of solving the labour trouble," he said, "is that business men must treat their employees as human beings, and not as mere machines." Whitley Councils did not provide the right means, because they mixed capital with labour in discussion. He had come to the conclusion that responsible people must not be mixed with the operatives, and he devised three boards—a board of directors, responsible for the policy of the firm and for expending money; an advisory board, consisting of the heads of departments; and a production board, drawn from the practical side of the workrooms. There were also nine conciliation boards, in which every class of labour was represented. On the receipt of any large order there was mutual consultation, and no attempt was made to hide prices or profits.

Catalogues, Price Lists, &c.

The Lanston Monotype Corporation, Ltd., 43, Fetter-lane, E.C. 4, have issued a catalogue containing particulars of the Radbore Head, which is manufactured by Messrs. Lawson & Company, New York. It is claimed that the radbore head is the only tool attachment which bores a square hole in one operation, out of solid material, without previous preparation or subsequent finishing.

The Electrical Apparatus Company, Ltd., have recently issued leaflet H.29, which contains an illustrated description, with prices, of their new Float Switches. Of mica steel construction, they have a quick make and break action; they are used for the automatic control of electrically-driven pumps, and are of sufficiently robust construction to be capable of starting and stopping the motor direct in the case of small motors, instead of in conjunction with automatic starters. To enable this to be done, the float switches are standardised for a single, double or triple-pole operation.

A nicely printed and well illustrated Bulletin (No. 9), dealing with the design and construction of their rotary converters, has been issued by the General Electric Company, Ltd. This is the second edition of the Bulletin, which describes briefly but lucidly the present position of the rotary converter. It is divided into five main sections, devoted to general principles, voltage regulation, starting and synchronising, design and rotary converter sub-stations. In view of the increasing importance of converting plant in electricity supply the technical information, diagrams and other particulars given of G.E.C. rotary converters should prove very useful to engineers in charge of or who contemplate using such plant.

Two new lists, containing particulars of some new designs of hydraulic machinery, have been issued by Messrs. Hollings & Guest, Ltd., Birmingham. List A 112 gives prices and details of hydraulic and hand screw presses for extracting oil, copra, &c., and pumps for working same. In List A 113 there are illustrated particulars with prices of hydraulic forging and flanging presses, rivetters, &c. Among the machines shown is a powerful hydraulic press for joggling ship frames and plates and for bending, straightening and general use in shipyards, constructional works, waggon and railway yards, &c. There are also an hydraulic press for pressing wheel rims and for forging end flanging work, and a double acting press with horizontal and vertical rams for flanging, bending, &c. In the latter the work is held in suitable dies by the vertical ram and the horizontal ram applies the necessary pressure for the work. Fixed and portable hydraulic rivetting machines, various types of hydraulic power pumps and accumulators are likewise described

Business Items, &c.

The address of Messrs. E. G. Appleby & Company, Ltd., is now 70, Victoria-street, Westminster, S.W.1.

Henry Murray Watkinson and Charles Sutherland, trading as the Grassendale Motor Company, automobile and electrical engineers and dealers, 25, Aigburth-road, Grassendale, have dissolved partnership. Debts by Mr. Watkinson.

It is announced that telegrams for Russia (including Russia-in-Asia as far east as Lake Baikal) are now forwarded over the Anglo-Russian cable, between Peterhead and Alexandrovsk, in Northern Russia. The Russian Administration has notified that, owing to congestion and other difficulties on certain lines, telegrams can only be accepted at the sender's risk. Telegrams can also be forwarded under the same conditions by the Great Northern Company's route via Libau (Latvia).

Messrs. Salterns, Ltd., of Parkstone, Dorset, have made an arrangement with Mr. Percy Pitman, M.I.M.E., for the manufacture and sale of power generating water turbines of all descriptions and their accessories. At present considerable attention is being paid to water power development, owing to the increasing cost of and difficulty in getting coal or oil for generating purposes, and wherever possible turbines will be used as prime movers. The turbines will continue to be manufactured under the supervision of Mr. Pitman, who has had a long experience in the design and installation of hydraulic plants.

Personal and Appointments.

Mr. E. D. Wootten, electrical engineer, of Abertillery, has been appointed engineer and manager of the Malvern gas & electricity undertakings.

The King has been pleased to approve of a Peerage being conferred upon the Right Hon. A. H. Illingworth, M.P., on his retiring from the office of Postmaster-General.

The following appointments have been made at Manchester University: Assistant Lecturers in Physics, Mr. J. C. M. Brentano, D.Sc. and Mr. H. Lowry, B.Sc.; Assistant Lecturer in Metallurgy, Mr. Hugh O'Neill, B.Met.

Mr. H. E. Blain, assistant managing director of the Underground Electric Railways Company of London, has left on a visit to Toronto to report on transport problems in that city. Subsequently he will visit New York, Chicago, Detroit and other American cities in order to study transport methods.

Bankruptcies and Liquidations.

A Receiving Order has been made against Samuel Horace Dougherty, trading as the Mersey Electrical Co., 106, Kensington, Liverpool.

Claims against Wm. Hy. Pease, electrical engineer, lately trading at Royal Hotel Shops, Scarborough, and 19 and 20, Baxter-gate, Doncaster, are to be sent by June 1 to Mr. L. J. Clegg, 14, Figtree-lane, Sheffield.

Tenders Invited and Accepted.

Aldershot Urban Council want tenders by May 24 for supply and installation of about three miles of 6 600 volt three-phase cable. Particulars from the Electrical Engineer.

Wimbledon Corporation require tenders by noon, May 25, for the supply and erection of h.t. substation switchgear. Specifications, &c., from the Electrical Engineer.

Belfast Tramway Committee want tenders by May 27 for the reconstruction of about 11 miles of single track. Specifications, &c., from the General Manager.

Doncaster Corporation require tenders by May 23 for doubling the tramway route from Cleveland-street to Balby Bridge. Specifications, &c., from the Borough Engineer.

Edinburgh Corporation requires tenders by May 26 for e.h.t. and l.t. switchgear for sub-stations. Specification (No. 29) from Sir Alexander Kennedy, 17, Victoria-street, Westminster, S.W.1.

Plymouth Gas Committee requires tenders by May 26 for works including the supply and erection of an electrically-driven push-plate conveyor. Specifications, &c., from Mr. Isaac Carr, M.Inst.C.E., Farnborough, Widnes.

St. Helens Corporation require tenders by May 25 for relaying about 4 000 lineal yards of tramway permanent way, the supply of 60 cwt. of fish bolts, 1 500 tie bars and 2 000 bands. Specifications from the Borough Engineer.

The Borough Council of King William's Town (S. Africa) invites tenders for steam-driven electrical generating machinery, boilers, switchgear and cable. Specifications from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C.2, to whom tenders by June 25.

The Uruguayan Ministry of Public Works invite tenders for three electric gantry cranes and a "Temperley"-type aerial transporter for the port of Paysandu. Tenders (in Spanish) by June 28. A translation of the specification may be seen at the Department of Overseas Trade.

The Department of Sanitary Works, Buenos Aires, requires tenders (by June 13) for the supply and erection of electric batteries and lighting plant at Mar del Plata. Local representation is essential. Specification at the Department of Overseas Trade.

It is notified that the date on which all tenders for the supply of plant and material for the electrification of the Cape Town-Simonstown & Durban-Pietermaritzburg Railway lines has been extended to noon, July 5. Tenders to the High Commissioner for the Union of South Africa, Trafalgar-square, London, W.C.

The Victorian Government Railway Commissioners invite tenders for the supply and delivery of 50 oil-immersed single-phase track and signal transformers for power signalling (contract No. 33 901). Tenders to the Commissioners, Spencer-street, Melbourne, by June 15. Specifications may be consulted at the Department of Overseas Trade.

Antwerp Municipal Council invite tenders for the supply of 11 500 metres of double and 5 000 metres of quadruple conductor armoured paper insulated telegraphic cable. Tenders (with deposit of 2 000 francs) by midday May 27 to Le Bourgmestre d'Anvers, Hotel de Ville, Anvers. Specification (in French) may be consulted at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

The National Board of Sanitary Works, Buenos Aires, invite tenders by June 3) for the supply and erection of plant for a new generating station, including three 375 H.P. four-cycle Diesel engines (to run on crude petroleum) and three three-phase alternators, each of 250 kW, 2 200 V between phases, 50 cycles and power factor of 0·8. Conditions, &c. (in Spanish) at Department of Overseas Trade, 35, Old Queen-street, S.W.1.

The New Zealand Public Works Department invite tenders for the supply and delivery at Lyttelton of two 50-kVA, two 100-kVA and two 200-kVA condensers, in connection with the Lake Coleridge electric power supply scheme (Section 116); and also for 10 single-phase oil transformers for the Waikato power scheme for converting three-phase current at 50 cycles, the voltage ratio being 50 000/11 000. Tenders by June 28 to the Secretary of Public Works, Tenders Board, Wellington. Specifications may be seen at 35, Old Queen-street, S.W.1.

The Victorian Government Railways Department invite tenders for the supply and delivery of a lifting magnet and motor generator with control apparatus (Contract No. 34 072), machines (including lathes, drills, &c.) (No. 34 028), an industrial storage battery truck and battery charging equipment (No. 34 070), varnish and compound for impregnating plant (No. 34 084), copper rod (10 ton $1\frac{1}{8}$ in. and 10 ton $1\frac{1}{16}$ in.), &c. Tenders to the Victorian Railway Commissioners, Spencer-street, Melbourne, by June 22, in the case of the first two items, and by June 29 in the case of the remainder. Deposit of half per cent. of total amount of offer required, and local representation. Specifications may be consulted at the Department of Overseas Trade.

Barnsley Corporation has accepted the Western Electric Company's tender for h.t. and l.t. cables at £5 821.

Ilford Urban Council has accepted the tender of the Hackbridge Cable Company for the supply of cable and that of Hadfields, Ltd., for tramway crossings, points and tongues.

Glasgow Corporation has placed an order with the British Insulated & Helsby Cables, Ltd., for the supply of wire and copper bonds for the tramways department and with Ferguson-Pailin, Ltd., for switchboards for Buchanan-street and Cadogan-street sub-station at £7 444.

Patent Record.

APPLICATIONS FOR PATENTS.

October 19, 1920.

29 461 Shannon. Portable electric lamps.

29 473 Smith. Electrical fittings.

29 479 Pattison (Dectograph Products Corporation). Telephone switch separators.

29 515 Eckersley & Round. Means for generating high-frequency oscillations

29 527 Ten B[illegible] Wall plugs (23/7/19, Holland.)

29 529 Ransomes Sims & Jefferies & Mossay. Electric locomotive cranes.

[illegible] Oliver. Testing electric ignition.

29 54[illegible] Maina & Pilatu[illegible]. Manufacture of stator and rotor laminations.

29 562 Aymard. Electrically-operated horns.

October 20, 1920.

29 600 Booth & Wilmot. Mechanism for providing feed holes in telegraph perforating instruments.

29 608 Boltshauser & Cosmophas Warke A. G. Electric pocket lamps.

29 646 Sperry Syroscope Co. Relay transmitters. (20/10/19, U.S.)

29 649 Payne. Hydro-electric apparatus.

29 658 Oliver. Electric resistances.

29 668 Metropolitan-Vickers Electrical Co. Interruption devices for electric circuits. (6/11/19, U.S.)

October 21, 1920.

29 703 Midland Electric Mfg. Co. & Sutherland. Switches and fuses.

29 707 Automatic Telephone Mfg. Co. & Savin. Telephone systems.

29 731 Automatic Telephone Mfg. Co. Measured telephone service systems. (13/12/19, U.S.)

29 733 Felstead. Terminals for electric coils.

29 780 Smalley. Electric furnaces. (21/10/19, U.S.)

29 783 Fletcher. Secondary cell containers.

29 844 Oldham. Switches.

October 22, 1920.

29 851 Padmore. Plug and socket-like connectors for electric leads.

29 852 Padmore. Electric heaters for kettles, &c.

29 856 Wingrove & Rogers. Controllers for electric vehicles.

29 901 Barr. Electric water-heater.

29 931 Ges. fur Drahtlose Telegraphic. High-power conductors for transmitting high-frequency oscillations. (1/12/19, Germany.)

29 957 Lant. Sending devices for radio-telegraph stations. (23/10/19, France.)

29 962 Morshead & Selvey. Cooling electrical machines.

October 23, 1920.

29 988 Browne. Self-contained electric time-pieces.

30 002 Hadwen & Willis. Drop electric lamps.

30 024 Earle & Kluijtmans. Electric heating apparatus.

30 025 Amberton. Switches, relays, contractors, &c.

30 028 Pearce. Protecting a.c. systems and apparatus.

30 051 Graf. Switches. (26/1/20, Germany.)

October 25, 1920.

30 074 Lubbock. Electric coupling.

30 109 Bouteille. Circuit closing and breaking devices. (26/10/19, France.)

30 121 McKenzie. (Holland Westinghouse Power Signal Co. & Pearse.) Relays.

30 122 Thomas. Electro-pneumatic breaking apparatus. (2/4/21, U.S.)

30 133 Igranic Electric Co. & Yereer. Relays.

30 135 Metropolitan Vickers Electrical Co. & Miller. Electrically driven planers, &c.

30 148 Schmierer. Luminous electric discharge tubes for illuminated signs. (25/10/19, Germany.)

30 156 Robinson. Magnetic circuit of motors and dynamos.

30 167 Richardson. Electric flame projector.

October 26, 1920.

30 193 Richards. Electro-magnetic signalling device for automobiles, &c.

30 216 Bethenod. Electric installations for automobiles. (21/10/19, France.)

30 227 Gross. Electric generator.

30 230 Stancliff. Actuating switches from a distance.

30 231 Barr & Strand. Transmitting and receiving instruments.

30 265 A. C. Cuffing & Welding Co. & Smout. Electrode-holders for welding.

30 267 Chloride Electrical Storage Co. & Dean. Secondary batteries.

30 278 North. Magneto-electric machines.

30 287 Hausen-Ellehammer. Wind-power electric generating plant.

30 290 S. G. Brown. Cable telegraphy.

30 292 Landau & Levy. X-ray plates.

30 301 Eccles. Three-electrode thermionic vacuum tubes.

30 305 Ges. fur Drahtlose Telegraphic. Wireless telephone transmitters. (11/11/19, Germany.)

30 306 Ges. fur Drahtlose Telegraphic. Telephony and telegraphy by high-frequency currents and transformers. (2/12/19, Germany.)

30 307 Ges. fur Drahtlose Telegraphic. High-frequency interrupters. (7/11/19, Germany.)

October 27, 1920.

30 313 Davenport. Telephones.

30 389 B.T.-H. Co. (G.E. Co.). Electric motor control.

30 409 Durando. Electric cooking vessels. (20/11/19, Italy.)

30 410 Dubilier Condenser Co. High-potential condensers. (7/3/19, U.S.)

30 413 Thor Electric Safety Lamp Co. & Stretton. Locks for miners' lamps, &c.

30 425 Wiard. Electric machines.

30 433 Lounge & Smith. Electric means of preventing theft of motor vehicles.

30 434 Lounge & Smith. Switches.

October 28, 1920.

30 458 Page. Long-range electric switch.

30 465 Grossi. Electro-magnetic control mechanism.

30 473 Vogel. Automatic switches.

30 504 Societie Independante de Telegraphie sans Fil. Vacuum tubes. (28/10/19, France.)

30 529 Dimitrievitch. Submarine cable signalling.

30 534 Boorne. Electrode for arc welding, &c.

30 552 General Electric Co. & Goucher. Drawn-wire filaments.

October 29, 1920.

30 56[illegible] Collier & Milne & Elcock. Dynamo and switchboard for motor vehicles.

30 576 Radio Communication Co. & Scott-Taggart. Molulation of electrical oscillations, &c.

30 581 Cave. Cable suspender for mines.

30 597 Johnson & Sheffer. Electric rivet heater.

30 599 Garrard, Wilson & Railing. Means for interlocking electric switches.

30 628 Potter (Pernat & Rich). Electric transmission of intelligence.

30 631 Morgan. Electrically transmitting pictures, &c., to a distance.

[illegible] Battson. Electric heating and cooking apparatus.

October 30, 1920

30 702 Wall. Magnetic circuits for electro-magnetic apparatus.

[illegible] Orling. Telegraph relays.

30 737 De la Rue. Insulators.

30 740 Eyre & Harrison. Electric light, &c., fittings.

30 743 Appleby & Knoll. Radio apparatus. (14/6/19, U.S.)

November 1, 1920.

30 775 Laird & Pate. Electric heating and cooking apparatus.

30 783 Cheyne. Terminals for electric connections.

30 784 B.T.-H. Co. (G.E. Co.). Automatic Regulating systems.

30 788 Wren. Ferrules for electric conduits, &c.

30 805 Stroud. Electric light fittings.

30 826 Siemens & Halske, A. G. Amplifier-connecting apparatus for telephonic installations. (31/10/19, Germany).

30 829 Edison Swan Elec. Co. & Shergold. Switches.

30 834 Dimitrievitch. Printing telegraph system.

November 2, 1920.

30 890 Huxley. Prevention of fouling of overhead gear by trolley head.

30 937 Quain Elec. Co. & Spink. Electric Stoves.

30 983 Igranic Elec. Co. (Cutler-Hammer Mfg. Co.). Power transmission mechanisms

30 984 Igranic Elec. Co. (Cutler-Hammer Mfg. Co.). Induction relays.

30 985 Igranic Elec. Co. (Cutler-Hammer Mfg. Co.). Thermally-controlled circuit-interrupters.

30 986 Igranic Elec. Co. (Cutler-Hammer Mfg. Co.). Motor-control systems.

30 987 Igranic Elec. Co. (Cutler-Hammer Mfg. Co.). Motor-control systems.

31 001 Mark-Wardlaw. Thermo-electric condensing in steam engines.

31 016 Sanguinetti. Electric motor-car lamps.

31 035 Automobile Service, Ltd. & Were. Car-lighting sets.

31 053 Walker. Electric-harmonic analyser.

31 042 Rademaker. Electrical sounding device.

31 052 Turton. Apparatus for electro-deposition of metals.

31 059 Schaeffer. Luminous electric discharge lamps. (14/7/20, Germany).

31 093 Robertson. Transmitting and recording telephone, &c., messages.

31 094 Dimitrievitch. Relays.

31 098 Webber. Electric lamp shades, &c.

31 147 Pedersen. Arc generators for producing oscillating currents of high frequency. (5/8/20, Denmark).

31 150 Taylor. Electric transmission.

November 4, 1920

31 166 Lancashire Dynamo & Motor Co. & McLeod. Electric motors.

31 176 Cranmer, Cheshire & Summerhayes. Electric heating or cooking utensils.

31 180 Cranmer, Cheshire & Summerhayes. Electric heating units.

31 182 Larsson & Lienzen. Switching apparatus for automatic, &c., telephone systems.

31 206 Ford. Medical coils for use with dry batteries

31 207 Burne. Charging secondary batteries.

31 223 & 31 224 B.T.-H. Co. (G.E. Co.). Incandescent lamps.

31 225 Barker. Locking holder for incandescent lamps.

31 230 Dick. Electric speed regulator.

31 233 Metropolitan-Vickers Electrical Co. (Westinghouse Electric & Mfg. Co.) Transformers.

31 244 Roberts. Telephony.

31 275 & 31 276 Colson. Electric kettle, &c.

November 5, 1920.

31 284 Bosch (R.) Akt. Ges. Battery ignition systems. (13/11/19, Germany).

31 298 Automatic Telephone Mfg. Co. Telephone systems.

31 317 McLoughlin. Electric wiring systems.

31 318 Simplex Conduits, Ltd. & McLoughlin. Continuity devices for conduits and fittings for cables.

31 340 B.T.-H. Co. (G.E. CO.). Electric glow devices.

31 344 Lehmann. Electric switches.

31 346 Western Elec. Co. Terminal banks for electric switches.

31 362 Dutton. Oil-cooling stators of electric machinery.

31 371 Betulander. Call-distributing arrangements for telephone plants. (22/11/19, Sweden).

31 372 Frost & Welch. Electrically-heated vulcanising apparatus.

31 376 Scott-Taggart. Electron discharge devices.

November 6, 1920.

31 403 Ness. Electric toasting apparatus.

November 8, 1920.

31 490 Mordey. Electro-magnetic engine or motors.

31 516 Metropolitan-Vickers Electrical Co. Transformers. (10/12/19, U.S.)

31 517 Metropolitan-Vickers Electrical Co. Electric speed regulator systems. (6/11/19, U.S.)

31 528 B. T.-H. Co. & Pearce. Protective devices for.

31 529 B. T.-H. Co. & Clinker. Electric indicating and measuring instruments.

31 536 Bergman. Electric reactors. (25/6/20, U.S.)

31 576 Thor Electric Safety Lamp Co & Stretton. Electric lamps for miners, &c.

31 578 Balsera. Apparatus for supply of electric current.

31 586 Merz & McLellan. Power installations.

31 588 Slee. Electric alarm apparatus.

November 9, 1920.

31 617 Bosch (R.) Akt.-Ges. Magneto-electric ignition machines. (24/4/20, Germany.)

31 618 Bosch (R.) Akt.-Ges. Magneto-electric, &c., machines. (22/4/20, Germany.)

31 632 Sloman. Flanged electric conduit.

31 641 Automatic Telephone Mfg. Co. Utilisation of electrical properties of new material, &c.

31 644 Morrison. Electric light switch.

31 660 Bundy. Electrical advertising sign.

31 665 Macneur (Rae). Telegraphic tell-tale instruments.

31 676 B. T.-H. Co. (G. E. Co.) System of electric power transmission.

31 681 Frankling. Stud for electric welding to bulk-heads, &c.

31 687 Hall (J.) & Co. Switches.

31 689 Ostins. Switches.

31 706 Jones. Supply of electric current to railway, &c., vehicles from trucks.

31 711 Payne & Wild. Electric igniters.

November 10, 1920.

31 730 Baker, Dudgeon & Cross. Collectors for electric tramway and railway vehicles.

31 734 Berry. Transmitting pictures, &c., by telegraphy.

31 749 Austin. Electric lamp fittings.

31 763 Draycott. Device for prevention of fires by electricity.

31 804 Soc. Anon. Kummler & Matter. Electric resistance material. (10/11/19, Switzerland.)

31 809 B. T.-H. Co. & Holbrook. Transformers.

31 833 Amberton & Bray. Loose-handle circuit-breakers, switches, &c

November 11, 1920.

31 869 Bosch (R.) Akt.-Ges. Dynamo-electric machines. (18/6/20, Germany.)

31 891 Davis & Dearle. Miners' electric safety lamps.

31 908 Stewart. Electrodes on plates for accumulators.

31 910 Weston. Rotary telephone number indicator.

31 929 B. T.-H. Co., Holbrook & Clinker. Transformers.

31 935 Faure-Bulle. Electro-magnetic clocks.

31 936 Faure-Bulle. Frames for electro-magnetic clocks.

31 943 Fairbrother. (Electric Tool Mfg. Co.) Non-arcing commutating switch.

31 956 Garman. Electric cooking, &c., apparatus.

31 964 Wade. (Buckman & Pritchard.) Insulators.

November 12, 1920.

31 991 Moore. Rotor conductors in squirrel-cage motors.

32 003 Danson. Trolley heads.

32 014 Naamlooze. Vennootschap Philips' Gloeilampenfabrieken Alternating current electric light installations. (5/12/19, Holland.)

32 034 Chloride Electrical Storage Co. (Smith.) Battery plates or electrodes.

32 039 Masterman & Rogers. Electrolytic apparatus for preparing hypochlorite solutions.

32 066 Oldham. Switches

November 13, 1920.

32 117 Lunitz. Electric heating of kettles, ovens, &c.

32 142 Bosch (R.) Akt. Ges. Magneto-electric ignition machines. (14/11/19, Germany.)

Companies' Reports, &c.

The directors of the American Telephone & Telegraph Company have authorised the issue of $90 000 000 additional capital stock.

The recent issue of 2 500 000 7½ per cent. cumulative preference shares of £1 each made at par by Brunner, Mond & Company, Ltd., was over-subscribed.

The directors of the Anglo-Argentine Tramways Company, Ltd., recommend a dividend of 5½ per cent. on the cumulative second preference shares, in satisfaction of arrears to Dec. 31, 1916.

The directors of the Anglo Argentine Tramways Company, Ltd., have declared a dividend of 5½ per cent. on the cumulative second preference shares out of profits for 1920, in satisfaction of the arrears to Dec. 31, 1916.

The following companies will be struck off the Register of Joint-Stock Companies unless cause to the contrary is shown before July 29 :- Electric Tramways of Ribeirao Preto Brazil, Midhurst and District Electric Supply Company, Trueman Engineering Supplies.

Sir Herbert Austin has announced that all the additional finance required to put the Austin Motor Company, Ltd., on a sound financial basis has been settled, subject to the approval of the creditors of the company. The loan has been privately arranged and there will be no public issue.

The net profit of the Ever Ready Company (Great Britain), Ltd., for the year to March 31, 1921, after writing off depreciation, was £21 100. The directors recommend final dividend of 2½ per cent. on the ordinary shares, carrying forward £953. The Company has acquired the lease of one of its factories at Stoke Newington.

The receipts of the Mackay Companies for the year to Feb. 1, 1921, from investments in other companies totalled $4 868 988. The dividends paid absorbed $4 230 330. Operating expenses, including Federal income tax, transfer agents, registrars, auditors and trustees' compensation, salaries, &c., totalled $535 400, leaving to be carried forward, $103 251. A contract has been signed with Messrs. Swan Hunter & Wigham Richardson for the construction of a new cable repairing steamer to replace present cable ship "Mackay-Bennett."

The 59th annual meeting of the London & Lancashire Insurance Company was held in Liverpool on the 27th ult. The report for the year shows that the fire premiums amounted to £3 668 249, the marine to £2 669 515 and the accident premiums to £1 746 672. The aggregate premiums for the year were £8 084 436. After writing off £500 000 to cover depreciation and paying a total dividend of 12s. per share (less tax) the balance of £979 419 was carried forward to the next account. The reserve funds of the Company now amount to £6 464 329.

At the meeting of the Bristol Tramways & Carriage Company last week it was reported that the revenue for 1920 was £920 744. Working and general expenses and renewals came to £958 884, and in view of the abnormal conditions £45 000 was transferred from reserve, so that with Excess Profits Duty repayable and amount brought forward, the balance available was £90 224. After paying interest on the 4 and 4½ per cent. mortgage debenture stock and bankers and loan interest (£37 497), a final dividend was declared on the ordinary shares at rate of 4 per cent., making 7 per cent. for the year, carrying forward £3,727.

The Pernambuco Tramways & Power Company announces that the State Government of Pernambuco has granted the company the right to increase tramway fares subject to the completion of the electrification of the 10 kilometres of the steam tramway and an extension of 6 kilometres of single track of the suburban electric lines. In order to repay temporary loans, to complete the tramways and to extend the lighting and power network, separate meetings of shareholders and debenture holders have been called to authorise the creation of prior lien debentures of £650 000.

The report of the Northern General Transport Company for 1920 states that the capital expenditure on motor omnibuses is £139 345, and the company possesses 102 motor vehicles. Traffic receipts (less working expenses), dividends and other revenues amounted to £52 335. After providing for administration expenses, deducting £2 290 for loan and debenture interest and providing £9 438 for renewals, there remains, with £12 231 brought forward, a sum of £48 422. The directors recommend placing to sinking fund for redemption of debenture stock £1 336 and payment of a dividend at rate of 10 per cent. for year on the ordinary shares, carrying forward £17 852.

The report of Siemens Brothers & Company, Ltd., for the year 1920 shows a profit of £253 254, plus £315 776 brought forward. The directors recommend a final dividend of 1s. per share (tax free), making 10 per cent. for the year, placing to a special surplus fund £30 000, and carrying forward (subject to excess profits duty for 1918, 1919 and 1920, and to corporation tax) £435 218. It is proposed to increase the share capital from £1 500 000 to £2 500 000 by the creation of 10 per cent. cumulative preference shares, to be issued when required, and to capitalise £300 000 surplus assets, to be distributed in the proportion of one 10 per cent. cumulative preference for every five shares held.

The total revenue of the Gateshead & District Tramways Company for the year 1920 was £125 238, and after deducting all expenses chargeable to revenue, including provision for renewals (£3 000), the balance is £31 866. With £3 659 brought forward, the available total is £35 525. The directors recommend that £215 be placed to reserve, £10 000 to special reserve, and £3 034 to sinking fund for redemption of mortgages, that the dividends on the 6 and 5 per cent. preference shares be paid, and that a dividend on the ordinary shares at the rate of 10 per cent. be declared, leaving to be carried forward £2 018. The expenditure on capital account during the year amounted to £22 721, making the entire capital outaly £362 926.

The report of the directors of the Anglo-American Telegraph Company, Ltd., for the year ended March 31, states that three quarterly interim dividends of 15s. per cent. on the ordinary stock and £1 10s. per cent. on the preferred stock, were paid in May, July and November, 1920, absorbing £157 500, and in February last the directors paid the final dividend for the year 1920, amounting to £1 10s. per cent. on the ordinary, the preferred and the deferred stock. These payments absorbed £262 500, being the rent paid by the Western Union Telegraph Company for the year, equal to 3¾ per cent. on the ordinary stock, 6 per cent. on the preferred and 1½ per cent. on the deferred stock. The balance at credit of revenue account (£72 157 15s. 2d.) includes £6 532 15s. 2d. interest received, and the balance of £65 625 is available for the payment of dividends for the quarter ended March 31, 1921.

Presiding over the meeting of the Northern General Transport Company, Ltd., last week, Mr. C. S. Hilton stated that they had a balance of £48 422 available for distribution. They proposed to place to the sinking fund for the redemption of first mortgage debenture stock £1 336, to pay a dividend of 6 per cent. on the preference shares and a dividend of 10 per cent. on the ordinary shares for the year, leaving £17 852 to be carried forward. The year's results of the three tramway companies in Gateshead, Tynemouth and Jarrow, in which they had a large interest, had been satisfactory. The dividends of 10 per cent. on the ordinary shares had been maintained in the cases of Gateshead and Tynemouth, but the Jarrow Company was paying 5 per cent., instead of 6 per cent. As the Bill of the Durham County Council for powers to construct 33 route miles of tramway and to operate 57 route miles of trackless trolley vehicles has been rejected it was now hoped that the local authorities would be less difficult in giving consent to opening new services, which were so urgently needed by the public.

The capital expended by the Potteries Electric Traction Company, Ltd., during 1920 amounted to £22 081, most of it in respect of the purchase of additional motor omnibuses. The revenue for the year was £299 929, the traffic and parcels receipts amounting to £280 632, or £28 194 over those of last year. The expenses increased by £44 261, due principally to increases in wages and to higher cost of fuel. After deducting all expenses chargeable to revenue, including £11 025 for debenture interest, and providing £15 000 for renewals, there remains £28 501, compared with £44 141 in 1919. With £12 082 brought forward, the balance available is £40 582. The directors recommend that £10 000 be placed to reserve, that a dividend at the rate of 5 per cent. per annum be paid on the preference and ordinary shares, leaving to be carried forward £6 082. The reserve now stands at £110 687 and the renewals fund at £71 319. As the increases in wages granted during the year were heavier than during any previous year, and as it was not possible to increase the revenue to the same extent, the balance available for distribution is consequently less. The traffic receipts for the current year were satisfactory until the mines closed down. Considerable competition with the regular services of the company is being experienced at present from motor vehicles, and steps are being taken to meet it.

The revenue of the Oldham, Ashton & Hyde Electric Tramway (Ltd.) for the year 1920 amounted to £62 072 and the expenditure (including £1 176 for debenture interest) to £50 572, leaving a net profit of £11 500, and with £5 987 3s. 3d. brought forward, the available balance is £17 487. The directors propose to place £6 000 to reserve, to pay the year's dividend on the 5 per cent. cumulative preference shares (£2 500) and a dividend on the ordinary shares at rate of 6 per cent. for the year (in respect of which an interim dividend for 6 months at rate of 5 per cent. per annum has been paid), absorbing £3 000, and leaving to be carried forward £5 987. The £29 400 first mortgage debentures have been paid off.

In regard to the abitration and legal proceedings to determine the price to be paid for the undertaking by the purchasing local authorities it is stated that the amount of the award (£142 174 and costs) was reduced by the court by £9 532 and a sum of £2 880 was referred back to the arbitrator for further analysis. In order to avoid further litigation, negotiations have taken place between the parties, and the local authorities have made a definite offer of £125 000 (in addition to the stores, which are to be valued at the time they are handed over) to settle all matters outstanding. The directors advise the shareholders to accept the offer. In addition to the £125 000 there will be available the value of the stores and certain other assets, against which there are law costs and other expenses to be defrayed. The amount that will ultimately be available for distribution cannot be definitely stated, but there will be a surplus for both classes of shareholders after repayment of the capital.

A long and interesting speech on the progress of the Calcutta Electric Supply Corporation, Ltd., was made by the chairman (Lord Meston of Agra and Dunottor) at the annual meeting on the 12th inst. During the year they sold nearly 39,000 000 units, against 32 000 000 in 1919. The increase was contributed to by every class of consumer; the supply of power for industrial purposes rose by nearly 20 per cent., and for private lighting and fans by nearly 25 per cent. When Calcutta was plunged in darkness by the strike of the gas works employees in October last their staff provided at the shortest notice lights at the principal cross-roads of the city and maintained them until the strike ended. The total expenditure for generation and distribution, including all overhead charges in India, was under 19 lacs of rupees, against 17½ lacs, or an increase of 9 per cent., due to the greater number of units generated and to the higher cost of coal, labour disputes, &c. Salaries had been revised and the staff, with hardly an exception, worked loyally and well.

Owing to the increasing expenses they had to advance the price of current by 15 per cent. from January 1 last. They hoped to modify and ultimately to abolish that surcharge when the general range of prices became more normal and their new capital became fully remunerative. The policy of reducing rates had been fully justified in the past and in their business the maxim of a large turnover and low profits would command approval. Last year the authorised capital was raised from £1 500 000 to £3 000 000, and there were hopes of a share issue to follow. A difference of opinion, however, arose among the shareholders; the moment for a successful issue was lost and they had to issue £500 000 first mortgage debentures. The proceeds had enabled them to push on with the provision of one 15 000 kW set and one 6 000 kW set with the necessary boilers and auxiliaries and transmission mains. The total capital expenditure in 1920 came to nearly £360 000. They had also to strengthen their boiler capacity, improve the distribution system, and to make a beginning in equipping themselves for the fresh demands that would inundate them when Calcutta returned to normal conditions of industrial development. After referring to the burden of taxation, he said they were paying 10 per cent. for the year, with a bonus of one per cent. They proposed to obtain £100 000 for extensions by means of an overdraft and thus provide the temporary financial support urgently required by the Company.

New Companies.

The following list is compiled from information supplied by Messrs. Jordan & Sons, Ltd., company registration agents, Chancery-lane, London, W.C.2 :—

CARSON & SONS, LTD. (174 435).—Reg. April 28, capital £500 in 500 shares of £1 each, to carry on business as consulting engineers. Directors: R. Carson and D. Carson. Reg. office: 1, Humber-place, Hull.

DUGUIDS, LTD. (174 506).—Reg. May 2, capital £5 000 in 5 000 ordinary shares of £1 each, to carry on business of merchants and manufacturers of scientific and engineering apparatus and appliances. Directors: S. N. Duguid, L. N. Duguid and A. H. Leeves. Reg. office: 7, Chapel Walks, Manchester.

POWER & LIGHTING SUPPLIES COMPANY, LTD. (174 477).—Capital £5 000 in 5 000 shares of £1 each, to acquire and carry on business of electrical and mechanical engineers. Directors: G. Rigby, H. C. Sowerby and J. Price. Reg. office: 5, Cathedral-yard, Manchester.

X-RAY TUBES, LTD. (174 544).—Reg. May 3, capital £1 000 in shares of £1 each, to carry on business as manufacturers, repairers and sellers of X-Ray tubes, &c. J. W. Mason, 11, Torrington-place, W.C.1, is managing director.

Prices of Metals, Chemicals, &c.

Tuesday, May 17.

		Price.	Inc.	Dec.
Copper—				
Best selected............	per ton	£73 10 0	£0 5 0	—
Electro Wirebars ...	,,	£75 0 0	£1 0 0	—
H.C. wire, basis	per lb.	0s. 11 9/16 d.	⅛d.	—
Sheet	,,	1s. 0¼d.	—	¼d.
Phosphor Bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. 3 9/16 d.	⅛d.	—
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1d.	—	—
Wire, basis	,,	1s. 1d.	—	—
Pig Iron—				
Cleveland Warrants .	per ton	£6 10 0	£0 5 0	—
Galvanised steel wire, basis 8 SWG	,,	£27 0 0	—	—
Lead Pig—				
English	,,	£24 10 0	—	£0 10 0
Foreign or Colonial ...	,,	£23 5 0	—	£0 15 0
Tin—				
Ingot	,,	£178 15 0	£2 10 0	—
Wire, basis	per lb.	2s. 5¼d.	¼d.	—

Salammoniac.—Per cwt. 75s.-70s.
Sulphur (Flowers).—Ton £13 10s.
,, (Roll-Brimstone).—Per ton £12 10s.
Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £30.
Boric Acid (Crystals).—Per ton £69.
Sodium Bichromate.—Per lb. 7½d.
Sodium Chlorate.—Per lb. 4¼d.

Rubber.—Para fine, 10¾d.; plantation 1st latex, 9¾d. lb.

The metal prices are supplied by British Insulated & Helsby Cables.

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Forty Years Ago.

(The Electrician, May 21, 1881.)

Society of Arts.—On Wednesday last Mr. Alexander Siemens read an excellent paper on the "Electrical Transmission of Power and Electrical Railways," discussion of which was adjourned to Wednesday, the 25th May.

Royal Society.—A paper was presented to this society on Thursday last by Mr. W. Crookes, F.R.S., "On Discontinuous Phosphorescent Spectra in High Vacua," and another by Prof. Hughes, F.R.S., on "Molecular Magnetism."

The Brush Light in the City.—The Brush system of electric lighting, extending from Blackfriars to King-street, Cheapside, which broke down last week owing to the defective insulation, was started again in the early part of this week, the fault having been remedied. We hope there will be no more breakdowns in the future.

Constancy of the Leclanché Cell.—A correspondent of "*L'Electricité*" says that he fitted up an electric bell for a retired invalid army colonel in December, 1876, using three Leclanché cells, and that, with the exception of refreshing each with 25 grammes of ammoniacal salt in 1878, he has not touched them, and that they are working well to this day.

Benn Brothers' Journals.

Some Features of the Current Issues.

"Cabinet Maker."—"The D.I.A. Exhibition at Camberwell": and "Practical Polishing."

"Chemical Age."—"Manufacture of Motor Spirit by the 'Cracking' Process"; and Reviews of New Chemical Works.

"Farm and Home."—"Agricultural Shows and the Strike"; "Imports of Farm Produce"; and "Tractors for Gardens and Orchards."

"The Fruit-Grower."—"Early Potato Prospects"; "Importance of the Hoe"; and "Some Growers' Problems."

"Gardening Illustrated."—"Manuring Fruit Trees"; "Moraine Gardening"; and "The Loganberry in Small Gardens."

"The Gas World."—"Examinations in Gas Fittings"; "Work of the Institution of Gas Engineers"; and "The Turbine Boiler Furnace."

"Hardware Trade Journal."—"India's Demand for Hardware"; "Recent Work in Nickel Plating"; and "Appliances used in Beekeeping (II.)."

Arrangements for the Week.

FRIDAY, May 20th (to-day).

Junior Institution of Engineers.

8 p.m. At Caxton Hall, London, S.W. Lecturette on "Liquid Fuel," by Mr. A. Arnold.

TUESDAY, May 24th.

Royal Photographical Society.

7 p.m. At 35, Russell-square, W.C. Discussion on "Illumination Problems in Kinematography," to be opened by Mr. J. C. Elvy.

WEDNESDAY, May 25th.

University of London.

5 p.m. At University College, Gower-street, London, W.C. Lecture on "Wireless Telegraphy and Telephony by Continuous Waves," by Prof. J. A. Fleming, F.R.S. (Lecture 4.)

Institution of Electrical Engineers, Wireless Section.

6 p.m. At the Institution of Mechanical Engineers, Storey's Gate, London, S.W. Discussion on "The Development of a Useful Transmission Formula for Long Distance Wireless Transmission," to be opened by Mr. C. F. Elwell.

THURSDAY, May 23th.

Institution of Electrical Engineers.

6 p.m. At Savoy-place, Victoria Embankment, London, W.C. Lecture on "A Physical Phenomenon and its Application to Telegraphy, Telephony, &c.," by Messrs. A. Johnsen and H. Rahbek.

Institution of Electrical Engineers' Benevolent Fund.

5.45 p.m. At Savoy-place, London, W.C. Annual General Meeting.

FRIDAY, May 27th.

Physical Society.

5 p.m. At University College, Gower-street, London, W.C. Papers to be read on "A Method for the Micro-analysis of Gases by the use of the Pirani Pressure Gauge," by the General Electric Company (communicated by Mr. C. C. Paterson, O.B.E.); "On the Reflection of the X-Ray Spectrum from Fluor-Spar," by Mr. H. Peeling, M.Sc.; "The Intensity of X-Rays Reflected by the Diamond," by Sir W. H. Bragg, F.R.S. Exhibits of Crystal Models and of Photographs by the Duc de Broglie of Cathode Ray Spectra attendant on the Production of X-Rays will be shown by the President.

Institution of Electrical Engineers.

6 p.m. At Storey's-gate, London, S.W. Lecture on "The World's Money System," by Mr. J. G. Graves.

Junior Institution of Engineers.

8 p.m. At Caxton Hall, London, S.W. "Notes on Electrical Transformer Breakdowns," by Mr. S. A. Stigant.

Royal Institution.

9 p.m. At Albemarle-street, Piccadilly, London, W. Discourse on "Elasticity," by Mr. A. Mallock, F.R.S.

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Notes.

The West Riding Inquiry.

THE report of the proceedings at the public inquiry into the schemes for the reorganisation of electricity supply in the West Riding (Aire and Calder) Electricity District shows that the Electricity Commissioners are proceeding in a thorough and business-like way with their investigations. Each of the three schemes submitted has received a careful and impartial scrutiny and, judging by the questions put to witnesses by the CHAIRMAN and by Sir HARRY HAWARD, the Commissioners realise exactly what the engineering and financial requirements of a sound scheme are. The Leeds project, which was considered first, is an individual effort and is not supported by any other local authority in the district. It envisages the formation of a Joint Electricity Authority, it is true, but it suggests that the financing of the scheme should be the responsibility of the Ministry of Transport for five years. The undertaking of the Yorkshire Electric Power Company would not be acquired, the underlying idea being that the suggested Joint Authority should work side by side with the Company for 42 years, the latter being of course eventually extinguished by the pressure of competition.

Timid and Selfish.

THE scheme, which seems to us to be both timid and selfish, proposes the erection of three capital stations—at Leeds, Wakefield and Knottingley, with Morley as a control station for the whole district. As usual, an attempt was made to show that the capital required would involve a charge upon the rates, but Sir JOHN SNELL, having had plenty of practice, soon demolished that argument. He pointed out that the estimated capital expenditure by the Authority was only about £6 000 000, and calculated that if the several undertakings in the area were to provide for their own extensions over £7 000 000 would have to be expended, so that the rates would benefit rather than suffer.

The Bradford Proposals.

UNDER the Bradford proposals, which involve the formation of a Joint Authority composed of municipal representatives and the immediate purchase of the Power Company, it is calculated that in the year 1926 there would be a surplus with an average revenue of 1d. per unit of £280 175, or more than sufficient to meet the capital charges on the purchase price of the Company. Under either scheme the risk of a charge upon the rates is a remote one; but, for the purpose of raising the necessary capital cheaply, the security of the rates is valuable and places local authorities in a favourable position in this respect. The Commissioners, who sat throughout the week, including Saturday morning, spent the week-end in visiting the suggested sites of the capital stations, so that it may be truly said that their examination of details was practical as well as theoretical.

Relativity in a New Aspect.

A PAPER recently read by Prof. H. E. ARMSTRONG before the Royal Society of Arts on "Relativity and the Problems of Coal" should be studied not only for its characteristic manner, but for the importance of its matter. The text of the paper is that we are using our coal neither economically nor efficiently, and that this policy shows us to be lacking in a sense of proportion and particularly in the faculty of proportionate judgment. Most of the paper is concerned with technical questions relating to the use of coal and to the production of gas and need not, therefore, be considered here, but some of the dicta which Prof. ARMSTRONG proclaims with pungent directness are worthy of the widest attention. It is only fair to point out that no one who fails to recognise the importance of coal in our present state of civilisation, or who has disagreed with Professor ARMSTRONG's outlook on things in general, escapes criticism. In developing his arguments Mr. H. G. WELLS, EINSTEIN, "The Times," GLADSTONE and a number of other lesser personages suffer under the flail of his mordant wit.

The Hour and the Man.

But amid many harsh words and amid a good deal of what in the lesser man we should call buffoonery, Prof. Armstrong does disclose the very root of the whole matter when he says that if we are sane reasoning beings we should regard coal as our most priceless possession, and that we do not do so because we lack recognition of essentials and because teaching is entirely in the hands of the learned who, as Hazlitt has told us, are necessarily ignorant. If we agree the only remedy is in our opinion a broad outlook on essential national problems by one man. It is said that the hour brings the man, but so far in our present hour of danger the man is to seek.

A Criminal Expenditure.

The question of the right use of our resources is not confined to coal, for, as Prof. Armstrong rightly points out, an even more urgent problem is the depletion of the stores of phosphate and potash. The time has now indeed come, if it is not already long past, when to expend our resources with the prodigality which has up to now been usual, is not only most unwise but is criminal. To discover the best means of carrying out a saner policy will require the close study of intellectual men so that true economy of our natural resources on which the well-being of the nation, no less than of the world, depends may be obtained. Unfortunately, the intellectual man is fast being taxed out of existence and the intellectual woman, we quote Prof. Armstrong's dicta in both instances, is seeking man's scalp in every direction, and is being forced out of her proper sphere by the chimera of education. But, however this may be, the problem in all its grave importance cannot be dealt with effectively by any one interest. Co-operation is so essential to success that there must be a combination of forces; and many heads now unwilling to approach must, as Prof. Armstrong says, be knocked together. This question has, of course, been raised before, and is being continuously raised. But although the reiteration may be tiresome it is its tiresomeness that will lead to something being done.

A Chance for Oil Fuel.

Like other pioneers we have argued in season and out of season that a better use should be made of our fuel resources. To do this always is important, and is particularly important at the present time when our supplies of home-grown coal are entirely cut off for an indefinite period. At the same time it is necessary to utter a note of warning against the revolution which, according to some people, may dawn any day as the result of substituting oil fuel for coal in our power stations and on our locomotives. This warning is made in spite of the fact that no less than 16 out of the 52 boilers which are necessary for operating the rush-hour traffic on the London Underground Railways have been changed over to oil firing and that in one or two cases, notably at the Greenwich power station of the London County Council tramways and at the power station of the Newcastle-on-Tyne tramways, the Wallsend-Howden low-pressure system of burning liquid fuel has been adopted. At Southend-on-Sea too the Scarab system of oil burning is in use. But all these interesting examples of ingenuity and enterprise are nothing but emergency methods, for the wide adoption of oil for coal in steam raising will be governed not by engineering difficulties, but purely by finance. It is not going too far to say that an increased demand for oil will be followed by a large increase in price (that is the way things work) so that when the present industrial troubles come to an end, it will still be found quite as, if not more, economical to use coal as other fuels. This result, however, does not preclude, but rather emphasises the need for a careful examination of all our methods of utilising fuel with a view to determining how best the resources at our disposal can be utilised.

The I.M.E.A. Convention.

The cancellation of the I.M.E.A. Convention owing to th coal dispute will be a great disappointment, not only to the delegates and members of the Association, but to that much wider body who find in this meeting almost the one opportunity during the year of coming face to face with those who would otherwise be but names and of discussing informally and unofficially those minor worries which often loom larger than do real difficulties. We say cancellation and not postponement, for we understand it will be impossible to arrange another "week" later on in the year and the best that can be hoped for is that the annual general meeting and annual dinner will be held in London next month. We hope, however, that an opportunity will be found for the delivery of the Presidential Address and for the release of the various Papers which were to be read, so that the authors may have an opportunity of putting their views before as wide a public as possible, if not of having them discussed. We commiserate most heartily with Major Richardson who for the second time has been prevented from presiding over the Convention. We understand that no decision has yet been come to with regard to holding the summer meeting of the Institution of Electrical Engineers, but we fear that the difficulties with regard to transport in Scotland may also render its cancellation necessary.

The Railways Bill.

Though the new Railways Bill, which proposes among numerous other things to group the railways of Great Britain into six main divisions by amalgamating the principal lines and absorbing the smaller ones, may not appear to possess any immediate interest for readers of The Electrician, the policy therein foreshadowed must have an important effect upon the transport facilities of the country and upon the efficiency of the railway services generally, though perhaps not the effect which the promoters of the Bill in their optimism suppose. As there is no section of the public so affected by these important questions as those engaged in the engineering industry, the proposals enshrined in the 75 clauses and 67 pages of the Bill merit careful consideration by them. As is well known, Government control of the railways ends in August next and legislation was therefore necessary to settle outstanding questions between the Government and the railway companies, and also to improve the existing railway organisation by abolishing competitive services.

Railway Rates.

To overcome certain difficulties with regard to rates disputes, a new Rates Tribunal is therefore to be set up, the Railway Commissioners, who have heretofore dealt with these matters, remaining as arbitrators for the Transport Ministry. The basis on which rates are to be fixed will be designed to secure for each company a standard revenue, based upon that which was obtained in 1913, together with 5 per cent. upon capital expenditure incurred during Government control, and a further allowance in respect of the capital expenditure not fully remunerative in 1913. Existing charges will continue, but it is proposed to review the rates annually for three years and subsequently at stated periods at the Minister's discretion. It is to be hoped that the new Tribunal will justify itself, but we are doubtful about it, and we are afraid it will soon settle down into the usual bureaucratic methods—standardised rates and stereotyped methods which Government departments are so fond of, a policy which, if carried to a logical conclusion, kills initiative and militates against progress, as we well know. However, it is to be hoped that the new Bill will form a way out of the present *impasse* regarding certain much required electrification schemes. There are two reasons for the present stagnation, one lack of money, the other doubt regarding the future. The Bill should at least remove the latter; and, with that removal make the obtaining of the former easier.

Light Railways.

IMPORTANT changes are proposed in the law relating to light railways. For various reasons, including the opposition of the railway companies and the conditions attached to the grant of financial assistance by the State, the Light Railways Acts have not been employed as extensively as was originally hoped. It is intended to abolish the Light Railway Commissioners and to transfer their powers to the Ministry of Transport. By the Ministry of Transport Act, of 1919, the Minister is empowered, with the consent of the Treasury, to make advances in aid of light railways without the restrictive conditions hitherto enforced. The financial clauses of the Light Railways Acts will, therefore, be repealed, and the provisions of the Ministry of Transport Act will replace them. Light railways will also be given power to charge rates 25 per cent. higher than those of standard railways, and will also be placed in a privileged position with regard to assessment. In this way it is hoped to revive interest in the construction of this type of communication, and so improve the transport facilities in rural and agricultural districts. Electrical engineers will be interested in this aspect of the question, as the majority of the new lines ought to be equipped electrically.

Steam Turbine Design.

IT is quite in accordance with the fitness of things that two very critical discussions on Mr. K. BAUMANN's Institution Paper on "Some Recent Developments in Large Steam Turbine Practice" should have taken place recently in Manchester and Newcastle respectively. For the latter city is not without strong claims to be termed the home of the steam turbine, as it was earlier the home of the locomotive, while Manchester is Mr. BAUMANN's spiritual home, and that we know, on the highest authority, is where a prophet's reputation reaches its nadir. If we interpret the object of Mr. BAUMANN's voluminous Paper aright, it is to lay all the cards of his wide experience on the table, explain the deficiencies in our knowledge and construction of steam turbines, and, setting down nought in malice, to disclose all the troubles, negligences and ignorances which beset that equipment—all this with the laudable object of providing a firm stage for future progress under both headings. This, we think, he has succeeded in doing, though, as Prof. STONEY pointed out, the Paper, if, indeed, that is its proper designation, does not lead itself to easy assimilation or discussion.

THE CHIEF CAUSE OF TURBINE TROUBLE.

If we were asked to state in one word the chief cause of the present troubles, we should say that the trend of the Paper itself and of the various discussions point definitely to that cause being vibration. In the case of single-flow turbines the movement towards larger capacities at a given speed has necessitated an increase in the peripheral speed of the cast wheels with a consequent increase in the stresses involved. Increased vibration is as obviously the result, and remains the root, of the majority of the present difficulties. If that were all it would be bad enough. For we know very little about vibration *per se*, and, as Prof. STONEY pointed out, the mathematical solutions of the phenomena are unsatisfactory. But, in addition, certain fundamental principles, not only in steam turbine construction but in good engineering practice, seem to have been neglected and more attention must be paid to such matters as the rigid bolting of condensers to the turbine, to the tendency towards the use of too fine clearances, to the cracking of the turbine discs from static stresses, to an uneven distribution of temperature, to the elimination of local high stresses at certain parts, and, generally, to a lack of flexibility not only in design but in construction.

PRESSURE AND VELOCITY.

Other questions are the changes which take place during running in both pressure and velocity, which factors, as Mr. GUYE said, are not operated at their full value, while, as Mr. DOWSON pointed out, steps must be taken to ensure that the present weak construction of many diaphragms is overcome so that the breakdowns which result from the danger of too high stresses may be avoided. In addition, there are such questions as corrosion and erosion arising from the modern use of high temperatures and pressures which require careful consideration, not only because of their theoretical interest, but of their increasingly practical importance in steam turbine design, construction and operation. A number of these minor points would, however, find their solutions during a close study of the whole of the phenomena of vibration, and the general question is, therefore, one which might be taken up not only by the makers themselves, but by some central body such as the B.E.A.M.A.

A LACK OF KNOWLEDGE OF FUNDAMENTALS.

All these points came out in the discussion, perhaps more by inference than in any direct way and are all subjects for future study. At present there is more than a little cloudiness of thought about them, possibly because so very little is known about the fundamental causes of much that occurs. Unfortunately, the breakdown is the best way of obtaining knowledge on these points, and, though we have often insisted on the usefulness of breakdowns in increasing our knowledge of obscure points, we shall not go so far as the Chinee, chronicled by LAMB, and we are sure both turbine constructors and users will be at one with us in our diffidence in this respect.

SPEED AND SIZE.

Two other important points which are closely related in turbine design and which emerged from the discussion are speed and size. The advantages of forcing up the speed above present limits are that smaller size machines can be used and the difficulties which attend the production of large forgings are thereby eliminated. On the other hand, to increase the speed very much above 3 000 revs. per min. for machines of an output of 12 000 to 15 000 kW will, it is feared, introduce difficulties not only from vibration but from other causes which would more than outweigh any advantages obtainable. This, then, is a question where compromise is once more the best policy. As regards size, the same argument applies. Envious glances are being cast in some quarters at the very large machines which are now being built and put to work in America, apparently on the principle that mere size is an advantage in itself. Apart from the fact that the construction of these large machines is attended by very great difficulties, as Mr. W. H. Patchell and Mr. S. L. Pearce have both shown, their operation is by no means reliable judged by standards in this country. It is also very much to be doubted whether their employment is economically desirable under the conditions which pertain over here. As Mr. J. N. Wayte rightly said, the maximum sizes for the generating unit employed should be such that, if the largest set breaks down, the load can be shared among the other sets.

We hope that this tendency will not develop with the establishment of capital stations. For reasons of space and efficiency in operation it would be, of course, undesirable to equip such stations with units as small as 5 000 kW. On the other hand, there is already talk of units of 50 000 kW, and, while the design and operation of such large machines will be the object of close study by designers in this country, especially to discover how the limitations imposed by turbine blade construction and mechanical stresses will be overcome, we do not suggest the adoption of such sizes over here even to the extent of following the American practice of constructing two or more separate machines which work together as a single operating unit. This type of construction has the advantage that it is not necessary to shut the whole of the machine down when repairs are necessary, while, at the same time, it allows larger units to be employed than could be produced on a single shaft. At the same time it does not get over the disadvantages of greater floor space and introduces switching and other operating and economic difficulties.

Our Real Requirements.

These are among the more important of the very important fundamental points which are raised by this interesting Paper and the equally interesting discussions. Turbine design, in our view, does not depend on whether the impulse or reaction turbine is the best for no general answer can be given to a question of that kind. The real problem is the determination at the most critical stage in the history of the steam turbine of the general principles of good design and the accumulation of well-sifted knowledge on fundamental phenomenon so that the turbine finally produced is, from both an economical and engineering point of view, most suited to what have been shown to be our requirements in this country.

London District Electricity Schemes.

When on the fourteenth of next month the Electricity Commissioners begin the inquiry into the present condition of electricity supply in the London and Home Counties Electricity District they will be confronted with four definite schemes, all of which have been propounded with a view to improving the existing organisation. The proposals in three of these schemes cover the whole district as provisionally determined. Even on this comparatively minor point, however, there is not absolute agreement. For the London Electricity Committee are not satisfied that the district as now delimited is the best and most economical that could be devised, and may ask for leave to introduce modifications at the inquiry. As regards the engineering details all three of the proposals are based on the technical schemes prepared by the consulting engineers of the London County Council, the Conference of Local Authorities and the Joint Committee respectively. Particulars of these were recently published in The Electrician and need not be referred to at the moment. The battle is therefore to be fought on administrative and political grounds, about which there is widespread disagreement.

Constitution of the Joint Authority.

This is evident when we say that, apart from the fact that each of the three schemes contemplates the formation of a Joint Electricity Authority, they bear little similarity to one another. In regard to the constituton, powers and duties of the suggested authority, its numbers and the mode of their election, as well as regards the important question of the financial provisions, there are obviously considerable differences of opinion and we are afraid it will take the Commissioners some time to reconcile such great divergencies and to evolve therefrom a scheme acceptable to all parties. It would not, of course, be difficult to find loopholes in the draft constitution of any of the proposed Joint Authorities, but as constructive effort and co-operation are vitally needed at present we propose to confine ourselves to a discussion of some of the more important general points and to suggest certain modifications solely in the interests of harmony and progress.

The L.C.C. Scheme.

To take the London County Council scheme first. This proposes an authority numbering 28 members, eight of whom would be representatives of the County Council, six would be drawn from the local authority and company undertakers respectively, four from the purchasing and other local authorities outside the County of London, two from the railways and large consumers and two from the workers in the industry. But as the chairman and vice-chairman may be appointed from outside the authority may consist of 30 members. On the other hand, the Conference of the Greater London Local Authorities suggest an authority numbering twenty-four, eight of whom would be elected by London local authority undertakers, four by local authority undertakers outside the County of London, three by the L.C.C., one by the City Corporation, two by local authorities in and two by local authorities outside London who are not undertakers, and four by company undertakers. As the chairman and vice-chairman need not be elected members and as the Minister of Transport may also appoint three members to represent the railways, large consumers and other interests including labour, the total of the Board may be as high as twenty-nine, a figure which is substantially the same as that proposed by the County Council.

A Bad Provision.

It seems to us unnecessary to give the Minister of Transport power to vary the constitution of the Authority. Another and very objectionable condition is that all municipal members of the Joint Authority must be members of the local authorities who have the right to elect. This provision will not make for either efficiency or progress, as the right type of man will not always be found by such a method of election, and it will also introduce party politics and other causes of friction which are certainly not required by a highly technical body like an Electricity Authority. We think it most desirable for the Authority to be able to elect or co-opt outside engineers and business men, that is men who take little interest in politics and who refuse to submit themselves to the trouble and worry of a contested municipal election. The fact that the chairman and vice-chairman in all three schemes need not be elected members of the Authority may, but will not necessarily, result in the introduction of one or two good men with commercial experience, but this is hardly enough. For if the political element is in the ascendant, as we fear it cannot fail to be, little can be expected from this small number. In our opinion at least one third of the Authority should be men with engineering or business training.

Representation Anomalies.

The London Joint Committee has adopted a peculiar method of constituting its Joint Authority. The L.C.C. is to be allowed five members, the City Corporation one, the local authorities outside London whose purchase rights have been transferred to the Authority two, the railway companies and large consumers three members, while there is an ambiguous provision for the representation of undertakers (whether they have agreed to transfer their undertakings or not) according to the number of units sold, companies and local authorities being treated alike in this respect. It is impossible to ascertain the aggregate of this Authority, but, apparently, the idea is to give those undertakers who have agreed to transfer their undertakings double the representation of those who decline to do so. The voting power of the members of the constituent committee is stated clearly enough, but it will necessitate the compilation of a register of voters, which may vary from month to month. There is no provision for electing representatives of Labour, an omission which can easily be rectified.

On the other hand, the members appointed to represent the railways, large consumers and Labour would, according to the Conference of Local Authorities, be appointed by the Minister of Transport and would number three. The London County Council proposes to authorise the Minister of Transport to appoint two representatives for the railway companies and large consumers and the Minister of Labour to appoint the two representatives of Labour. The London Joint Committee would give three members to the railways and large consumers (*i.e.*, those who use over 250 000 units a year), but apparently they would be elected by their own class. This seems to us the only equitable and proper method.

These are only a few of the points to which objection may be taken in what may be called the politics of the scheme, but as they are fundamental ones, affecting the constitution of the Authority, great care is necessary to define the basic principles on which such representation is made. There is, in fact, such a want of clarity and precision about the constitution of proposed Authorities that we wish the Electricity Commissioners could see their way to lay down for our guidance some general rules for the equitable representation of all interests on all such bodies.

The Payment of Members.

Another objectionable feature, not we hope introduced in emulation of another assembly, is the proposal to pay salaries to the Chairman and Vice-Chairman of the Joint Authority, and to the Chairman of any Committees that may be formed, though the L.C.C. confine payment to the Chairman of the Authority. A permanent chairman might be paid and reasonable personal expenses should be allowed to chairmen of committees and other members, but the proposal to create a number of paid appointments, apart from the technical and clerical staff, is to encourage the formation of a municipal bureaucracy which would add materially to the expenses of the ordinary administration and would also militate against progress.

An East London Electricity District.

The scheme of the Poplar Borough Council for the creation of a Joint Electricity Authority for East London also contains some curious provisions. The district will extend from Islington and Southwark on the west, to Tilbury, Orsett, Billericay, Gravesend Borough, the Northfleet and Dartford urban districts on the east. The Joint Authority will consist of 37 members, 32 of whom are to be representatives of local authorities. Twenty-two will be elected by authorised undertakers, seven by Councils having the right to purchase undertakings and three by County Councils. Large consumers will have three representatives and Labour two. But the Minister of Transport is to make these appointments! We are left in the dark as to the principle upon which the appointments are to be made by the Minister, though this is not the only obscure point in this wonderful scheme. For there is no provision for the representation of supply companies or of the railway companies. Each member of the Authority will have one vote in the case of authorised undertakers and an additional vote for each million units of electricity purchased from the Joint Authority in the preceding year. Apart from the County Councils there are about 40 local authorities in the area and the scheme will require amendment if only to avoid conflicts about representation. Drastic measures would, however, be the best way of dealing with it.

Extensive Powers of Authority.

The East London Joint Authority will, it is proposed, take over the powers of authorised distributors in areas without supply at present and will, if it is allowed, make regulations controlling the systems of distribution to be adopted and the method of charging employed. The purchase powers of local authorities are to be vested in the Authority and provision is to be made for giving supply in places contiguous to the proposed electricity district, to enable authorised undertakers to render mutual assistance. The prices to be charged for energy are to be sufficient to ensure that the income shall cover all expenditure, including interest and repayment of principal, and any deficit is to be met out of the succeeding year's revenue, thus avoiding a demand upon the district rates. It is proposed to obtain authority "to manufacture gas for the purpose of generating electricity, and for the construction, erection, maintenance, hire and sale of machinery, plant, electric lines, wires, lamps, &c., and for the supply of hot water and steam." These extraordinary and somewhat unusual powers will arouse a very strong opposition and will jeopardise the whole scheme, for we certainly do not require a sort of engineering Selfridge. This is also an objectionable feature of the scheme of the Conference of Local Authorities. Though the sale of electric fittings and apparatus may be allowed under limited conditions, the powers asked for seem to be too wide and are not, it seems to us, essential for the purposes of a Joint Electricity Authority.

System to be Adopted.

The system of supply proposed is to be three-phase alternating current, with a frequency of 50 cycles. The main primary transmission pressure will be 30 000 to 33 000 V between phases and the local secondary pressure 6 600 to 11 000 V. It is not proposed to discard any of the existing generating stations immediately, but a committee of the engineers of the participating undertakers will prepare technical and financial data on the whole subject. Existing stations are to be interconnected in groups and a new capital station at Dagenham, with an initial capacity of 100 000 kW and capable of extension to 400 000 kW, is proposed.

The Regulation of Synchronous Generators.

By A. G. WARREN, B.Sc., M.I.E.E.

(*Concluded from page* 583.)

POTIER'S METHOD.

The important feature of Potier's method is the manner of separation of the armature reaction and leakage reactance. In addition to the no-load characteristic, a curve is obtained connecting the terminal voltage and field current for constant full-load wattless current in the armature. Under these conditions the ohmic drop, being in quadrature with the reactive drop and the effect of armature reaction, contributes but a negligible amount to the total drop. The armature magnetomotive force is in direct opposition to the impressed magnetomotive force, and the latter must be increased by an amount equal to the armature reaction if the generated voltage is to be maintained. The reactive drop subtracts directly from the generated E.M.F. The characteristic for a constant wattless current is, therefore, identical in form with the no-load characteristic, but is displaced to the right by an amount equal to the armature reaction, and downwards by an amount equal to the reactive drop. QCK (Fig. 10) represents a curve so obtained. Each point on this curve such as C is derived from a corresponding point A on the open circuit characteristic by a constant vertical movement AD (the reactive drop) and a constant horizontal movement DC (the armature reaction). The fact that this curve when determined by experiment may be made to coincide reasonably well with the open circuit characteristic, by a movement which retains the axes in their original directions, is proof of the approximate accuracy of the assumptions underlying the method. The curves, therefore, when obtained enable the two components AD and DC to be determined with considerable accuracy.

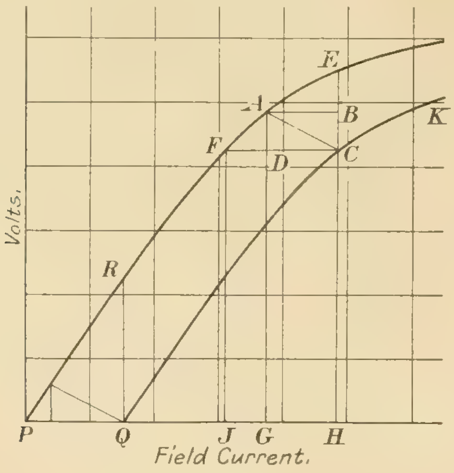


FIG. 10.

Before passing on to modifications of Potier's method we may notice how the various methods mentioned so far are illustrated by Fig. 10. Potier's method assumes that on wattless load with a field current, PH, which produces a voltage, HE, on open circuit, the drop, CE, is brought about by the effective field current first being reduced in value to PG, when the generated voltage becomes GA; in addition there is a reactive drop of AD, giving the terminal voltage as GD or HC. Both the synchronous impedance and magnetomotive force methods naturally give the same result for this case when the necessary quantities are deduced from the wattless full load current readings. The former method assumes that the fall of voltage is entirely due to a reactive drop, CE, the latter to an armature reaction, CF. The inapplicability of the values determined from the short-circuit test to this case is also clear from the diagram. The synchronous impedance method assumes that the drop is entirely due to reactance, and is constant; the value at short-circuit is QR, which is much greater than CE. The magnetomotive force method assumes that the drop is entirely due to armature reaction and is constant; the value at short-circuit is PQ, which is considerably less than CF. The pessimism of the former method and the optimism of the latter is thus shown clearly.

MODIFICATIONS OF POTIER'S METHOD.

The difficulties attending the experimental determination of the wattless characteristic, QCK (Fig. 10) over its whole range has resulted in many attempts to derive the leakage reactance and the armature reaction coefficient from more limited experimental data. So far the methods which the writer has met involve the determination of (*a*) the open circuit characteristic, (*b*) the excitation to give full load short-circuit current, (*c*) the voltage generated with this same excitation when a wattless current, less than the full-load current, is taken from the machine. Such data theoretically allow the coefficients to be determined completely. Methods of working out the coefficients (identical in principle) have been published by Blondel and Fischer-Hinnen. A little critical examination of the methods, however, reveals the fact that the particular data selected for the determination of the coefficients can afford but very inaccurate results. The only part of the magnetisation curve that is used during analysis is confined within a very small range near the origin. This part of the curve does not depart sensibly from a straight line. It has already been remarked that for an air core machine all methods would give identical results. Identical results are necessarily obtained so long as the magnetisation curve is rectilinear. If the curve were rectilinear over its whole range the coefficients would be indeterminate by any experimental method; only the combined effect of armature reaction and reactance could be measured. Under these circumstances their separation would be quite unnecessary. It follows, however, that if use is made of only the lower part of the open circuit characteristic, the separation of the two components can only be accomplished with very indifferent accuracy. The evil does not stop there; one may be easily lead into a false sense of security by the very difficulty of separating the components. It is readily imagined that since the same result is obtained if part of the armature reaction is attributed to reactance, or vice versa, that the exact division of the voltage drop into its separate components is of little importance. This is true for the lower part of the curve, but the machine is not used under these circumstances, but is used with the magnetic circuit approaching saturation. When the magnetisation curve has departed considerably from a straight line it is necessary for the separate components of the drop to be known with considerable accuracy. In addition, it must be remembered that the assumptions made, though reasonably accurate if applied under suitable conditions, are not rigidly true. Great accuracy, therefore, could not be expected if the coefficients are determined from data departing so far from normal working conditions.

FISCHER-HINNEN METHOD.

A brief consideration of the Fischer-Hinnen method, which is also representative of others of the class criticised, will show how difficult is the analysis of the drop into its separate components with any accuracy. Let OAK (Fig. 11) be the lower part of the open circuit characteristic, OQ being the field current giving a short-circuit armature current I_s. Suppose for the moment that the point A corresponding to Q (the lowest point of the wattless current characteristic of Fig. 10) be known. Then both AC and CQ would be determined, and the coefficients would be AC/I_s and CQ/I_s. Let the terminal voltage for some smaller wattless current I be V. Let I/I_s be equal to $QD/QC=QE/QA$, then for this smaller current, the effective reduction in field current due to armature reaction is QD, and the generated voltage is DK. The reactive drop is DE. Hence the terminal voltage V is equal to EK. Hence E is on the curve GEF, drawn a distance, V, below OAK. It is also on the curve, JEH, drawn so that $QE/QA=I/I_s$. E is determined by the intersection of these two curves; and so the position of A is found. For the curve shown in Fig. 11 there is no difficulty in determining A. But in actual practice OAK is nearly straight. Fig. 11 is redrawn in Fig. 12 for the actual alternator under consideration. The position of A in the figure has been fixed from a knowledge of the constants of the machine. It is clear that its position could not be determined for this machine by the method described. The slightest inaccuracy either in experiment or in draughtmanship would result in the curves FG and HJ not intersecting at all. Although this magnetisation curve is nearly straight, it is by no means uncommonly so, and the method is valueless unless a very heavy short circuit current is employed.

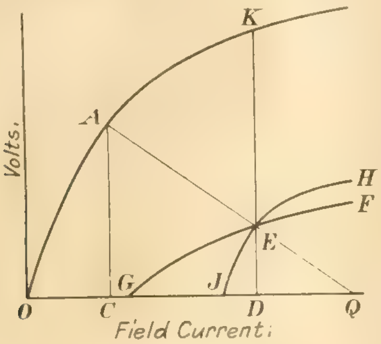


Fig. 11.

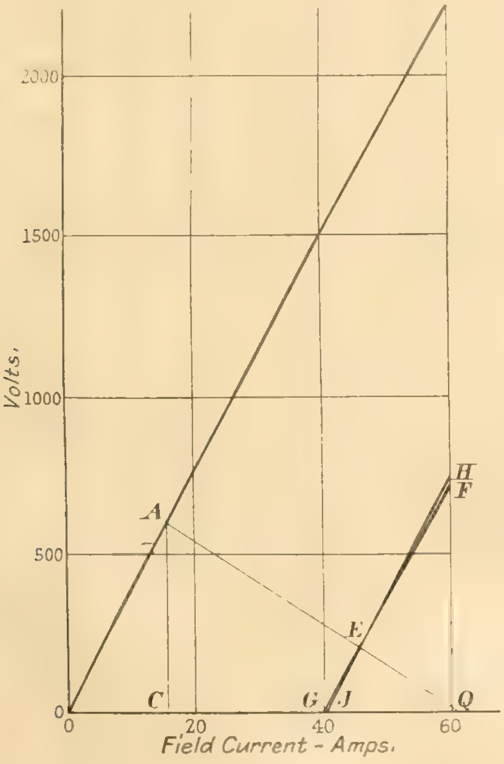


Fig. 12.

Such difficulties are entirely overcome if the wattless current test is carried out with the same *armature* current as was obtained in the short-circuit test, instead of with the same *field* current. The excitation is adjusted to about that corresponding to normal full load. It is clear that data obtained on this basis would be more likely to give results applicable in practice than data based upon measurements made far below saturation. Further it will be seen that small errors in experiment or in draughtmanship only affect the accuracy of the coefficients to a small degree.

The method employed by the writer is illustrated by Fig. 13. In addition to the no-load characteristic, the data employed are:—

Field current 60·7 A for short-circuit armature current of 300 A.
Field current 245 A for wattless armature current of 300 A at 4 950 V.

Suppose for the moment that the point A be known. On the wattless current test the effective reduction in field strength is $Q'C'=QC$, and the reactive drop is $C'A'=CA$. The terminal voltage V is therefore $A'U$. The point A' therefore lies on the curve $O'A'R$, exactly similar to OAU displaced to the right an amount $OO'=CC'$=the difference of the field currents in the two tests $(245-60{\cdot}7=184{\cdot}3)$; it also lies on the curve $SA'T$ exactly similar to OAU displaced downwards by an amount V. The point A' is thus determined by the intersection of two curves. Since the two parts of the magnetisation curve concerned are of very different slope there is no doubt about the point of intersection, and A' is determined with considerable accuracy. In this case $A'C'$=600 volts, whence the leakage reactance is 2 ohms, and $Q'C'$=45 amperes, whence the armature reaction coefficient is 0·15.

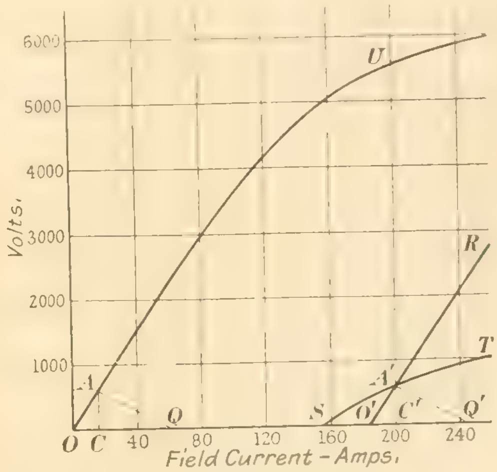


Fig. 13.

Greater accuracy of draughtmanship can be obtained by plotting only the part of the diagram centred round A'. For this purpose Table I. is prepared, as shown. One curve is then given by plotting column II. against column IV., the other by plotting column I. against column III. A large scale can be chosen, and we obtain Fig. 14. A comparison of results calculated by the various methods is given in Table II.; the regulation is defined as the percentage rise of voltage when a current of 300 A at 5 000 V is switched off. The

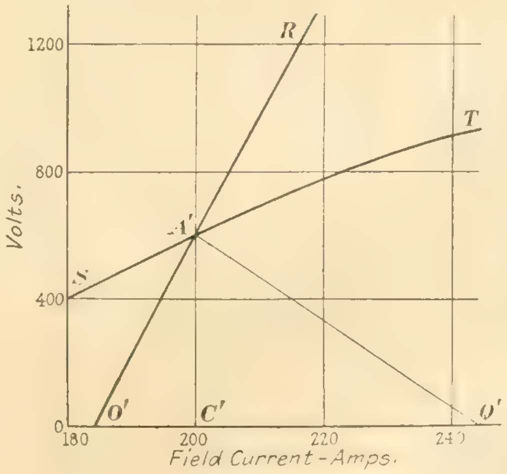


Fig. 14.

Table I.

No-load characteristic.		III. II.—4 950	IV. I. (245—60·7).
I. Field current.	II. Phase voltage.		
0	0	...	184·3
20	765	...	204·3
40	1 500	...	224·3
60	2 220	...	244·3
80	2 935	...	...
100	3 580	...	...
120	4 160	...	...
140	4 655	...	...
160	5 060	110	...
180	5 350	400	...
200	5 550	600	...
220	5 725	775	...
240	5 860	910	...
260	5 970	1 020	...

Table II.

Method.	Armature reaction coefficient.	Leakage reactance, ohms.	Percentage regulation.	
			P.F.=1.	*P.F.*=0·8.
Synchronous impedance —short-circuit (pessimistic method)	0	7·5	10·3	32·4
Synchronous impedance —wattless current......	0	3·13	2·46	12·8
Magnetomotive force—short-circuit (optimistic method)	0·202	0	4·4	14·0
Magnetomotive force—wattless current.........	0·303	0	7·5	17·5
Writer's modification of Potier's method	0·15	2·0	5·0	14·0

Table III.

No-load characteristic.		III. II.—800	IV. I.+80.
I. Field current.	II. Phase voltage.		
140	4 655	...	220
160	5 060	...	240
180	5 350	...	260
200	5 550	4 750	...
220	5 725	4 925	...
240	5 860	5 060	...
260	5 970	5 170	...

striking feature of this table is the accuracy of the magnetomotive force method under suitable circumstances.

Further Modification of Potier's Method.

One obvious criticism that may be directed at the writer's method is that it still makes use of the short-circuit condition, when the field is far below saturation. This is true, though it is believed that the accuracy of the method, apart from the accuracy resulting from the simplicity of analysing the experimental results, is far greater than any method which employs low saturation for both the experimental tests.

This criticism, however, does not apply to the following method. As before, two points on the wattless load curve are determined, one for an excitation rather above the normal and one for an excitation rather below. The coefficient of armature reaction and the leakage reactance are calculated from these determinations. The analysis of the results is effected in an exactly similar manner to that employed in the previous method. For the two tests the load current is maintained constant.

As before, let OAU (Fig. 15) be the open circuit characteristic. Suppose that when the field current is $F=PM$ the terminal voltage is $V=QM$. Suppose for the moment that the point A, corresponding to Q, be known. Let the field current be increased to $F+f=PN$, the terminal voltage consequently increasing to $V+v$. Since the armature current is maintained at the same value, both the reactive drop and the armature reaction are unaltered. The effective field current is PL and the generated voltage is LU. The reactive drop is $A'C'$, and therefore the terminal voltage is $LC'+A'U$. But $LC'=V$, and therefore $A'U=v$. A' is therefore on the curve $SA'T$ drawn v below OAU. It is also on the curve $O'A'R$ drawn to the right of OAU by an amount $CC'=QQ'=f$. The point A' is therefore determined by the intersection of two curves similar to OAU, one drawn an amount f to the right of OAU and one drawn an amount v below OAU. As before, a table may be employed and only the part of the diagram in the neighbourhood of A' plotted. The results used are :—

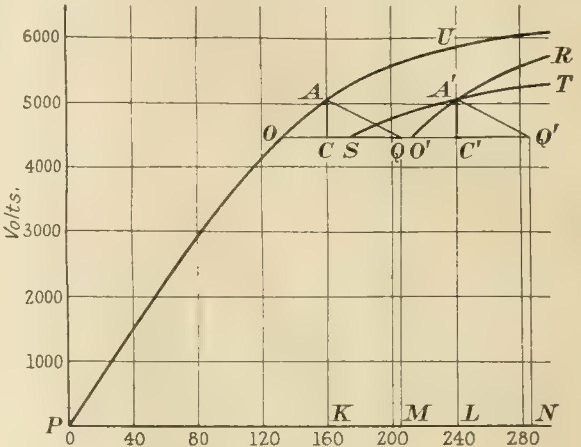


Fig. 15.

For a wattless current of 300 A the voltage is 4 460 when the field current is 205 A, and rises to 5 260 V when the field current is increased to 285 A. Here $f=80$ and $v=800$.

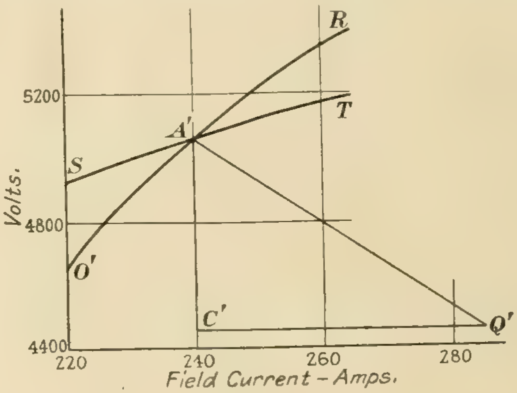


Fig. 16.

The curves are plotted in Fig. 16, and from them we obtain the same value of the armature reaction coefficient and of the reactance as were obtained previously.

Conclusion.

The tests outlined above enable both the armature reaction and the leakage reactance to be obtained with considerable accuracy on the assumption that these quantities are independent of the power factor of the load. For non-salient pole generators the assumption is perfectly justifiable. Even with salient pole generators the accuracy of the results obtained is often very good. Greater accuracy in the latter case can be obtained by splitting the armature reaction into two components.

In the case of singlephase machines it is doubtful whether such refinement justifies itself. For such machines the diagram given in Fig. 1 is correct, as far as it goes, but it only represents part of the facts. The armature reaction is not confined to a flux stationary with respect to the field system but also includes a transformer current in the field circuit, which reacts again on the armature circuit. It, therefore, has to be recognised that the theory on which the foregoing methods are based, though nearly true in most cases, is not complete. Attempts at extreme refinement may therefore be misplaced.

The Latest Bleriot "Phi" Starting and Lighting Equipment.

The design of the Bleriot Phi starting and lighting equipment for motor cars has been influenced solely by considerations of "performance" and a serious endeavour has been made to produce a system which will fulfill its purpose under the most arduous and varied conditions. The question of control of the dynamo output has, in particular, received very thorough attention, and, whilst additional apparatus has been incorporated, the results obtained fully justify the extra cost. In no case has any device been adopted which it has been thought would diminish the reliability of the equipment as a whole, or increase the amount of attention required to keep it in good order.

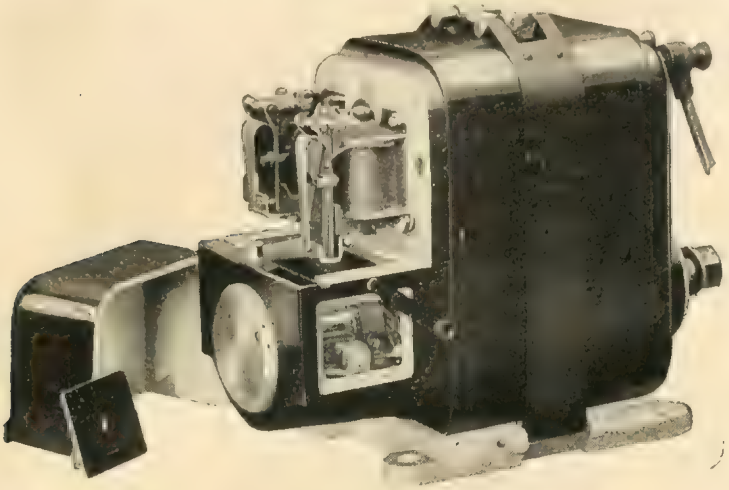


Fig. 1.—View of the Bleriot-Phi Dynamo.

The system is of the "two-unit" type, that is to say, the starting is performed by a specially designed motor, and a separate machine is provided for charging the accumulator. This arrangement has been adopted because, up to the present, the "single-unit" system has not been found very suitable for large engines, though, for light cars, it is most satisfactory. The Bleriot-Phi equipment is intended for the highest class of cars, which, as a rule, are fitted with large engines. In the following description, each part of an equipment will be described separately.

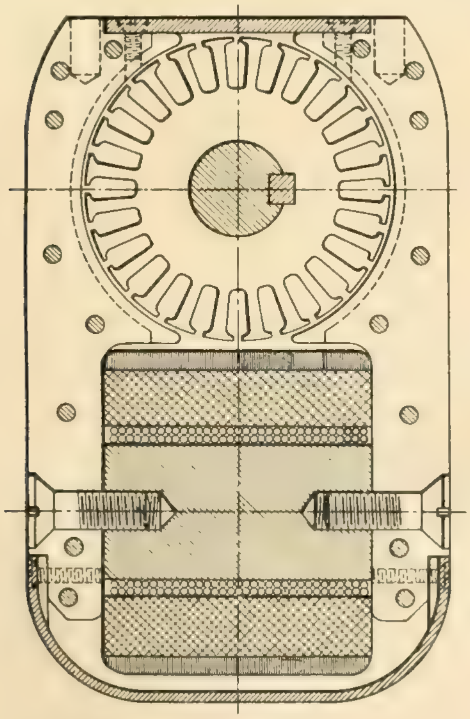


Fig. 2.—Section of the Bleriot-Phi Dynamo.

The "Bi-Compound" Dynamo.

This is a two-pole machine of very simple and robust construction, and is illustrated in Fig. 1. A section is shown in Fig. 2, from which it will be seen that only one field coil is used. The whole of the magnetic circuit, with the exception of the portion on which the excitation coils are wound, is built up of laminations. The armature is, of course, carried on ball bearings which are mounted in the end brackets. The usual type of carbon brush is used, and the gear is arranged so that a brush may be very readily renewed. The rectangular shape of the machine allows it to be fitted alongside the engine without inconvenience, and the height of the armature shaft above the base is such that the machine may be driven in tandem with the magneto.

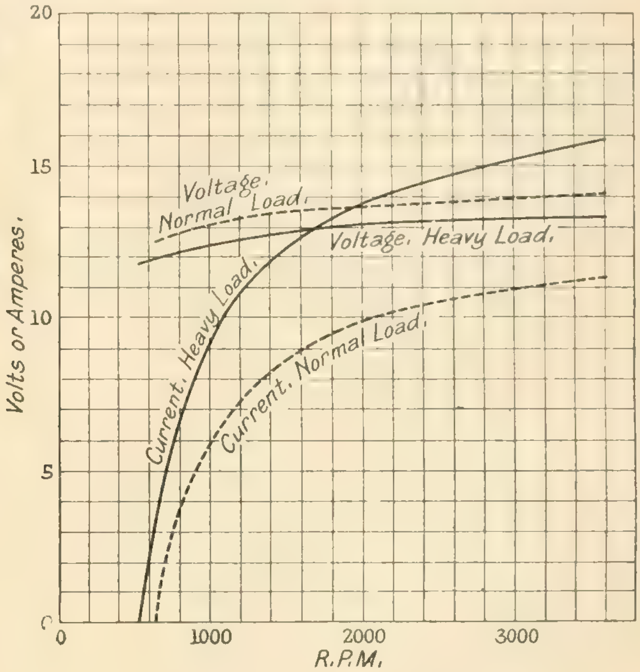


Fig. 3.—Performance of the Machine.

Control of Output.

The dynamo is primarily a compound-wound machine in which the series winding exerts a demagnetising action. If this were the only arrangement governing the output of the machine, a charging current would be given which had no definite relation to the state of the accumulator at any moment. The general result would be for a greater output to be given as the accumulator became charged, due to the increase in its voltage. This method of control is quite good within limits, but cannot be considered satisfactory for an

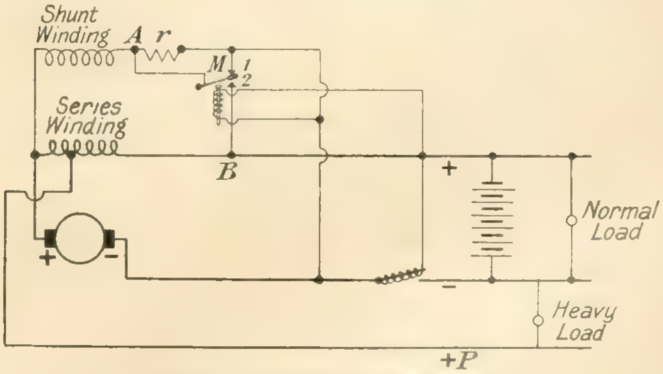


Fig. 4.—Circuit Arrangements.

equipment of the highest class. In order to improve the control, a voltage regulator of the vibrating type is fitted, the function of which is, of course, to introduce a resistance into the shunt excitation winding when the voltage of the machine rises above a certain value. This voltage regulator is adjusted to come into operation at 16 V.

The result is an arrangement whereby the dynamo output is controlled entirely by the demagnetising action of the series winding until the voltage rises to 16, beyond which value an appreciable increase in voltage, and hence of current, is not possible as the voltage regulator comes into action. In practice, when the dynamo is charging the accumulator, the series winding limits the current until charging is nearly complete, when the E.M.F. of the accumulator commences to rise rapidly and soon brings the voltage regulator into operation. This results in a gradual diminution of the charging current. By this means, the accumulator is fairly rapidly re-charged, but over-charging is prevented.

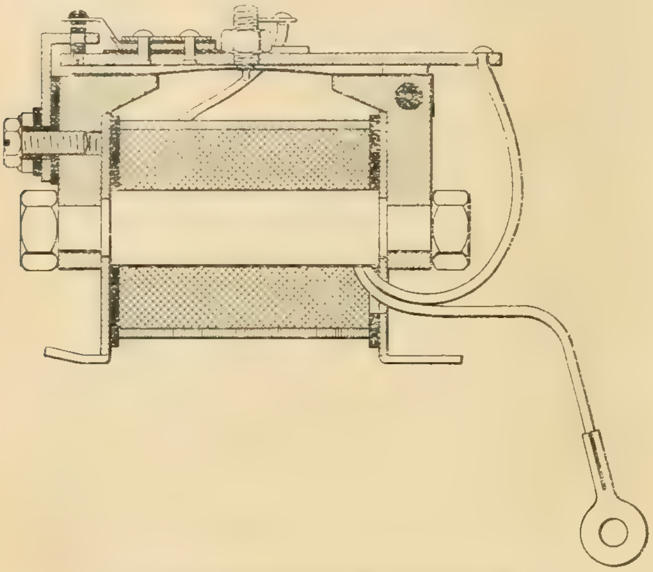


Fig. 5.—Section of Voltage Regulator.

Control for Auxiliary Apparatus.

In addition to the arrangement for limiting the output in accordance with the requirements of the accumulator, another control is introduced. It is frequently desired to use powerful headlamps, or some other devices, such as electrically-heated gloves, &c., which require a large current for their operation. This may result in the energy withdrawn from the accumulator exceeding that supplied to it by the dynamo, which is undersirable, as, sooner or later, the excessive demand will completely discharge the accumulator. In order to overcome this defect, a tapping is led off from a point on the series winding, and the circuits, whose demands are great, are supplied from this lead. The effect is to reduce the number of demagnetising series turns, and, as a result, to increase the output of the dynamo. The actual results obtained from a machine are well shown in Fig. 3.

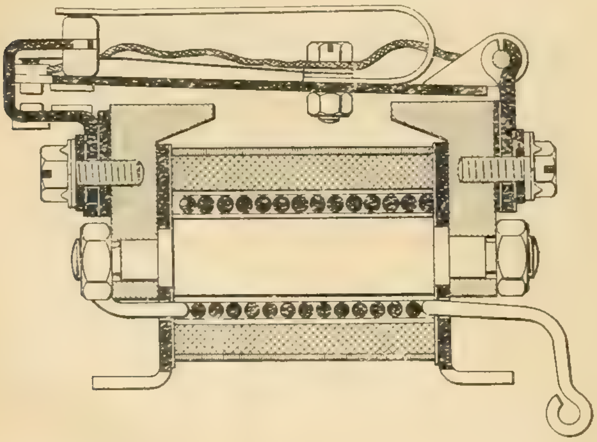


Fig. 6.—Section of the Cut-out.

Circuit Arrangements.

The arrangement of the circuit is shown in Fig. 4. A close examination of the diagram will show that the voltage regulator has two fixed contacts. In the normal position of the vibrating armature, the shunt resistance is, of course, short circuited. When the regulator commences to act, this resistance is intermittently inserted in the shunt field winding. If the voltage continues to rise, the armature makes connection with the lower contact, thereby placing the series and shunt field windings in parallel. This is practically equivalent to short-circuiting the shunt, and reduces the magnetisation of the field sufficiently to keep the voltage within the required limits, under the worst condition. The arrangement also reduces the sparking at the contacts to an insignificant amount.

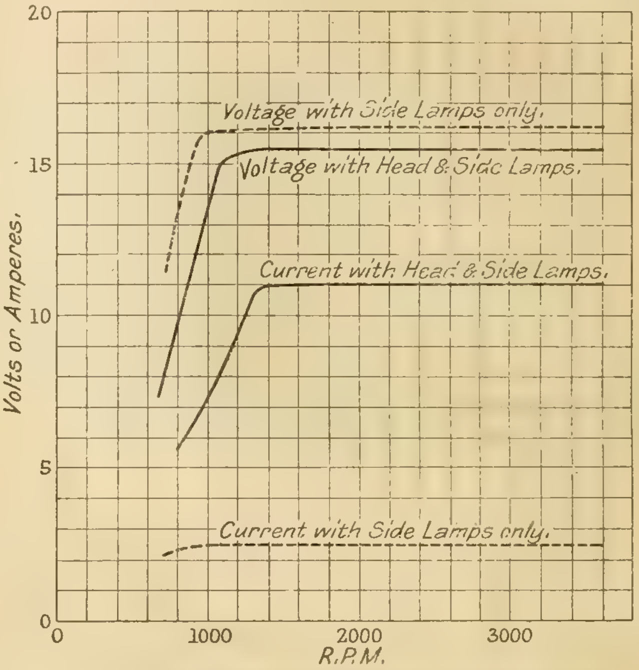


Fig. 7.—Voltage Regulation Curves at Various Loads.

The voltage regulator, a section of which is shown in Fig. 5, is mounted on the commutator end bracket, as also is the cut-out. Both will be seen in Fig. 1. The cut-out is the standard "Bleriot-Phi" compensated type, which was described in The Electrician of October 29, 1920. A section of the instrument is given in Fig. 6. The arrangement of the circuits and the method of control adopted fulfills the following requirements:—

1. The charging current is governed by the state of the battery at any moment, and over-charging cannot occur as the current is automatically reduced when the battery voltage exceeds a certain value.
2. The voltage regulation allows the lamps and other apparatus to be operated by the dynamo only, so that, even if the accumulator fail altogether, the lighting is still available. The curves given in Fig. 7 show how effective the voltage regulation is on widely different lamp loads without an accumulator in circuit.
3. The output of the dynamo is automatically increased when a heavy load comes on the system, thus guarding against the accumulator becoming discharged.
4. The location of the voltage regulator and cut-outs on the dynamo itself greatly simplifies the wiring.

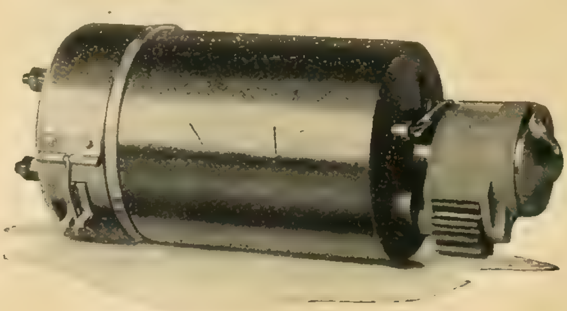


Fig. 8.—View of the Starter.

The "Bleriot-Phi" Dynamo is made in two sizes, the output data of which are given below.

Type.	Volts.	Output.	Cutting-in speed.
C.3	12	200 W	700 revs per min.
C.4.L.	12	150 W	470 revs. per min.

The type C.4.L. is specially suitable for driving in tandem with the magneto on six-cylinder engines. The height of the spindle centre is in all cases 45 mm.

DETAILS OF THE STARTER.

This is a separate machine, and is a simple series-wound motor built in a tubular yoke (*see* Fig. 8). The gear engaging mechanism is of the usual bendix type, which is so largely used. The armature is mounted on plain bearings, as the machine is in use for such short periods that lubrication presents no difficulty. The question of electrical-mechanical efficiency has received special attention, so that the starter is able to deal with a large engine without throwing excessive strain on the accumulator.

The following data refer to two sizes of machines :—

Type.	Diameter.	Torque.	Suitable for engines.
D.R.1	115 mm.=4·53″	230 in.-lbs.	Up to 3 litres capacity
D.R.2	130 mm.=5·12″	350 in.-lbs.	Over 3 litres capacity

THE SWITCHBOARD.

This instrument is the centre from which all lamps as well as the starter are controlled. It contains three switches, which operate the head lamps, the side lamps and tail lamp. All circuits are protected by fuses, and in the case of the head lamps, each lamp has a separate fuse. A centre zero ammeter of the moving-coil type is fitted to the front of the board, and indicates the charging current in one direction, and the lamp load, &c., in the opposite direction. There is no switch for controlling the dynamo circuit, as this is not necessary, owing to the automatic regulation of output. The starter is put into operation by a small push button switch, which closes the relay switch circuit. A plug circuit is provided on the board, so that a portable inspection lamp may be easily connected when required. The switchboard is illustrated in Fig. 9.

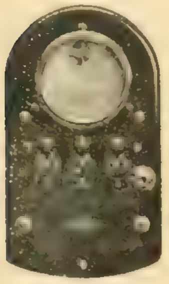


FIG. 9.—THE SWITCHBOARD.

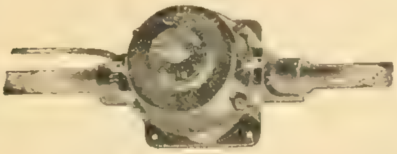


FIG. 10.—EXTERNAL VIEW OF SWITCH.

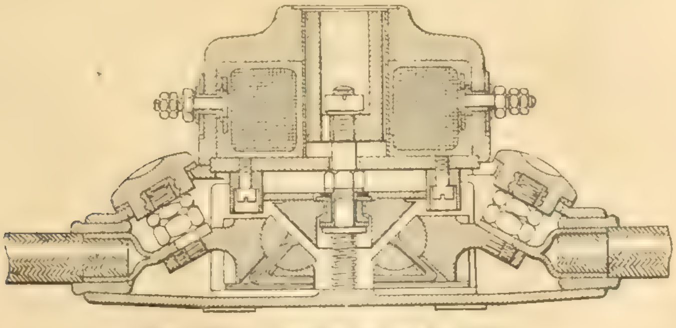


FIG. 10(*a*).—SECTION OF THE SWITCH.

RELAY SWITCH.

This switch, shown in section in Fig. 10(*a*), and an external view is given in Fig. 10, closes the starter circuit, and, as the current necessary to obtain the required torque is very considerable, the contact surfaces have to be large. It is, of course, very important that the voltage drop be as low as possible. The switch is operated by a solenoid, and the fixed contacts are self-adjusting, as they are bedded on hemi-spherical seatings. In this way any trouble due to defective alignment is entirely obviated, and intimate contact is obtained over a considerable area of the metallic surfaces. The main contacts are protected from pitting by subsidiary carbon sparking buttons. The relay switch is conveniently fitted to the chassis side member in a position directly between the starter and the accumulator. The amount of heavy cable is thus reduced to a minimum, as it is only necessary to connect the relay switch to the push button of the switchboard by small section leads.

WIRING.

The system is generally arranged for an "earth return," and, accordingly, only single-core cable is required. The advantage of "earth return" is that it allows better contacts and insulation to be used on bulb holders, lamp connections, &c. It is, however, very necessary to take special care with the insulation of the cables. A special type of covering has been developed which not only fulfills this condition, but also has a very pleasing appearance, and is much more durable than the usual metal armouring. The starter circuit does not employ an earth return, as the conductivity of the chassis cannot be relied upon for heavy currents where voltage drop is of the utmost importance.

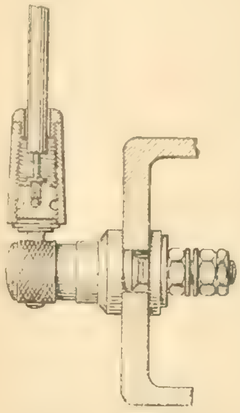


FIG. 11.—DIAGRAM OF CHASSIS TERMINAL CONNECTOR.

The lamps are connected up to independent terminals mounted on insulation and fixed to the frame or other convenient member. The terminals are of a suitable spring type, so that any lamp, together with its short length of lead, may be removed from the car without trouble. This arrangement obviates the use of adaptors, which are a source of frequent trouble, and the wire entering the lamp may be permanently connected to the bulb holder. A chassis terminal and connector is shown in Fig. 11.

Some Recent Developments in Steam Turbine Practice.

Mr. K. Baumann's Paper on "Some Recent Developments in Steam Turbine Practice" was recently discussed in Manchester. An abstract of the Paper was given in our issue of April 15, 1921.

A most appreciative reception was accorded the Paper, and those who took part in the subsequent discussion were unanimous in their tribute to the masterly treatment of the subject, the Paper being described as a worthy successor to Mr. Baumann's classical Paper to the Institution in 1912.

Prof. G. STONEY described the author's earlier Paper as epoch-making, and remarked that perhaps the term might, with even more justice, be applied to the present contribution. He said, however, that it was a Paper which did not lend itself easily to discussion. He considered Mr. Baumann quite right in his opinion that the critical speed should be about the running speed. He mentioned that he had plotted a curve for a period of 30 years showing steam pressures, size of turbines and temperatures of steam, all on ever-rising curves, with no signs of saturation and with the vacuum also improving. He considered the rule given with regard to the factor of safety to be good, remarking that what was really required was an easy way of measuring the elastic limit. The serious problem was vibration, and the mathematical solution was very difficult, and not very satisfactory. He suggested that the problem could probably only be tackled satisfactorily by a series of experiments in a bomb-proof chamber. These, he remarked, would necessarily be expensive, but perhaps a wealthy firm like Metropolitan-Vickers might be prepared to undertake them. Prof. Stoney exhibited a lead disc bent under stress in a manner which showed two nodal diameters. He had experimented, he said, with rubber discs of 7½ in. diameter, and had always found that they vibrated on two nodal diameters. He was surprised to note that Mr. Baumann said that there were ordinarily four nodal diameters in the vibration of the turbine discs. He considered the author was quite right in thinking there was a great future for the 3 000 revs. per min. turbine in big power schemes. It was much easier to make a small forging absolutely reliable than a large one, and higher class material could be used. The difficulty of making large forgings of high-grade steel was very great indeed. He had always considered that the impulse turbine would be much improved if the shrouding was not only riveted but also brazed on. A much more rigid connection would be made, and the damage to the shape of the blading would be infinitesimal if the work were properly done. The analysis given by the author of the results of variations of the economical rating under various conditions was most valuable and, so far as Prof. Stoney was aware, entirely new. With regard to the table of breakdowns, he considered that such candour of discussion was an excellent thing, and that freer discussion of difficulties and failures would make for more effective progress. The particulars shown in the table, he considered, should be taken as a caution against the danger of going to too high stresses, and that the disc must be made strong enough not to vibrate. In spite of what Mr. Baumann had said, he considered that many troubles might be avoided if two-cylinder designs were more largely adopted for very large sizes. For ordinary sizes leaving losses could very well be dealt with by Mr. Baumann's ingenious method of the multiple exhaust. This he considered was one of the most radical improvements of recent years.

Undesirable Modesty.

Mr. H. L. Guy said that in one respect the charge might be made that the author had dealt inadequately with part of his matter, that relating to the subject of multiple exhaust. While the motive which caused the author to pass lightly over the merits of this development of his own work might be applauded, he feared it might result in the principles and properties of that construction being too little understood. It was not clear from the brief description of the novel construction as to what happened to the inner tiers of blades at the low pressure end. The pressure and velocity changes which took place in the inner tiers of the multi-exhaust blading had obviously not been appreciated by some of those who took part in the discussion at London, and he would suggest that in his reply the author should publish a diagram showing these changes. The great advantage which resulted from employing the multi-exhaust construction was that it enabled one to employ a smaller mean diameter for the stages than could be employed by any alternative construction. From that fact followed a very large number of advantages which not only improved the efficiency of the machine, but very materially affected its speed and reliability. The remodelling of the Metropolitan-Vickers machines had made it possible to reduce the mean diameter by 25 per cent. in spite of the fact that the new machines could deal with output three times that of the old machines. In consequence, the blade stresses had been reduced by over 20 per cent. ; the stresses in the discs had been reduced to three-quarters, the stresses in the diaphragm blade were reduced to two-thirds, the deflections of the diaphragms, because of their much smaller diameter were easily reduced one-half, and it was now possible, because of the much smaller dimensions, to make in cast steel at reasonable cost many of the parts which had previously been made in cast iron. Higher temperatures could thus be handled and the discs, because of their smaller diameter, could be made so stiff that their first critical speed was appreciably above the running speed. There were nine counts at least upon which the reliability of the machine had been materially improved through this development.

Mr. Pearce's Experiences.

Mr. S. L. Pearce referred to his recent visit to the United States. He agreed with the author in appreciating the frankness of American engineers in disclosing their troubles. The growth in turbine size from 1912 to 1917 might be expressed as from 15 000 to 45 000 kW, but probably the latter figure was somewhat fictitious in view of the troubles and failures which had occurred, especially with large single-shaft machines. One could fairly say that the record of single-shaft machines in the States had not been altogether satisfactory. There had been too many wheel failures. He doubted whether, so far as the steam end was concerned, the author's " Proposed Practice for 1921 " would be followed. He wished to ask the author whether he agreed that for single-shaft machines the size limit was somewhere about 30 000 kW at 1 500 revs. per min. and 15 000 kW at 3 000 revs. per min. These sizes, he was confident, were safe if designed with the particular type of exhaust for which the author was responsible. Users and designers should frankly exchange views. The General Electric engineers believed that the thermal economies expected from the 30 000 kW Brush-Ljungström machine would not counterbalance the heavy cost of construction. The Westinghouse Company of Pittsburgh were responsible for many designs, chiefly in the reaction type, and he thought that they had been freer from trouble than the General Electric. On the problem of the elimination of corrosion, he thought the author was perhaps a little too optimistic. Total elimination of corrosion was practically impossible, and even a closed feed-water cycle was not a guarantee. He mentioned that the use of kerosene was first tried at Stuart-street, Manchester, but remarked that no credit was claimed for the original idea, as he believed it was taken from some German source. The Glasgow results given by the author were extremely valuable. If those could be obtained at Glasgow, he felt confident they were going to beat them at Barton. The broad conclusion he had come to on British and American practice was that the American manufacturers were not so advanced in development as British manufacturers. This had been the substance of his report on his return from the States. An eminent consulting engineer in America to whom he sent a copy had commented : " I agree with you entirely. I regret that I have to do so."

Prejudices Against High Speeds.

Mr. J. M. Newton said there was a prejudice amongst buyers against high speeds. For any given output, increase of speed would reduce the diameter, and if the same hydraulic efficiency of the blading were maintained the result would be a decrease in all the losses, mechanical leakage and disc friction. He found the higher percentage of scrap in manufacture of large forgings was a serious disadvantage, and he expressed strong preference for high-speed machines. He hoped one of the effects of this Paper would be to cut into the prejudice against running turbines at high speed. He suggested that probably 12 000 to 15 000 kW at 3,000 revs. per min. was ideal, except for the largest power stations.

Buyers and Multiple Exhausts.

Mr. H. M. Martin remarked that the multiple exhaust appealed very strongly to buyers, who would point to it almost before they had time to appreciate any other features of the machine.

Mr. G. A. Juhlin agreed with the author that there was no advantage on the electrical side in a high-speed turbo-alternator, but the advantage lay in increased economy on the turbine side. He said that it was a great achievement with regard to the electrical side that they could now ask the turbine engineer to follow the size of the alternator, as alternators could now be designed to absorb any output of steam turbines. He expressed his agreement with the author's statement of the advantage of an average factor of safety. That point was of considerable importance on the electrical side, where they had to deal with a highly tensile material such as nickel chrome-vanadium steel. When they considered that the elastic limit was somewhere about 115 000 lbs./sq. in., and the ultimate 145 000 lbs./sq. in., they would realise the advantage obtained by taking an average factor of safety rather than working on the old system of the elastic limit.

The Author's Reply.

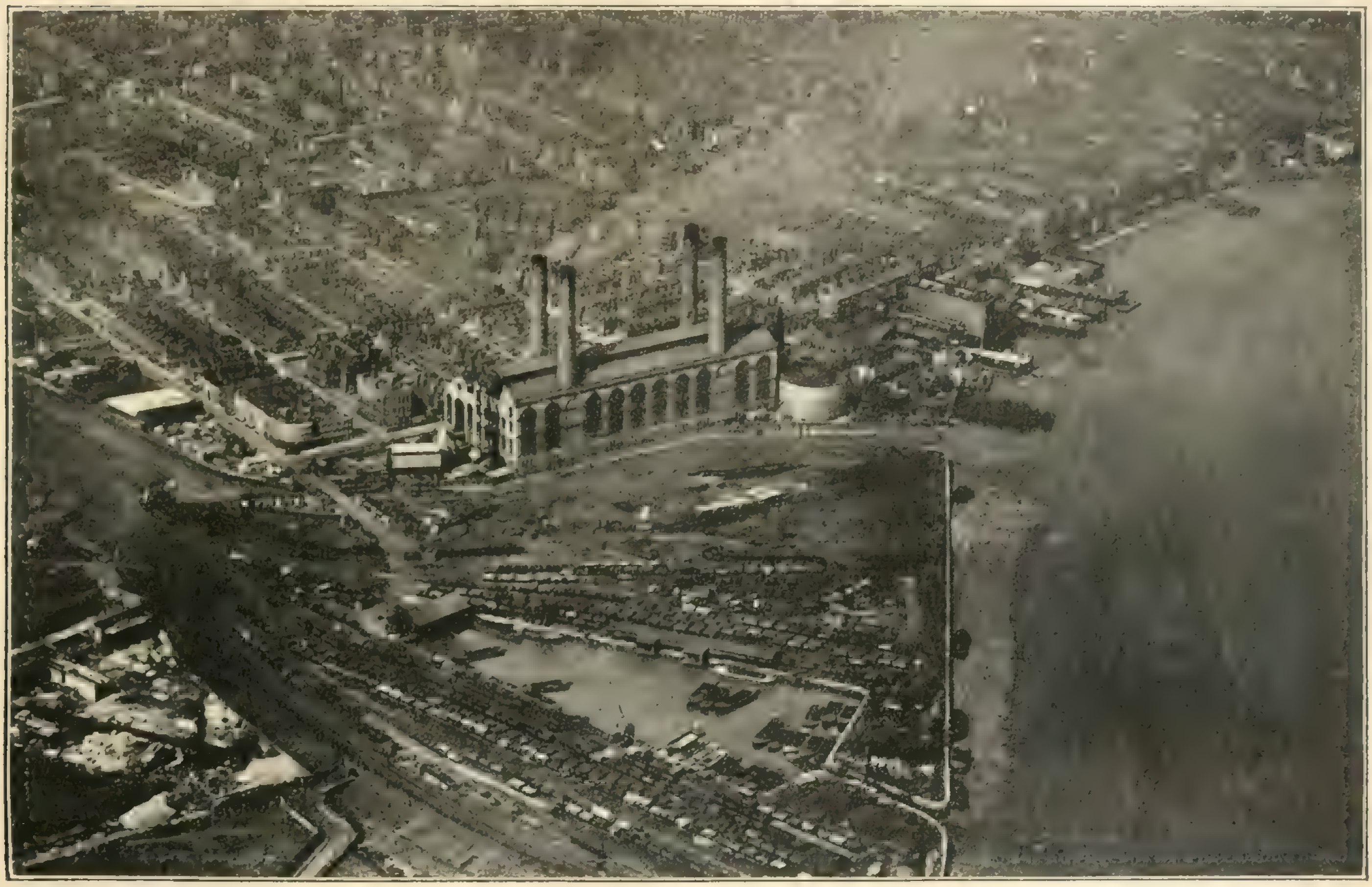
Mr. Baumann said, in reply to Prof. Stoney on the question of two or four nodal diameters, they had attempted to measure the small deflection of the disc, but so far had not been successful. The existence of four nodal diameters in disc vibration was given on what was probably the highest authority possible, that of Prof. Stodola. He agreed with Prof. Stoney on the possibilities of the two-cylinder design for large units, but did not consider that units were needed large enough for two-cylinder machines in this country. In reply to Mr. S. L. Pearce, the maximum output of single-cylinder construction should not be as high as 50,000 kW if that necessitated a speed of more than 2 000 revs. per min. He considered that future turbine development must be on the lines of increasing the output of the 1 500 revs. per min. machine. He agreed with Mr. Pearce that in the States, on account of the difficulties with impulse turbines, with large diameters and high peripheral speeds, there was a tendency towards reaction turbines made in two cylinders. He had endeavoured to explain in his Paper that single-cylinder turbines could be made which did not involve the use of large diameters. To the use of large diameters he attributed much of the trouble in the States, trouble not only from disc vibration, but also from large deflection. He felt absolutely confident that the right lines were being pursued in the machines being installed for the Barton power station. He agreed with Mr. Pearce that the question of corrosion was not a simple one, but he thought that the closed feed water design would go far to meet it. During the war Germany had been unable to get nickel steel for turbine construction, and had had to use mild steel for this purpose. Mr. Guy had recently had occasion to examine in Germany a turbine in which mild steel had been used for some considerable time, and they were surprised to find that it was all in perfect condition, the Germans responsible for that station having evidently realised that the highest possible degree of purity of feed water was absolutely essential.

Discussion in Newcastle.

Mr. Baumann's Paper was also discussed in Newcastle. We give an account of the remarks of the various speakers below.

Mr. F. W. Gardner considered the point of primary interest in the Paper to be its bearing on the old controversy of the relative merits of impulse and reaction turbines. The tables comparing the total kilowatts of the impulse and reaction turbines constructed within recent years tended to give the impression that there was a marked preference for the impulse type. In the section dealing with breakdowns there was no corresponding table of the failures of impulse turbines expressed as a percentage of the whole, but there was a whole catalogue of wrecked impulse turbines, in contrast to the few minor failures of reaction machines. The reason reaction turbines had not burst, like the impulse type, was simply because they had been able more than to hold their own, without resorting to the use of special steels and highly stressed rotors. The author apparently disliked the tandem turbine on the grounds of their lower efficiency and higher cost. When it was desired to increase the output at a given speed, beyond the maximum attainable, efficiently, with a single cylinder, the alternative to a tandem turbine with a two-flow two-pressure element would be the multi-exhaust type described. This multi-exhaust, however, would also add considerably to the length, weight, complexity and cost of the turbine. There was no evidence in the Paper to show that a multi-exhaust could be as effective as a two-flow tandem in keeping down the leaving losses. Moreover, when the turbine was working at outputs below the economical, the steam jets from the guide passages would strike the backs of the idle blades and would be turned through a negative angle, thus involving an additional loss from shock at entry. The multi-exhaust undoubtedly marked an advance upon a single blade exhaust, but more concrete evidence of its actual performances was required before the author's optimism as to its efficiency could be shared. Another advantage in favour of the tandem arrangement was where the practice of re-heating the steam at the stage where the initial superheat disappears was adopted as this involves withdrawing the whole of the steam from the turbine and then returning it for the remainder of the expansion. The turbine, therefore, became a two-cylinder design. Blade vibration was most effectively prevented by binding the blades together at frequent intervals along their length; this could be done without appreciable loss of efficiency in reaction blades, as with this type the velocity of the steam at the inlet edge was comparatively low. Also the spread of the blades at the tips could be made greater with reaction blading without serious loss of efficiency. The author naturally preferred to rely on test results obtained with commercial machines rather than on experimental turbines. This is sound, but the experimental turbine served a useful purpose, its function being to enable the effect of detail improvements to be predicted, rather than to afford direct criteria of the overall efficiencies obtainable in practice. With a small turbine in the maker's works, where the conditions were under full control and not subservient to the exigencies of commercial running, it was possible to exactly repeat the conditions for a succession of similar tests; this was invaluable for such purposes as the comparison of different blade profiles, blade spacings, clearances, &c. The author's work in establishing rules for the comparison of different machines on the basis of a commercial standard economic rating was interesting and instructive, but such investigations were limited in their practical application as they were necessarily based on some arbitrary assumptions, which, if not properly interpreted, lead to very misleading conclusions. Such laws as output varying as the root square of the back pressure and even the law of output varying inversely as the square of the speed were, at best, bold generalisations, and though they can be fairly substantiated in theoretical investigation, other factors were apt to creep in when considering actual design which might necessitate a modification of the results by an appreciable percentage.

"Lots Road" from the Air.



The Central Aerophoto Co., Ltd.

We are glad to be able to publish this "air view" of the well-known Lots Road Generating Station of the Underground Electric Railways of London. Not less striking than the station itself, with its smoke-tipped chimneys, are the rows of empty coal trucks in what we suppose is still called the foreground. These trucks are on the West London Extension Railway. Lots Road still seems to be getting some coal from the barges, or is it only dispensing with ashes?

The Operation Point of View.

Mr. J. N. Waite, speaking from the operation point of view, pointed out that although there was much to be said on the question of impulse versus reaction type turbines; neither type was immune from breakdown. The maximum size of turbine to be used must depend upon the size of the system on which it was to be installed. Breakdowns of plant could not be prevented, yet it was essential that the reliability of supply should be maintained. This could only be done by arranging for the maximum size of machine to be such that should the largest machine break down, its load could be shared between the overload capacity of the other machines. The author's suggestion that the tripping speed of large machines should be 15 per cent. above the normal speed was very good; the previously accepted value of 10 per cent. had, in the past, been found insufficient for reliability of supply. To give the figures for the maximum and economical ratings of turbines was useful, but the practical engineer would require to see their experimental confirmation before accepting them. If the turbine designer could give the efficiency rating of the machine, the operating engineer could readily determine for himself the economical rating. With regard to the by-passing of steam, to give overload capacity, this was not a good feature, but it must be borne in mind that a turbine was not designed to run on overload for any length of time, and this factor was not, therefore, of such importance.

Mr. A. Dowson remarked that the author's statement regarding the "race for the maximum output at the highest possible speed" did not apply to the progress of the reaction type of turbine, the designers of which had always considered reliability first and economy second. In the case of the machine for the Commonwealth Edison Company in Chicago, the reaction designers had adopted a speed of 750 revs. per min. and did not lower their factors of safety. The origin of the tandem turbine design was due more to the desire for reliability than for increased output, because although with the double ended cylinder and double exhaust the output was doubled, there was no increase in the stresses. In the discussion of the merits of different forms of blading, no mention was made of diaphragms. These were not desirable and were constructionally weak, forming one of the disadvantages of the impulse blading. In considering the relative values of increased fuel cost and decrease in prime cost, the calculations must be based upon some term of life, but no mention is made of this item. With the reaction type of turbine it was essential to by-pass steam to obtain overload capacity, but when considering this method it must be remembered that the H.P. cylinder of a reaction turbine was much less liable to distortion than would be the case with an impulse machine.

Dr. B. Morrow was surprised that no mention was made in the Paper of the Rankin cycle, although the Carnot cycle was referred to. He considered the Rankin cycle to be the more vital basis of comparison. The stresses in the discs of impulse turbines were sometimes very high, also the stress due to forcing the hub on to the shaft must have some effect on the disc and should, therefore, be taken into account.

Mr. R. M. Longman desired to know at what temperature and pressure there would be any danger of splitting up the steam and liberating hydrogen. If such action did occur, there would also be a liberation of oxygen which would rapidly attack the blading.

Mr. F. K. Skevington referred to the by-passing of steam with the reaction turbine and desired to correct the general impression that all the steam was passed to the second expansion when working with the by-pass open. Actually, only a quite small proportion of the steam was so by-passed.

Mr. K. Baumann (in reply) agreed that the list of troubles included few troubles with the reaction turbine, but pointed out that this was due to his interest being particularly in the impulse turbine, and did not signify that troubles did not occur with reaction turbines, about which he had not so much information available. The troubles with the impulse turbine were usually of a more serious character than those with the reaction turbine, but the object of the Paper was to show that these difficulties must be overcome. He particularly desired to warn turbine designers against large diameters and high peripheral speeds. The increased outputs must be obtained by other means without reducing the factors of safety. It might be necessary to use tandem turbines more frequently in the future, but it must not be forgotten that they had disadvantages and also entailed additional cost. Experimental turbines were necessary, but it was wrong practice, apart from being extremely difficult, to arrive at the efficiency of a 10 000 kW machine by measuring the efficiency of a 5 000 kW machine, as there were too many factors disturbing the blading efficiency. The lower efficiency on overload due to the by-passing of steam was not very important, but the liability to distortion was of first importance. In this connection it was more dangerous to by-pass steam in the impulse than the reaction turbine. The expression of "the race for maximum output at the highest possible speed" did not mean the highest possible peripheral speed, but rather the reverse. The multi-exhaust turbine was designed to utilise a higher vacuum at a reasonable cost, and not to increase the output of a machine at any particular speed, and was certainly less costly than a two-cylinder machine. In turbine work use was always made of feed heating, for which the Rankin cycle is not so applicable, and the efficiency was best given by considering the Carnot cycle. The stresses in the discs due to shrinking on the boss certainly had to be considered, but these stresses were not great and were considerably relieved when the machine was running.

The Royal Society Conversazione.

With a physiologist, Prof. Charles Sherrington, of Oxford, in the chair of the Royal Society, physical exhibits were rather less conspicuous at the conversazione held on Wednesday, May 11th, than they have been on recent occasions. It may, perhaps, be said in general that the many exhibitions of scientific apparatus, arranged during and after the war, somewhat impaired the interest in displays of scientific novelties by learned bodies when they were resumed after the war. We shall have to limit ourselves to matters physical.

The gravity torsion balance of Baron Eötvös, the veteran professor of the University of Budapest, which the Science Museum exhibited, was not the apparatus recently designed by Eötvös for demonstrating the loss in weight which a body undergoes when moving eastward, but an instrument (constructed by H. Süss, of Budapest) for determining the variation of gravity over comparatively short distances. The instrument, a doubly-jacketed (to keep out all disturbances) brass pillar, about 2 m. high, with a torsion wire 60 cm. in length for a weighted beam of 40 cm. length, has also been utilised in Hungary in the search for ore deposits.

The astronomical exhibits consisted of eclipse photographs, and diagrams of binary star orbits (from the Royal Observatory, Greenwich); spectra of Nova Cygni III., 1920; and sun spots drawings (Rev. A. L. Cortie, S. J. Stonyhurst); and an astronomical model to illustrate the motions of sun, earth and moon (Dr. William Wilson). Sir G. Hadcock and Sir G. Greenhill demonstrated collision and rebound between two steel spheres, each weighing 1 cwt., suspended on the Kelvin five-point system.

Sir Robert Hadfield exhibited the specimens and part of the apparatus used in the research on the influence of low temperatures upon the magnetic properties of nickel steels and manganese steels, which Prof. Kamerlingh Onnes (recently elected a foreign member of the Royal Society) and Dr. H. R. Woltjer had, in the Ergoscopic Laboratory, Leiden, tested at the lowest temperatures realisable with the aid of liquid helium, hydrogen and air. It was known that while nickel steels become more magnetic as they are cooled, some manganese steels remained non-magnetic in liquid air, and it has now been found that steels containing, say, more than 15·7 per cent. of manganese remain non-magnetic even in liquid helium—*i.e.*, at about 3°C. above absolute zero. The critical percentage varies with other conditions, but it seems that there exists a non-magnetic (or very faintly magnetic) compound of iron and manganese, in addition to a magnetic compound of the two elements. In estimating the specific magnetism of a specimen bar less than 2 in. long, Sir Robert suspended the bar by two threads from the ends of horizontal rod and approaches a horse-shoe magnet to the bar; he then slides the magnet up a path which is a graduated arc of a circle described about the rod. The bar adheres to the magnet until gravity overcomes the magnetic attraction.

The Hon. Sir Charles Parsons and Mr. Stanley Cook explained attempts made to reach high instantaneous pressures by the collapse of a hollow sphere of lead under explosive pressure. The substance to be compressed is placed in a hollow sphere, 1 in. internal diameter about $\frac{3}{4}$ in. wall thickness, which is built up of two hemispheres; a piece of paper is put between the hemispheres, which are then soldered round the joint. The sphere is placed in an explosion chamber, trinitrotoluene being packed all round the sphere. With the aid of wires entering the chamber, the T.N.T. is fired simultaneously at six spots. Under the pressure the lead spheres collapse, and are subsequently found practically filled with flown lead; but the paper prevents the welding up of the two hemispheres. If the final diameter left in nuclear form is 1/200 of the initial diameter, and the T.N.T. pressure 20 tons per square inch, the nuclear pressure produced is one million tons.

The portable cotton-sorting mechanism of Mr. Lawrence Balls, M.A., constructed by the Cambridge and Paul Instrument Company for the experimental department of the Fine Cotton Spinners' Association, Manchester, analyses a collection of fibres such as cotton hairs by distributing them on a collecting surface in the order of their lengths, so that the frequency distribution can be plotted. The portable pattern of the machine exhibited was re-designed for the use of cotton growers and experimental stations abroad. The machine is not electrical, and the sorting mechanism is based upon the observation that the traverse motion along the axial line is almost the only motion not given to rollers in spinning mills. The instrument consists of a small sledge body, sliding and also rolling on two rear wheels along a 6 ft. strip of black plush; with the aid of a number of hand-operated draw boxes and rollers the fibres are arranged and fed out; the short hairs are at once held by the plush, the longer ones are not so quickly retained, and thus little heaps are formed, which are brushed off with the finger (moved in the direction of the pile, the traversing having been in the opposite direction), and weighed on a scale. 10,000 hairs would weigh about 50 milligrams. The inventor himself finds the chief defect of his machine in the fact that a "sliver" of parallel straight hairs has first to be prepared.

The Cambridge & Paul Instrument Company itself exhibited Mr. Takeo Shimizu's clever modification of the C. T. R. Wilson cloud-expansion apparatus for watching the disintegration of radio-active bodies and observing the individual tracks of the rays which was mentioned in our recent notice[*] of Sir E. Rutherford's lectures on "Electricity and Matter"; we reserve illustrated description of this novelty.

The Needham pulsator system of speed measurement and control of Messrs. Evershed and Vignoles was noticed by us last February in connection with the Exhibition of the Physical and Optical Societies[†]; it is found especially convenient for use on board ship. The Freeman precision automatic temperature control of the British Oil & Fuel Conservation, Ltd., of 9, Southampton-street, W.C.1, was also shown then. The control is effected by regulating the supply of gas or the position of the furnace dampers, &c. An air bubble is enclosed within the furnace, but remains disconnected during heating up to the desired temperature; the air bulb communicates with a U-tube, mounted almost horizontally, so that a slight change in the air volume produces a large shift of the mercury thread in the U-tube; a wire in the mercury controls the operating solenoid. High constancy of temperature is very desirable for oil distillation.

Several departments of the National Physical Laboratory were represented. Dr. Guy Barr exhibited his relay for breaking moderately-large currents between mercury electrodes in a hydrogen atmosphere; the apparatus was discussed by the Physical Society last November. On a surface of mercury, contained within the core of a solenoid, floats an iron rod supporting a silica cup also containing mercury; the terminals lead to the two masses of mercury. When the solenoid pulls the iron and cup down, the circuit is complete; when the silica cup emerges from the pool, the contact is broken by the silica cup; the spark is made in hydrogen which does not maintain an arc, so that the spark is quenched; currents of 20 A at 200 V do not contaminate the mercury.

The new Standard Optical Pyrometer of Dr. G. W. C. Kaye and Dr. Ezer Griffiths is based upon the principle of the disappearing filament, first utilised by Holborn and Kurlbaum in the 'nineties at the Reichsanstalt in the course of the researches on black-body radiations, and subsequently applied in the Nela Institute. In the telescopic arrangement exhibited the body to be examined is behind the collimator; between the collimator and the telescope is a cross slide by the aid of which one of two standard lamps is brought into position; the eye-piece contains a red glass, and the observer, by adjusting a sliding resistance, varies the current through the standard filament until the image of this filament, which will at first appear brighter or less bright than the image of the source under test, can no longer be distinguished from the other image upon which it is superposed. The filament is horizontal and provided with a kink to make it more conspicuous; two quickly interchangeable lamps, each readily adjustable in three planes, are used in order to check the calibration.

The various hygrometers of Dr. E. Griffiths and Mr. F. H. Schofield are specially designed for cold-storage work and partly for observation from distant points. There was, *e.g.*, a hair hygrometer, the pointer of which moves up and down in front of a drum which is a resistance coil; when a push-button is depressed, the pointer is horizontally pressed against the coil, and a reading is obtained on the Wheatstone bridge in circuit.

In the aspiration instrument a current of air is drawn past the wet-bulb and dry-bulb thermometers mounted by the side of one another in a tube, when the fan is driven by the small electric motor fixed to the upper end of the tube. To observe the dew point near a cold body the end of a simple telescope is brought up to the body; a mirror near that end then covers itself with a film of moisture.

Specimens of "Omal," the new manganin alloy of copper, manganese and nickel, entirely made in the National Physical Laboratory, illustrating the manufacture and uses of Omal, were exhibited by Dr. W. Rosenhain and Messrs. S. W. Melsom, S. L. Archbutt and H. C. Booth. The alloy is made in two types, having resistivities of 45 and 35 microhms per centimeter respectively; it was shown in ingots and stout bars, as well as in rolled strip and drawn out to wires. Within a limited range the resistance change does not exceed 1 : 1 000 000 per degree C. No. 16 Omal wire is used in the 0·01 ohm Standard Resistance for currents of 200 A. These wires are very openly wound on a skeleton framing, the whole element fitting into the cylindrical opening of a metal box, about 16 in. by 14 in., in which water-cooled oil is kept stirred by an electric motor. The soft-solder joints are not imbedded in the resistance element, and the potentiometer leads are taken off the terminal copper bars. The report on the temperature coefficients of these alloys, their constancy and secular changes will be of considerable interest.

In the last exhibit of the Laboratory, the radiotelegraphic direction finder (of the Robinson type), exhibited by Mr. R. L. Rose-Smith, the direction of the source is not found in the usual way by determining the two positions of a receiving coil for which the signals have equal intensity. Two rectangular box coils, of the same height, but of different lengths, are used in combination with a tuning condenser and amplifier; the coils are always at right angles to one another and turn about their common vertical axis; by means of a switch the connections in one of the coils are reversed, and when this reversal does not affect the signal intensity, the long coil (5 ft. long, 2½ ft. high, about) will be in the plane of the source. This position can be ascertained within 0·5 deg. Unfortunately the precision of the instrument exceeds that of determining the true bearing. By experimenting with stations of known bearings it has been found that the indicated bearing may differ by several degrees from the true bearing, especially at sunset and sunrise and during the night. To investigate the cause of these discrepancies, instruments of this kind have been installed at the universities in about a dozen stations. It will be understood that this instrument does not indicate whether the source is in front or behind; to ascertain that two or more stations are required.

The Radiological Branch of the Royal Arsenal Research Department, Woolwich, explained by photographs the measures adopted for the protection of the investigators when examining large metal objects and various materials, *e.g.*, a howitzer recuperator body. The pin-hole photographs displayed illustrated the changes in the focal spots and in the radiations from different parts of the target which take place when the currents are raised from 2 mA to 4 and 8 mA and higher. To keep the focal spot constant, small bulbs of the Coolidge radiator type are recommended. There were no X-ray bulb demonstrations at the Conversazione.

The Western Electric Company, Ltd., of Norfolk House, W.C.2, exhibited various telephone transmission measuring apparatus. The portable high-frequency bridge set is designed to give instantaneous readings at any frequency of the capacity of a cable already installed; the line impedance bridge determines the resistance and reactance components of the line impedance; the transmission-gain measuring set indicates the losses and gains in transmission due to the addition of special apparatus and of amplifier valves. In the variable frequency oscillator the valves are arranged for the frequency range of normal voice currents, from 200 up to about 2 000 cycles per second. The output of 20 mA is said to be uniform at all frequencies, and the wave form pure, owing to the use of "a filter" (variable inductance and capacity) to cut out the harmonics; the first of the three valves serves as oscillator, the others act as amplifiers.

The recording kata-thermometer of Dr. Leonard Hill indicates the cooling power which the environment exerts on the surface of the thermometer bulb which is automatically kept at skin temperature. Our sense of warmth and cold depends more upon that cooling power than upon the actual temperature. The kata is filled with alcohol and contains a coil of wire of a high temperature coefficient; this coil forms the arm of a bridge balanced for a coil temperature of 36·5°C.; an ammeter in series to the coil indicates the current needed to keep the coil at this temperature, and thus the cooling power. The instrument is made by the Cambridge and Paul Instrument Company, New Southgate, N.

The liquid oxygen vaporiser of Mr. E. A. Griffiths is a vacuum flask of copper containing 3 lb. of liquid oxygen, the emission of which is regulated by means of a diaphragm and screw. The bottom of the outer vessel is a corrugated diaphragm of silver to which a block of copper is soldered fitting the bottom of the vessel; when an increased rate of oxygen supply is desired (up to 10 litres per minute), the diaphragm is pressed by the screw into closer contact with the jar, so that more heat is transmitted. The apparatus was designed with the aid of the Tyndale Mining Research Studentship of the Royal Society.

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[*] See The Electrician, April 15, 1921, p. 457.

[†] See The Electrician, February 18, 1921, p. 228.

The gas-storage system of Mr. Franklin Kidd, of the Food Investigation Board, is to keep English apples fresh during the winter, not by cold storage, but, at less expense, by storing them in an air-tight chamber in the gas produced by their own respiratory activity, without machinery. Moisture and carbon dioxide collect in that chamber, and are circulated by the variations of the external temperature in an external pipe joining the top and bottom of the chamber; the condensing moisture is trapped, and the CO_2 percentage, determined at intervals by electric means, is diminished if necessary by admitting air into the chamber.

Of the many varied other exhibits we can only mention one of the most interesting and promising, the Microscope for Ultra-violet Lights of Mr. J. E. Barnard, of the National Medical Institute, Hampstead. The arrangement is expensive; it involves the use of quartz and fluorspar lenses and prisms, of a Chance Brothers light filter transparent to waves of 300 to 400 $\mu\mu$, and of a quartz cell. But this illumination transforms every point of the object into a fluorescent self-luminous object, and a remarkably clear definition is obtained.

Semi-Automatic Induction-Generator Plants.*

By L. J. Moore.

The use of induction generators for automatic stations has been much discussed, but few have been installed. The two plants now described were placed in operation early in 1919 by the San Joaquin Light & Power Corporation, and the plants have been in operation several months with gratifying results.

The plants are known as power house 1-A and Crane Valley power house respectively. The former has the greater amount of control apparatus, consisting chiefly of float control to permit full usage of water, apparatus for automatically disconnecting the machines in case of line short circuit or de-energising of lines, and arrangements to prevent serious pipe vibration. The generator in power house 1-A is a 42 kVA, 6 600 volt, 245 revs. per min. induction machine, driven by a 600 h.p., 39 ft. head, end-inlet, double discharge Francis type turbine. Power is transmitted at the generating voltage a distance of about 4,400 ft. to power house No. 1, where it is stepped down to 2,300 volts and connected to the main busbars of this plant.

Control Arrangements.

The gates of the turbine are operated by a 1 h.p., 220 V, three-phase induction motor, the direction of rotation of which can be regulated by the closing of the proper contactor on the control panel. No waterwheel governor has been provided. The control of the turbine gates can be given to a pull-button switch for hand operation by closing the triple-pole, double-throw switch on the control panel to the proper position. The other throw on this switch gives the gate control to a float for automatic operation. In "putting the plant on the line" the attendant brings the unit to the proper speed by using the pull-button control on the gates. He then closes the oil switch and, still with the button control, brings his load up until neither signal lamp is burning. He then throws the double-throw switch to the float-control position and the job is done.

In case the power line is de-energised from power house No. 1 the low-voltage release on the oil circuit breaker disconnects the plant from the line, thus preventing load being thrown back on to the semi-automatic plant with the induction machine still connected and running at a high rate of speed. To provide for over-speed, either from the line opening at power house No. 1 or for any other reason, a centrifugally operated switch is provided on the shaft to close a set of contacts that in turn operate the gate motor in a direction to shut the unit. An overload relay with circuit opening hand-reset contacts is used as an interlock, so that when the motor is closing down for overspeed the float cannot operate it to open up, as would be the case immediately the water began to rise at the intake. Three reverse-power relays have been installed and connected to open the generator oil switch, by means of a no-voltage release, in case of failure of the water supply causing a reversal of power. While an induction generator cannot run away if it is connected with synchronous machines whose speed is normal, it may happen that a short circuit occurs or line voltage is otherwise reduced to such an extent that the induction generator receives no excitation, in which case it will run away. In this particular district these conditions could easily occur.

Crane Valley Power House.

The Crane Valley power house contains a 1,000 kVA, 2,300 V, 458 revs. per min. induction generator coupled to a 1,310 h.p., 100 ft. head, single discharge, overhung Francis type turbine. This plant takes its water directly from the Crane Valley storage reservoir. The head in the reservoir varies from a maximum of about 117 ft. down to a minimum of about 60 ft., but the average is about 100 ft. A 48-in. pipe line is incased with concrete to the lower end of the tunnel and carries the water to the turbine, which discharges directly into the conduit for No. 3 power house. Provision is made to bypass the water around the plant, but the operation is not automatic in this case, the attendant having to close the butterfly valve on the turbine and open bypass valves from the pipe.

The turbine gates are operated by a small direct-current motor driven by a direct-current generator which is belted to the shaft. The centrifugally-operated switch on the generator shaft responds to about 35 per cent. overspeed, opening the no-voltage coil on the generator oil switch and also operating the automatic controller on the gate motor. The motor continues to run until the limit switch on the gates opens at the closed position.

The speed-limit switch opening the generator oil switch comes in operation if the plant is left on the line with one of the small synchronous plants in that district but without any load being connected. This might possibly occur during switching or trouble. In such a case the output of the induction plant is sufficient to cause overspeed on the synchronous plant. Thermo-relays are installed on the bearings and connected to open a no-voltage release on the oil switch thus disconnecting the unit from the line in case of a hot bearing. The overspeed feature shuts down the unit and rings the alarm for the attendant. The momentum of the unit is always sufficient to drive the direct-current generator long enough for complete operation of the gates. In fact, the gates never close tightly enough to stop the machine entirely. Load changes on this plant are made on an average possibly twice a day by the caretaker of the dam and reservoir.

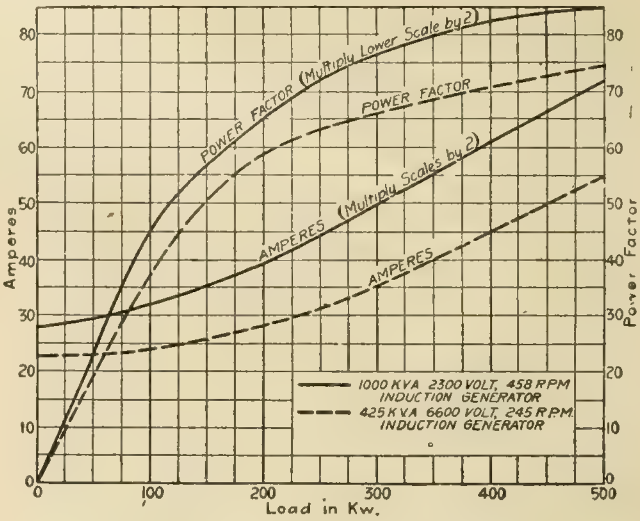

Fig. 1.—Characteristics of Induction Generators used by San Joaquin Company.

These plants were built for the purpose of developing two small heads, and it was necessary to keep the cost of the installation to the minimum if the development was to be economical. Induction generators were, therefore, selected on account of their simplicity of operation and the low cost of the installation, no exciters or other auxiliaries being necessary. Such machines are easily designed for overspeed and do not create high voltage when they are dropped off the line and attain high overspeed. In such a case the excitation which comes from the system immediately fails. Short circuits on the line have the same effect. No synchronising is required, and, therefore, skilled operators are not needed.

Performance.

The accompanying power-factor curves show the actual conditions under load. The higher speed machine has the better power-factor, requiring less lagging kilovolt-ampere from the line for excitation. As yet full load has not been carried on the higher speed plant on account of low water in the reservoir, but the curve indicates favourable conditions. Even with the lower power factor at power house A-1 no serious effect is experienced, because the size of the unit is such that a large amount of kilovolt-ampere is not required for excitation.

The total capacity of such machines that can safely be installed on any system is a matter of study in connection with the individual system. If the resultant system power factor is anywhere near unity, a reasonable amount, say, 10 per cent., of the system capacity in induction generators would not be seriously detrimental.

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* Abstract of an article in the "Electrical World."

The Reason Why:

The Tool Store is a Necessity.

By W. J. HISCOX.

In the organised factory to-day will be found the tool store—a department to which all applications for tools must be made, and from which no tool is issued without a check or token. The old days, during which a man took the tool he desired, without let or hindrance (supposing it to be available) have gone, and although in some cases the operator appreciates the uses of the tool store, in others he sees it as a check upon his movements, so far as his use of tools is concerned.

The Check Tool System.

The check tool system, which is in use in many factories, limits the number of tools a man may have in his possession at any one time, for but a limited number of checks are allotted and when these are exhausted he must return to the store one of the tools in his possession before he can get another. This causes the operator to grumble at the system, and yet, if the allotment of checks is upon a proper basis, no trouble or delay should be occasioned. As a matter of fact, this limitation of checks is in the interests of the operator, for it ensures a more equitable distribution of tools, seeing that it is impossible for one man to have an excess number of tools in his possession. There is not an unlimited supply of tools in the factory, and it is evident that, if one man is allowed to retain an excess number, another man must be put to trouble in order to get the tool he requires.

Even with the limitation of checks, it frequently happens that the tool desired by one man is in the possession of another, but the tool-room system minimises delay by giving prompt information of where the tool would be found. Without this record, the man desiring the tool would be obliged to search the department for the missing tool, this resulting in much wasted time. It is, no doubt, annoying when told by the storekeeper that, as no more checks are available, further tools cannot be issued, but the operator must remember that he has six or eight tools in his possession, and it cannot be argued that they are all in use. One at least can be released and when this is done another tool can be issued.

A Boon to the Operator.

The tool store is a boon to the operator, because it ensures that all tools and jigs issued are in good condition. In the past, the operator got the tool or jig he desired, only to find, when he commenced his job, that it was out of repair, this necessitating a return to the tool room. It may be that the trouble was not discovered until time had been spent in setting up the machine and then the machine had to be re-set, another job taken in hand, perhaps only to have the same trouble in connection with the tool for this job. The tool storekeeper takes steps to obviate this, by insisting upon a periodical inspection of all tools. He is concerned with the efficiency of his department, which means that the tool distribution is to the satisfaction of the shops. He has no use for "dud" tools, or "dummy" stocks, and he takes steps to ensure that his stores are in good condition.

The Importance of Correct Issues.

The issue of the right tool for the job is a matter which concerns the operator quite as much as the management, for work scrapped owing to the use of a wrong tool is a loss to both. Proper storage facilities obviates this, and the operator is assured that, when a tool is issued to him, it is right for the job he has to do. Nothing is more annoying to the operator than to find, upon application, that stocks of small tools in every-day use are exhausted, and that perhaps several days will elapse before further supplies are forthcoming. Lack of proper records is responsible for this, and here, again, the tool store is of value. The storekeeper watches his stocks—he is able to gauge the number required of every class of tool, and just how long his existing stock of any one tool will last. Consequently, he requisitions further supplies early enough, and should not these arrive at the time he estimates, he presses the Buying Department for them. As time goes on, and the tools do not arrive, he becomes more insistent, and emphasises the necessity for immediate delivery. His insistence usually bears fruit, and it is very rare that his stocks are actually exhausted before the arrival of further supplies. Work in the shop continues, new issues are constantly being made, and the operator knows nothing of the efforts of the storekeeper.

The Maintenance of Adequate Stocks.

The maintaining of adequate stocks is one of the principal duties of the tool storekeeper, and, no matter how busy he may be upon the affairs of the present, he must have an eye to the future. It is no light thing to ensure adequate supplies of the hundred and one different types and sizes of tools, and the storekeeper justifies his position, if for this reason alone. Apart from tools being kept in good condition mechanically, the storekeeper must see that they are always clean. The operator should, of course, clean the tool or jig before returning it to the store, but the storekeeper has plenty to do in this direction, and every tool is examined by him before being put back into stock.

The tool storekeeper will often undertake to store (over night and during week-ends) the operator's own tools, and, when one considers the amount of pilfering which goes on in some shops, this is no small matter. The operator possessing an expensive kit of tools is apprehensive at leaving this in the shop, even in a locked cupboard, whilst he does not want to take them home with him each evening. But, in the custody of the tool storekeeper, they are quite secure, and the owner's mind is at rest. The fact that no tool is issued, save upon a check, obviates dispute regarding liability for a missing tool. The tool is not in the store, but in its place is a check bearing the clock-number of an operator, and it is this individual who is liable if the tool cannot be found. Without this precaution any number of operators may be implicated, and nothing is more galling to an innocent man than to be concerned in a matter of this description. There are numbers of expensive tools in the factory, and they must be safeguarded. Two courses are open to the management —one the tool check system as described and the other to refrain from purchasing expensive tools for shop use. If the latter course be taken the operator must purchase his own, for, after all, in other industries the operator is not engaged unless he possesses a complete tool kit.

This is not wanted in the engineering industry, and need not happen if the tool store is established and its uses appreciated. The operator, on the whole, owes a good deal to this store, and although from time to time little troubles will occur, these cannot be compared to the troubles and delays which attend the factory which does not have a place for the tool store.

Reviews.

Practical Electric Welding. By H. G. Bevan Swift. (London: E. & F. N. Spon.) Pp. 104.

This little volume, we believe, is the first complete treatise on electric welding. True, during the last ten years the technical press has published from time to time no small amount of literature upon the various phases of this subject, but the reviewer has not before seen the subject treated so fully in one book. It is divided into nine chapters, and is written with some degree of originality in a clear and concise style. We rather doubt, however, whether the book does really supply the want in giving adequate information to those who intend to become arc welding operators, or who wish to select plant suitable for the purpose.

The first five chapters deal mainly with history and methods, and although the information given is accurate and well chosen, it is apparent that the author's experience of the broader application of the Benardos system has been limited, and that his knowledge of the metallic arc process has mainly been gathered from production work on more or less standardised lines. The whole book certainly leans towards American practice in equipment and application, yet we are surprised to find that the author severely limits his remarks on metallic arc welding to the specially coated and fluxed electrodes.

The chapters on equipment for electric welding follow makers' catalogues rather closely. A much wider study of working conditions and the behaviour of various installations under such working conditions would certainly repay those who wish to select plant for their particular use. The chapter on electrical resistance welding is interesting, and contains just sufficient information to initiate the reader into the elementary principles and possible applications of machine welding.

The book contains some original analogies, and is written in a style which will make it interesting to its readers, while at the same time it contains sufficient practical advice to help beginners in the industry to overcome initial difficulties and encourage them to probe more deeply into the technique of the subject.

The author would do well in the near future to enlarge considerably this volume, and enter more fully into the technique of welding, a subject which, after all, need not be beyond the understanding of the average works engineer or artisan.

H. S. Marquand.

Fundamental Principles of Electric and Magnetic Circuits

F. Allan Fish. (London: Hill Publishing Company.) Pp. xi.+ 194. 16s. 6d.

This book is written for undergraduate students, and contains what the author considers to be the vital fundamental principles of electric and magnetic circuits necessary as an introduction to the study of electric power machinery and transmission. The author is Professor-in-charge of the Electrical Engineering Department in the Iowa State College, and it will be understood that he writes to the American undergraduate, using his spelling and nomenclature. This is no drawback apart from the curious fact that every word which is spelled differently from our method appears to become unduly emphasised.

The book falls into the class which is always to be welcomed —the "fundamental principles" class; and we rejoice to note that the electrical engineering undergraduates of Iowa have got to swallow the fundamental digestive pill—undisguised at that and without sugar coating or jam camouflage—before proceeding to the *chef d'œuvres.*

There are eight chapters in the book, the first being a brief and breezy reminder of the fundamental units of force, work and power. The paragraph dealing with *Force* is rather unfortunate in that it gives the impression that action and reaction are *not* always equal and opposite. We are distinctly given to understand that "action" must be a little greater than "reaction" if we are to produce motion and acceleration. We do not think that the author meant to convey this idea—and if he will make it clearer what he means by driving forces and especially by "restraining forces," he will remove a possible source of trouble.

The second chapter, called Electricity and Magnetism, deals briefly with the simple cell, magnets and magnetic forces, the magnetic effect of a current and the definitions of the *abampere* (known in this country as the absolute unit of current) and ampere in electromagnetic and electrochemical terms. We would draw the author's attention to the somewhat ambiguous expression in this chapter that a magnetic field of unit intensity is "one dyne per unit pole." We know what he means, but an undergraduate might not. The remaining chapters are headed Electric Circuits, Electromagnetism, Electrostatics, Sine Wave Alternating Currents, Non-harmonic Currents and Polyphase Currents.

The general impression which the book leaves with us is that it is a very good notebook rather than a book of exposition; and to a student in attendance at lecture and tutorial courses it should be very welcome. It would be still more welcome if it were provided with some examples and exercises—for as it stands it is a cold collection of fundamental notes.

The general "get-up" is excellent—good paper, good print and good diagrams—but so it should be at the price which is asked for it.

J. Paley Yorke.

Shorter Notices.

Scienza e Tecnica dell' Illuminazione: Fotometria. By

Guido Peri. (Turin: S. Lattes & Company.) Pp. vii. + 479. Lire 26.

Compared with the mass of technical literature relating to the production and distribution of electrical energy for lighting the works relating to the utilisation of the small percentage available in the form of visible radiation are lamentably few, and the comparative neglect of this side of the subject is to be seen in the glaring misuse of electric lighting which is still only too common. The present volume is an excellent text-book on the utilisation of electric light as distinguished from its production. In the first two chapters the physical qualities of light and the mechanism of vision are discussed. We think it would have been preferable to have introduced at this early stage the quantitative discussion of intensity, light flux, illumination, which are postponed to Chapters IV., VI., where, however, they are dealt with in an adequate manner. In Chap. III. the fluctuations in the light of various types of lamps with alternating currents is considered at a somewhat unnecessary length. In this and other chapters there are references to consumptions of $\frac{1}{2}$-watt per candle-power in gas-filled lamps. As the makers have expressly renounced any claim to such efficiencies and recommend the less ambitious description of "gasfilled," the author is unduly optimistic in this respect. In Chap. VII. the distribution of light in different directions is well discussed, the curves of Rousseau and of Kenelly being described. A very full description of the various forms of photometer is given in Chap. XI., including portable illumination photometers, such as Trotters'. In Chap. XII. the effects of reflectors and globes are discussed. Chapters XIII. and XIV. deal with the application of the principles explained to the lay-out of lighting in closed spaces and in streets and open spaces respectively. The diagrams which are numerous are clear and well described. There is a well arranged Table of Contents, but it is to be regretted that there is no index or list of tables.

A. E. L.

Electricity and Magnetism: Theoretical and Practical.

By C. E. Ashford, LL.D., M.A. (London: Edward Arnold.) Pp. xii. + 303. 4s. 6d.

Dr. Ashford's book was first published in 1903 and has evidently been in steady demand ever since. It is written for Public Schools with their examinations and University Scholarships well in view. The price of the book is remarkably low for these days, and it is to be hoped that this is a sign that the prices of books in general have ceased from attempting altitude records.

It is a great pity that the symbols have not been revised so as to come into line with the recommendations of the International Commission. Presumably that could not be done at the price, but the reader will have to pay in another way, if and when he proceeds to read other literature on electrical subjects.

The book covers much ground—so much, indeed, that we feel inclined to doubt whether the average school-boy (and we are prepared to add Public Schoolboy) can be expected to take such a comprehensive survey. However, even though the book may not rouse enthusiasm in the breast of the average boy, it will certainly be of the greatest assistance to him in the gaining of scholarships.

Correspondence.

THE ORGANISATION OF THE SALARIED CLASSES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The Society of Technical Engineers is glad to see that so influential a journal as The Electrician is advocating the desirability of the organisation of the managerial, administrative and technical staffs of all manufacturing and commercial concerns since that is precisely the objective which this society, so far as the engineering industry is concerned, has had before it during the past three years. We believe that in the engineering industry, as in others, a properly constituted and carefully managed organisation of the salaried technical staffs, as a body, would be able to serve not only the interests of those staff men, but would be able also to contribute something to the efficiency and stability of the industry with which they are connected.

Within the last few years several societies of technical and other officials, engaged in various departments of the engineering industry, have come into existence, but there are already indications that they are tending towards a diversity of policy and action which can only lessen the influence of the profession as a whole. It is to be hoped that the technical workers will not, in this matter, follow the example of the manual workers, and spend years on the organisation of numerous separate craft unions, only to find the need for a constant series of amalgamations and federations into larger and larger groups.

It is, of course, possible to unite many distinct societies within a single federation, but we believe no federal constitution can give that degree of intimacy between its parts which is necessary for effective working in this field. We think that a single society, divided into appropriate sections, is what is needed for the adequate protection of the individual interests of its members, for advancing the status of the profession as a whole, and for making that special contribution to the stability and efficiency of the industry which is the province of the technical man. The problem of how to provide constitutionally within the limits of a single society the necessary degree of autonomy in regard to sectional interests combined with that unity in regard to the broader lines of policy, so necessary for the achievement of the ends which are common to all sections, presents no special difficulty.

We hope therefore, that the present phase in the history of the organisation of the technical worker, which is characterised by the formation of separate societies, will not go much further, but that those bodies which have recently come into existence will agree to sink their separate individualities within a larger union, and that individual engineers, especially those senior men who have not yet joined any society, will come in and take their part in the movement. This effort to constitute a single organisation of professional engineers for protective and industrial-political purposes is in accord with similar movements which are taking place in other parts of the world—in America, in France, in Italy and in Germany. It is, perhaps, worth mention that there seems no reason to anticipate any tendency on the part of this movement for the organisation of technical engineers, who are coming together primarily for protective purposes, to overlap the functions of the existing engineering institutions which are mainly scientific. Indeed, it is to be hoped that there may be found in the future some mode of co-operation between the scientific institutions and the protective societies in regard to certain broad issues such as the registration of engineers.—I am, &c.,

London, May 23. NORMAN WYLD, *General Secretary*,
Society of Technical Engineers.

New London Showrooms of Sloan Electric Co.

To be asked to describe anything that has been seen is a very difficult task unless, of course, one is a Pelmanist. This is our position at the moment in endeavouring to give some idea of the fittings showroom recently opened by the SLOAN ELECTRICAL COMPANY, LTD., at their newly-acquired premises adjoining their London office, 12, Golden lane, E.C.1.

At the invitation of the Sloan Electrical Company, we paid a visit of inspection and were greatly impressed with the whole scheme. The room is beautifully designed in oak panels with green ribbed canvas wall paper, polished parquet flooring with a few oriental rugs, the furniture being of the Jacobean period. The accompanying illustrations convey some idea of the artistic taste displayed in designing the showroom, but it is impossible to appreciate the whole scheme without a personal visit. The immediate reason for this development is that Messrs. Sloan Electrical Company have been appointed agents for London, South Coast and East Coast of Scotland by Messrs. PEYTON & PEYTON, LTD., Bordesley Works, Birmingham, manufacturers of decorative electrical fittings and art metal work. This firm has had a vast and varied experience in the design and manufacture of fittings for theatres, cinemas and public buildings, having recently equipped the Futurist Theatre, Birmingham, and the Manor Park Cinema. In addition to this class of work they manufacture a comprehensive range of fittings for ordinary domestic lighting, comprising many exclusive and new designs in dining and dressing room pendants, indirect lighting bowls and other units. The fittings are well lacquered to withstand the various climates and atmospheric conditions met with. All the classic styles and periods such as Louis XIII, Louis XIV, Empire, Adam, Georgian, &c., are represented, as well as a choice selection of bronze figures and porcelain table standards. In the showroom is a full range of heating and cooking apparatus of the Sloetric type, including vacuum cleaners and other labour-saving devices, ready wired for demonstration and display.

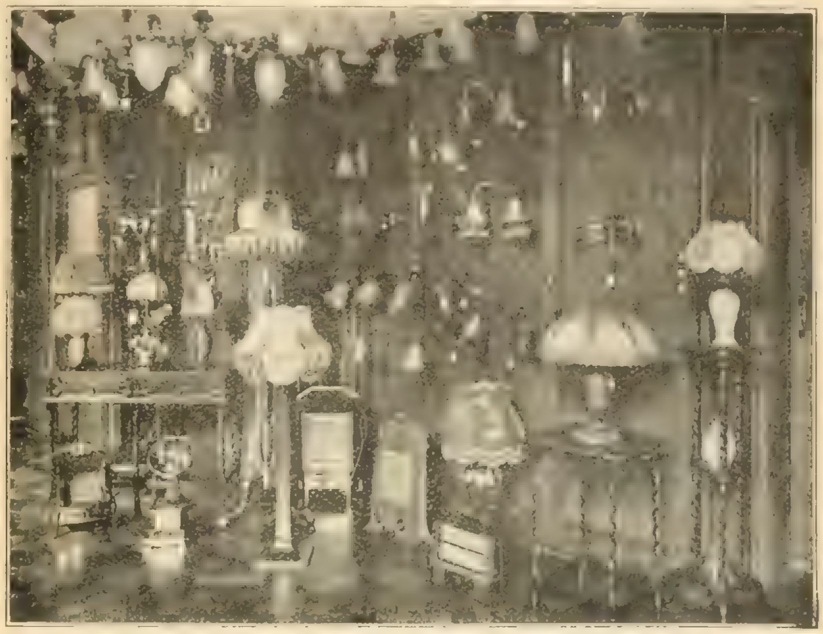

FIG. 2.—DISPLAY CORNER IN THE SAME SHOWROOM.

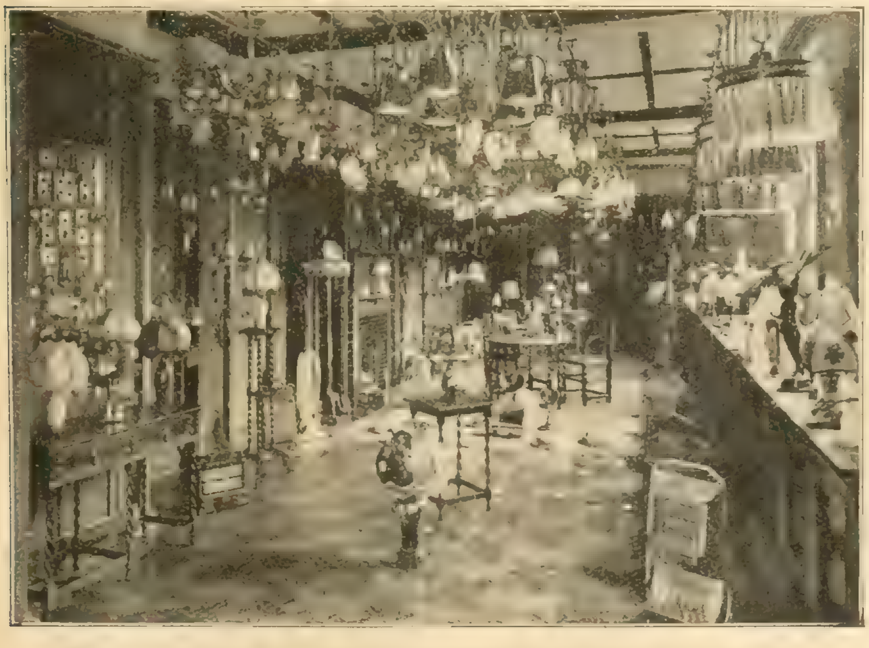

FIG. 1.—CORNER OF THE LONDON SHOWROOM (SLOAN ELECTRICAL COMPANY).

The annual conference of the TEACHERS IN TECHNICAL INSTITUTES was recently held at Cardiff. In his inaugural address the new President, Prof. Knox, of the South Wales Institute of Mines, referred to the difficult role which technical colleges had to play in education, being suspected on the one hand by the organised workers as being merely instruments for training better profit-making machines, and on the other hand sneered at by the high-browed academician as purveyors of soiled goods. Despite these attacks, he knew of no educational association which had done better work than theirs. There should be close co-operation between science teaching and industrial practice and in recent years enormous progress had been made in preparing students for industrial careers. The object of such an association as theirs was to convince educational authorities of the need of higher technical training, by evening classes, by full-time courses in pure and applied science, and by post-graduate courses in specified branches of applied science. We must realise that Great Britain no longer held a national advantage over its competitors in natural resources, but had to depend upon the trained intelligence and resourcefulness of its people to maintain its position.

The West Riding Electricity District.

On Wednesday last the Electricity Commissioners opened their inquiry into the organisation of electricity supply in the Aire and Calder (W. Riding) district, which has been provisionally determined by them. The area embraces the cities of Leeds, Bradford and Wakefield, the county boroughs of Barnsley, Dewsbury, Halifax and Huddersfield, the municipal boroughs of Batley, Brighouse, Keighley, Morley, Ossett, Pontefract, Pudsey and Todmorden, and a number of urban and rural districts, &c. Three schemes were submitted for improving the existing supply arrangements, viz., by Leeds Corporation, by the Yorkshire Electric Power Company, and by a Conference of Local Authorities in which Bradford took the lead. The commissioners were Sir John Snell (chairman), Sir Harry Haward, Mr. H. Booth and Mr. A. Page, and a number of counsel represented the various parties.

The Leeds Scheme.

Mr. Wooll, in opening the case for Leeds, said the scheme was the product of much care, close study and intimate knowledge of the area to be dealt with, but up to the present it had not received any substantial measure of support outside the confines of the city. For this absence of support the primary causes were undoubtedly questions of principle, of representation as existing between Leeds and the conference scheme, and also of the unsatisfactory and almost chaotic condition of legislation in reference to those matters. Leeds had been very much impressed by the cogency of the various representations by committees instituted by the Government in recent years both as regarded the conservation of coal and the improvement of electrical supply, but they found themselves left, as a result of the imperfections of the Act of 1919, with the necessity for electrical reorganisation and development, but with no powers of compulsion with reference to the acquisition of electrical undertakings, nor with any satisfactory financial arrangement. Leeds desired neither to share the apathy of those who thought the position involved essential futility, nor to share the precipitancy of those who desired to run before they had the power to walk. He wished to satisfy the Commission that the attitude of Leeds had not been one of selfish exclusiveness, and that they were abundantly capable of taking a larger view of local patriotism. It took part in a conference with representatives of the Bradford, Halifax and Huddersfield local authorities and the Yorkshire Electric Power Company, in order to see how far, under the enabling sections of the 1919 Act, those four local authorities and the one large private company could undertake to make themselves responsible for the whole generation of electricity in the area in future. On the issue of the notice prescribing a provisional area in June, 1920, a conference was held in Leeds and a committee appointed; but there was a tendency for the municipal obsession to obtrude itself, and those who were for an exclusive and aggressive municipalism declined to allow private companies to participate in the electrical usefulness of the area. At a later conference composed of local authorities only, the decision was taken to exclude on principle the Yorkshire Electric Power Company from any further participation in the scheme. Leeds then retired from the conference, and it had been reluctantly compelled to plough a lonely furrow which they were not without hope might yet produce a useful electrical harvest. They put forward the scheme as one which would supply the Commission with invaluable data and material, and which might well, after the defects of the Bradford scheme had been exposed, evoke even the support of those who were at the moment in sympathy with other claims. The general object of the scheme might be summarised under four heads:

Objects of Scheme and Area.

(1) To encourage efficient autonomy. Under the scheme the heads of great undertakings had the same impulse and the same incentive to develop their own electricity and to surpass their own past records in efficiency. (2) What might be called the main object—to enlist the co-operation of the Yorkshire Electric Power Company, as they regarded the Yorkshire Company not only as an inevitable but an invaluable factor in the electrical life of the area. (3) They wanted to avoid large and impossible capital commitments. (4) They wanted to avoid friction and they wanted to concentrate on the generation of electricity.

Leeds, like Bradford, adopted the district prescribed by the Commissioners; they regarded it as a suitable area and one of convenient size. The population was 2 114 000. Leeds was responsible for 445 550 of that, or one-fifth of the population, and it was also responsible for the generation of about 30 per cent. of the total electricity generated in the area in 1920. One peculiar feature of the electrical position in the area was that by 1935 there would be remarkably little difference in the situation, financial and electrical, from what prevailed now, whether the Leeds scheme or any other scheme, or no scheme, were adopted and normal independent evolution took place. It was not a practical proposition, owing to the difficulty of finding adequate cooling resources within convenient distance, to contemplate the erection of one super-station. Whatever scheme was adopted, there were going to be only moderate-sized stations, and those stations would probably be three in number. The projected sites for the stations in order of erection were Leeds, Wakefield and Knottingley.

Mr. Hefford's Evidence.

Mr. C. N. Hefford, chief electrical engineer to Leeds Corporation, said he had estimated the growing requirements of the area for the next 15 years. The estimated demand for 1930 he put at 256 units for each unit of the population, and for 1935 at 363 units. The maximum demand would be 177 000 kW in 1925 and 678 000 kW in 1935. It would be possible to install additional plant in the existing works, and as far as such extension of plant was concerned, a total of 258 100 kW would be available in 1925. If all the extra load in the area were dealt with from one generating station alone, there would be practically no saving of the generating machinery to be provided. The extreme limit of diversity would be 5 per cent., which he considered negligible. In order to deal adequately with the increasing demand to be anticipated, and also to provide for the replacement of obsolete machinery, he considered that something over 300 000 kW would have to be provided within the next 15 years. That demand could be met by the construction of three moderate-sized capital stations. It was not possible to entertain the idea of one super-station in the area, because of the insufficient supply of cooling water at any one point. The point nearest to Leeds at which there was sufficient water was practically at the junction of the Trent and Humber, between 30 and 40 miles away. It would be quite feasible to construct a super-station there to feed the area, but he considered the cost prohibitive.

Sites of Capital Stations.

The available sites for the three capital stations suggested must necessarily be on the banks of the Aire or Calder, or after the junction of the Aire and Calder. On the Aire there was a site at Leeds, on the Calder at Wakefield, and on the Aire, after its junction with the Calder at Knottingley or Ferrybridge. He proposed that stations on those sites should be developed in succession, the first at Leeds, because that was the point of intense demand at the moment, and the third at Knottingley. He suggested for Leeds and Wakefield five generating units of 25 000 kW each, and at Knottingley there would ultimately be eight such units. At Leeds the site was on the bank of the Aire, near South Accommodation-road. It comprised only 6½ acres, but he considered that in the peculiar circumstances that extent would be sufficient, because no large provision had to be made for siding accommodation. The bulk of the coal was brought by water, and barges capable of bringing 150 tons at one time could be quite readily dealt with. Railway sidings were already there, and the existence of factories around removed the necessity, such as apparently existed in other schemes, for providing land for the erection of factories. It would be possible to acquire adjacent areas, and there was also ample water for cooling. The site at Wakefield covered 20 acres, and was an exceedingly good one.

Morley as a Control Station.

By 1925 a certain amount of machinery would be installed at the Leeds station which would enable some of the output to be taken to Morley. It was essential that a link should be made between Leeds and Morley, and that would be the first step towards making Morley a control station. The energy generated at the various stations should be controlled at one point by an official with sufficient authority to instruct the stations in the event of a breakdown or any interruptions. It might be necessary to continue the Keighley station for some time, but it seemed to him that Shipley should be shut down. It would be utterly impossible to consider any demands from the railways before 1924. The capital expenditure on the Leeds scheme would be about 6 millions in 1925, 10 millions in 1931 and 17½ millions in 1935. By 1935 there would be a capital expenditure of 3½ millions on the Leeds capital station, £3,450 000 on the Wakefield and £2 690 000 on the Knottingley station.

In reply to Mr. Miller (for the conference of local authorities), Mr. Hefford agreed that the Leeds scheme left existing generating stations in the hands of their present owners, and it left the suggested joint authority to work side by side with the Yorkshire Electric Power Company. He did not think the purchase of the Yorkshire company was necessary at once.

The Chairman said that in the light of experience, 6½ acres did not seem to the Commissioners a very large site on which to build a 125 000 kW station, but there might be peculiar circumstances. At the moment, it appeared to have been overlooked that a station which was going to burn something like 1 000 tons of coal a day could hardly be expected to do without storage facilities. It did not appear on prima facie grounds that the site was a suitable one for a station of the size proposed. The site was rather suspect on account of its area, and should the Commissioners decide that it was proper to approve of it, they would require the fullest evidence that there was sufficient water available.

On the 19th inst. Mr. Hefford was further cross-examined by Mr. Miller. He stated that it was intended that the generating stations, now municipal or belonging to the power company, which were proposed to be retained, would distribute power direct to their own customers, but all would be connected with a control station at Morley, and Morley would distribute the surplus of power produced locally above the local requirements. That surplus would be ever growing in amount, and the control station would have to deal with a larger and larger amount of power. He regarded the direct connection of the Morley control station with each local generating station as better than the proposal of linking the various units in a ring. He knew that other engineers advising the Conference of Local Authorities had reported against the star plan in favour of the linked ring, but he believed that since doing so they had changed their minds on the point.

Mr. Miller suggested that the engineer occupying the position of control would have a difficult task. He might have to decide in favour of one station carrying more power than its fair share of the burden. How were such questions to be adjusted under the Leeds scheme?

Witness thought the first thing would be to get rid of the control engineer and appoint another if he wilfully acted unfairly. Questions of principle and differences between the different undertakings would be decided by the Joint Authority.

To Mr. J. Hunter Gray, K.C. (for the Yorkshire Electric Power Company), Mr. Hefford admitted that the company supplied its area efficiently than the Leeds scheme. Failing agreement with the power efficiently, but he did not agree that it would supply a larger area more company, it was impossible to work the Leeds scheme efficiently until Parliament passed other legislation increasing their powers. He knew that £6 000 000 would be required at the beginning to carry out the Leeds scheme, and that it was contemplated that that should be supplied by the Ministry of Transport under Sec. 18 of the 1919 Act.

Leeds Ratepayers' Advantage.

Mr. Hefford was cross-examined by Mr. J. A. Greene, on behalf of the West Riding District Councils' Association to show that under the Leeds scheme the citizens of Leeds were providing themselves with a capital station at no expense or risk to the citizens. Witness said the joint authority would be responsible for the gradual development of the scheme, and it would ultimately provide for the whole of the electricity supply in the area. In the interim it would control the operations of the various existing undertakings.

Mr. A. Tyler (on behalf of the railway companies) elicited the fact that in some schemes which had been before the Commissioners railways were admitted to representation on the joint authority, but that the Leeds scheme did not provide for similar representation. A body directly representative of all the large consumers would, Mr. Hefford thought, be too large to be workable.

To Mr. J. C. McGrath (for the West Riding County Council) witness said that it would be possible to supply electricity in 1925 under his scheme at the average price of 1¼d. per unit, with a surplus of £626,000.

The Chairman pointed out that it had been estimated by the witness that, under the scheme, his capital expenditure would be £6,147,000 in 1930, while, if the existing stations went on, they would have spent over £7 000 000 in capital expenditure. There was, therefore, an actual saving on those estimates.

Witness would not admit that the centralising of the control was a great mistake, in view of the possibility of an accident.

In re-examination Witness said that of the £6 000 000 capital expenditure, about £3 000 000 was for the acquisition of the existing stations. That was a capital expenditure to which the districts were already committed, in any case. So that the new capital expenditure was not £6 000 000, but £3 000 000 for the period ended in 1925. In the whole area there was no electric railway, and no talk of electrification of railways. Railway representation would be representation of consumers as such. There were other consumers vastly greater, in fact, than any potential railway consumption, and it would be unwieldy to bring them all in by direct representation. In regard to the South Accommodation-road site he said there was an alternative site at Knostrop, near the sewage works, where 30 or 40 acres of land were available. The construction of some works would be a little more expensive, and the site was a mile further from the load. Hence he preferred South Accommodation-road.

Sir Robert Fox, Town Clerk of Leeds, said that the Corporation had endeavoured to secure what help could be gained by conference with other local authorities. Those efforts broke down upon the deliberate exclusion by the conference and proposed expropriation of the Power Company, and upon the question of the acquisition of the existing works. The Corporation were also not disposed to contribute by rate aid. Sir Robert proceeded to give an explanation of the scheme in respect to the arrangements for representation of interests in the management of the Authority. At present 89 per cent. of the electricity consumed in the area came from five sources—Leeds Corporation, which was slightly the largest; the Yorkshire Electric Power Company, the Electrical Distribution of Yorkshire (which drew its power from the Power Company, and distributed it), the Bradford and Huddersfield Corporations. These were the largest producers, and represented the largest number of consumers, and they ought therefore to have a majority of representatives upon the Board. He had no desire to exclude railways for ever, but the railways in the area were not electrified. The main business of the joint Board under the Leeds scheme would be the generation and not the distribution of electricity.

In cross-examination by Mr. J. Hunter Gray, Sir Robert said the Leeds scheme did not propose to expropriate the Power Company, because they did not think it was business. They proposed to leave the company to die out, but in that death Leeds as an electricity authority would participate.

In answer to Mr. Miller, Sir Robert said Leeds could supply itself without the slightest danger of any charge upon the rates. That being so, they were asked to take part in a national object—that of preventing the waste of coal, and secondly they were asked to provide electricity for a large area of the county with which they had no direct concern. They considered, therefore, that they were quite justified in saying that if they were going to take such part in a national object and in helping others by their enterprise, there should be no call upon the rates of Leeds. He believed, however, that in any case there would be no risk because they were confident that, through economies in the production of electricity, the price of electricity could be reduced and the scheme be self-supporting.

In re-examination, Sir Robert Fox said he would not be averse from the representation of railways on the Joint Board at a future date. Leeds did not put their scheme forward with any idea of reaping advantages which would not be enjoyed equally by all other areas.

Sir Harry Haward drew attention to the fact that under the Leeds scheme double representation on the Board would be given in respect of electricity supplied in districts now served by the Power Company.

Sir Robert replied that it was so, but he saw no objection to it, and any remedy might be worse than the disease. The leading basis of representation was consumption of electricity.

Sir H. Haward: It seems to me that by pooling all the votes and not providing for any definite representation of local authorities, you stand the chance of a particular combination getting entire control of the representation. In those circumstances, it was conceivable that Leeds might have no representation at all, and could be outvoted by a combination of Bradford, Halifax and Huddersfield.

Sir Robert Fox: I agree that that might happen, but I am inclined to take the risk. I don't think any public-minded body of men would ever resort to practices of that kind.

Sir Harry suggested that it would be better that Leeds should have a definite number of representatives, and so with other authorities and the Yorkshire Electric Power Company.

Sir Robert Fox: Yes; I quite agree, and I should be prepared to amend the scheme in that direction.

Public v. Private Enterprise.

The Chairman (Sir John Snell) asked if Leeds Corporation had had any negotiations with the Power Company which the Town Clerk was at liberty to divulge.

Sir Robert Fox: No, except as to a working agreement.

The Chairman: Is it your view that the supply of electricity in this area would be better developed under a general public control, or would you agree to a scheme in which the Power Company might fully develop the area in co-operation with the local authorities? I mean, have you any primary objection to general development by private enterprise, or are you of the opinion that this is a matter for public management?

Sir Robert Fox: I am representing the Leeds City Council, and while I do not know that their view had been taken in the precise form you put, yet their general attitude in propounding this scheme is to raise no objection to private enterprise; indeed, they very much appreciate the private enterprise already brought to bear.

Do you think the city would be willing to co-operate in the best scheme, whether under private or public control?—Certainly, and that as a matter of business.

Financial Evidence.

Mr. Arthur Collins, City Treasurer of Birmingham, gave evidence on the financial question. He submitted figures showing that Leeds had 81,000 connections up to 1920, the Yorkshire Power Company was second with 62,600, and Bradford third with 55 000. It was a matter of surprise that the Power Company should come before Bradford. He had thought that Bradford was the biggest partner in the Conference scheme, whereas Bradford was proposing to buy up an undertaking bigger than its own. Since 1914 there had been a growth of approximately 30 000 kW in Bradford, 44 500 in Leeds, and 32 500 kW in the case of the Yorkshire Electric Power Company. That represented an increase of 125 per cent. in Leeds, 111½ per cent. in Bradford, and 110 per cent. in the area of the Power Company. In other words, these places had more than doubled their demand in the last five years, which, considering the retardation during the war, showed a striking development. The greatest development was noted in Leeds. The low cost of production in Leeds, was in part due to the low charges for coal as delivered at the works, and in view of these and other circumstances he couldwell understand the attitude of Leeds in saying that, if they did join in a district scheme, they should not be called upon to pledge their rates.

Sir Harry Haward said that in any comparison between the new scheme and the existing state of affairs regard ought only to be had to the costs of working the new undertaking, the existing stations being expenses of the local concern and not of the joint authority.

The Chairman added that it appeared to be the fact that Leeds stood to gain by going into the scheme rather than by standing out.

A Long-Date Loan.

Mr. Collins said that was the type of case in which the Commissioners might suggest that the scheme should be financed by the Ministry in its early stages after the manner practised by the Public Loan Works Commissioners. At present small local authorities were having to pay 7½ per cent. for money, and while the repayment of £3 000 000 during the next two, three, or five years might be done, it would occasion not a little anxiety.

The Chairman: Let me make it quite clear. The money is not at the disposal of the Commissioners, and, apart from the Ministry, the Treasury will have to be consulted.

Mr. Collins said that if the Power Company could supply current at a cheaper price than it could be produced by a municipality, the taking of such power ought to be very seriously considered. He regarded the inclusion of the Power Company in the Leeds scheme as a compromise between the two opposing schemes.

In cross-examination, the witness said that from the point of view of loan flotation he did not know an area outside London offering better advantages than that in West Yorkshire, though Manchester would run it close. If cautiously financed, and with the pledge of the rates, it afforded a sound financial proposition, though he regarded the proposed purchase of the Power Company as one of the most dubious parts of the conference scheme.

In reply to Sir Harry Haward, Mr. Collins developed his proposal for a long-date loan, with a break at the option of the Joint Authority in 10 years. The new Bill proposed to extend the present 2-year limit to five, and he understood that Leeds would not go forward if repayment even at the end of five years were insisted upon, though that would not necessarily shut down the proposal for a working arrangement.

The Bradford Scheme.

Mr. Miller, K.C., opened the case for the scheme of the conference of Local Authorities. In the district there were eight different varieties of supply all intermingled one with another, the whole providing a tangled situation such as the Act of 1919 was designed to unravel. The conference idea was public ownership and control over the generating stations and the main transmission lines over the whole of the area.

On Saturday Mr. Miller, K.C., concluded his opening address, and he urged that the authorities who supported their scheme were entitled to be heard with attention in view of their history. Taking the years at which electricity supply began in the area, they found the average among the conference authorities to be 1897, whereas the Yorkshire Power Company commenced in 1904. Not only had those authorities many years' experience, but their conduct of their undertakings was such as to show that they had been acting on the best advice. The conference had the largest stake in the area, each of them having their own special experience of just the work which a Joint Electricity Authority would have to undertake. Under their scheme the Yorkshire Company would get the fair and full satisfaction which they could properly expect to receive, and failing agreement, there would be arbitration to settle the purchase price. He submitted that in the national interest there should be public ownership of generating stations and main transmission lines. He argued that in the year 1926 there would be a surplus, on a penny charge, of £280 175, which the promoters of the scheme regarded as ample to meet capital charges on the purchase of the Yorkshire Company, and that in the matter of affording a cheap supply of electricity the conference scheme would be able to show an advantage. If it was possible to have public control of public services, with immediate satisfactory results financially, they had got a basis upon which for all time they could develop and extend within the area. It was not intended that there should be any payment out of the rates, but he wished to make it clear that the rates would be behind the scheme.

On Monday evidence was given by Ald. W. Turner, of Bradford, and by Mr. Thomas Roles.

The inquiry had not concluded when we went to press.

Lighting a Food Shop.

Good light is necessary for the proper enjoyment of food, and it makes the dishes look more attractive, while it also enhances the appearance of food displayed in a shop. Mac Fisheries, Ltd., have certainly appreciated the logic of this argument, and their shops are illuminated with a brilliant, evenly diffused light, which makes the fish and poultry look tempting.

The illustration shows the interior of the Rugby branch, the lighting of which was carried out with materials supplied by the British Thomson Houston Company. Semi-indirect fittings, equipped with opal glass bowls and Mazda gasfilled lamps, are used in the interior. The fittings are spaced to ensure a uniform illumination, while the bowls are sufficiently dense to prevent glare. As may be seen from the illustration, which is reproduced from an untouched photograph taken by the unaided light of the Mazda installation, the illumination on the counters, on the walls and other vertical surfaces is brilliant without being in any way obtrusive. A similar degree of brilliance with unshaded lamps, or with an ordinary direct lighting system, would have been accompanied by a great deal of unpleasant glare.

As Mac Fisheries have followed the usual custom of poulterers and butchers of hanging a considerable proportion of their stock outside the shop, it became necessary to provide some form of exterior lighting. In the present installation this is carried out effectively by means of two B.T.-H. "Globa" weatherproof lanterns, suspended from brackets fixed above the fascia, and equipped with high candle-power Mazda gasfilled lamps. The installation affords an interesting example of the application of modern methods of lighting to small retail shops. Such a system as the one described is economical in first cost, operation and maintenance, and is highly attractive and effective. It is suitable for almost any kind of light-coloured interior, although such details as spacing, height of suspension and size of lamps might require modification. Further information on the subject may be obtained from the British Thomson-Houston Company's Illuminating Engineers, at Rugby and London.

New Right-Angle Type Sealing Bells.

A weakness in connection with power transformer construction in common use at the present time is the exposure of conductors on the terminals. Messrs. A. Reyrolle & Company, Ltd., have prepared a new design of sealing bell which eliminates this undesirable feature by enclosing all conductors and immersing them either in oil or compound.

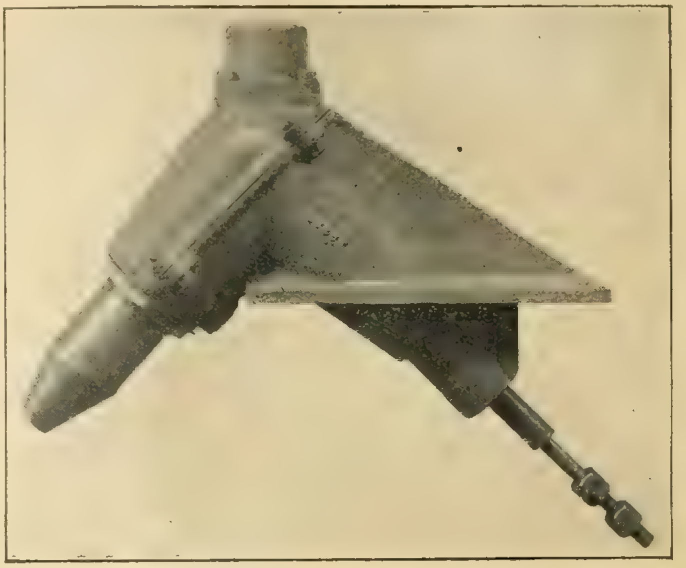

Fig. 1.—A Reyrolle "Right Angle" Sealing Bell.

These sealing bells, as shown in Fig. 1, are of a right-angle type for mounting on the top of the lip extension of the latest type of transformer, and the fixing flange is at an angle of 45 deg. to the plane in which the terminals of the conductors of the cable are placed. A complete range of this type of sealing bell has, we understand, been developed for pressures for from 440 to 66 000 V. The bell is shown in use in Fig. 2.

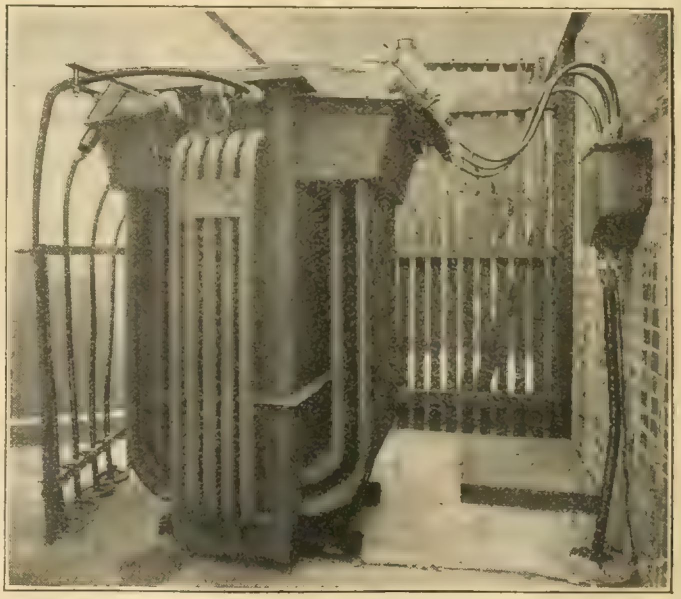

Fig. 2.—Showing the Bell in Use.

An experimental consignment of the new patent alcohol fuel "Natalite," has arrived at the Port of London per ss. "Cluny Castle" from South Africa. Natalite has been manufactured, and has been in general use in South Africa for four years. The whole of the first consignment will be used for demonstration and experimental purposes.

A Continental Trunk Telephone Cable.

The installation of an armoured trunk telephone cable, 22 miles long, has recently been completed between Luxembourg and Diekirch for the Luxembourg Posts and Telegraphs Administration. The cable is a composite one of 36 pairs in multiple twin formation, and is balanced and loaded for phantom working. It is the first trunk telephone cable to be installed in the Grand Duchy, and is particularly interesting on account of the extremely low values of cross talk which have been obtained, a very high standard in this respect having been called for.

As is well known freedom from cross talk depends very largely on the skill and care which are exercised in the joining in of the loading coils as well as on the balancing of individual loading-coil sections. On loaded lines in this country the coils are usually connected up by the Post Office, so that contractors obtain very little experience of this work, but, in this case, it was carried out under the supervision of Messrs. British Insulated & Helsby Cables, Ltd., who did all the testing, and were responsible for the final results. The loading coils were of the latest dust core type. and were supplied by Messrs The Western Electric Company, Ltd.

On the completed cable, the values of cross talk obtained in any quad, the unit of measurement being one millionth of the E.M.F. applied to the interfering circuit, were as follows :—

	Between side circuits.	Between side and phantom circuits.
Average of all quads.	50	105
Three greatest values	130, 130, 120	350, 250, 200

There is no doubt that this cable far excels any other cable on the Continent in freedom from cross talk, and Messrs. British Insulated & Helsby Cables, Ltd., are to be congratulated on having achieved this success for British Industry.

Dutch Electrical Engineers' Visit.

In our issue of October 17, 1919, we gave an interesting account of a visit paid by a deputation, representing the Institution of Electrical Engineers, to Holland, on the invitation of Mr. J. G. Bellaar Spruyt. During the week the visit is being returned by a representative group of Dutch engineers. The party arrived in this country on Sunday last, and they return to Holland to-morrow (May 28th) after a pretty comprehensive tour of inspection. The visitors, who numbered nine, include Mr. J. G. Bellaar Spruyt (President of the Association of Managers of Dutch Electricity Undertakings) ; Mr. G. J. F. Bakker (representing the Royal Dutch Institute of Engineers) ; Mr. C. Noome (Managing Director Provinciale Utrechtsche Electriciteits Maatschappij) ; Mr. E. van Dijk (Managing Director Provincial Electriciteits Bedrijf in Friesland) ; Mr. E. B. van Doesburgh (city electrical engineer of Groningen) ; Mr. H. Lohr (Managing Director Provinciale Electriciteits Maatschappij, Arnhem) ; Mr. J. C. van Staveren (Manager of the Office for High Tension Lines, Maastricht) ; Mr. W. Lulofs (City Electrical Engineer, Amsterdam) and Mr. A. B. van Hamel (Ministry of Commerce, Department of Economics, the Hague).

The following is a brief outline of the itinerary of the deputation :—The visitors arrived at Liverpool-street Station on Sunday morning and were driven to the Hotel Cecil. After an interval of two hours they left for Tagg's Island ; luncheon was taken on the island and subsequently the party drove to Weybridge, where they visited Mr. W. J. Crampton, at whose house wireless telephone communication was established with the Hague. A concert was heard by this means and a conversation also took place with the President of the Dutch Radio Institute.

Leaving the Hotel Cecil on Monday, a visit was first paid to the I.E.E. building and from thence the party journeyed to Lot's-road to inspect the Power Station. After lunching at St. Stephen's Club, the party drove to Henley, where they embarked for a river trip by special launch, returning to Henley for the night. Oxford was visited on Wednesday with Mr. F. H. Francis acting as guide. Leaving Oxford, the next place visited was Ettington Park, where the ruined chapel (1100 A.D.) and museum and house were inspected, lunch being provided at Ettington Park by the kind invitation of Mr. R. J. Petersen. In the afternoon, driving via Stratford-on-Avon, Evesham, Worcester and Ledbury the visitors arrived at Hereford where they remained for the night.

On Wednesday Shrewsbury was visited for lunch, driving via Leominster and Ludlow, and thence via Chester to Manchester. On the way the hydro electric installation at Old Dee Bridge, Chester, was inspected, Mr. S. E. Britton acting as guide.. The Barton site of the Manchester Corporation electricity works was visited on Thursday morning and after lunch at the Metropolitan-Vickers Works, the party inspected the works and the Ship Canal. In the evening the visitors were entertained to a municipal dinner. The deputation leave Manchester to-day and will proceed to the Hotel Cecil, London, from whence they will depart for Holland via Tilbury on Saturday morning.

Commercial Topics.

Forthcoming Exhibitions.

Among the forthcoming exhibitions of interest to electrical engineers may be mentioned the following : The British Medical Association Annual Exhibition, which will be held at Newcastle-on-Tyne from July 19 to 22 ; the Ideal Home Exhibition, which is also to be held in Newcastle some time in November ; and the General Meeting and Conference of the Institution of Municipal & County Engineers to be held in London from June 15 to 18. A demonstration of mechanically and electrically propelled vehicles for municipal work will be held in Lincoln's Inn Fields on the 16th from 4 p.m. to 6 p.m. in connection with the latter conference.

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Increased Postal Rates.

The business community is threatened with another serious increase in postal rates from June 13. It is proposed to make the rate for inland and foreign postcards 1½d., instead of 1d., for printed paper not exceeding 1 oz. 1d., instead of ½d., while foreign letters will be 3d. instead of 2½d. Other projected changes include the abolition of the collection and delivery of letters on Sunday. In announcing these changes the Postmaster-General (Mr. F. G. Kellaway) said that there would be a deficiency in the Post Office revenue on the commercial accounts of about £3 500 000 and his proposals would make this good. On postcards alone an increased revenue of £1,000 000 is expected. We have our doubts about this, but in any event the changes will have a disastrous effect upon the trade and business of the country, and it is to be regretted a more suitable method of balancing the Post Office accounts was not devised.

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Visit of Commercial Secretaries.

Mr. E. C. D. Rawlins, Commercial Secretary to H.M. Legation at Athens, and Capt. U. de B. Charles, Commercial Secretary at Madrid, are on short official visits to this country. Both will be pleased to meet manufacturers and merchants who wish to discuss questions relating to trade with Greece and (or) Spain, and who may desire information or advice regarding the appointment of agents, marketing and distributing of goods, terms of payment, Customs duties or general information as to openings for British goods.

Applications to interview Mr. Rawlins in London up to June 3 should be made to the Department of Overseas Trade, 35, Old Queen-street, S.W. 1 (the Reference Number 3 057 T.G. being quoted). Similarly Capt. Charles may be interviewed up to June 3 (reference 3 055 T.G.) Mr. Rawlins will visit provincial centres subsequently, and if circumstances permit Capt. Charles will also visit other centres after June 3

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New Zealand Customs Tariff Revision.

Some time ago the Federation of British Industries made some representations to the Prime Minister of New Zealand in regard to the proposed revision of the New Zealand Customs tariff and asked that British goods imported into New Zealand should be accorded a continuance of the preferential treatment at present in operation. The Federation has now received a reply from the Premier (Mr. Massey) in the course of which he gives an assurance that, when the new tariff is being framed, the interests of British industries will not be overlooked.

Under the circumstances the reply is very satisfactory in view of the many difficulties which have been recently experienced by British manufacturers consequent upon the recent or pending drastic revisions of Customs tariffs in most markets of the world, including those within the British Empire. It is a good illustration of the useful work that is being done by the Federation for increasing British trade and developing exports.

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The Future of the British Industries Fair.

The Committee appointed by the Board of Trade to consider the best policy to be adopted in future as regards British Industries Fairs has issued its report. The number of witnesses was limited, but a questionnaire was issued to chambers of commerce, trade associations, &c. The Committee are of opinion that the ideal arrangement would be for the Fair to be concentrated on one centre, and that centre London. In deciding whether either or both the Glasgow and Birmingham Fairs should be continued as part of the Industries Fair, the evidence showed that the Glasgow Fair did not receive enough support from the traders concerned to justify its continuance, and they recommend that the trades which have hitherto been scheduled in that section should be transferred to Birmingham. The measure of support given to the Birmingham Fair and the scope which it offers for expansion justify the Committee in recommending the continuance of the exhibition in that city.

Among other recommendations are the following : (1) That no new Fairs should be initiated in provincial centres as part of the British Industries Fair ; (2) that the Fair should be open to all branches of British industry desiring to participate, even in cases where the actual exhibition of such products as heavy machinery, engineering work, &c., is impracticable ; (3) that the Fair should continue to be held at such a time as will enable buyers from overseas to visit it *en route* to Leipzig and Lyons ; (4) that the holding of a second Fair in the year would not be justified ; and (5) that the Fair should continue in the main to be restricted to manufacturers and to wholesale firms taking the whole output of a factory or holding the selling rights of patented or proprietary articles manufactured in the British Empire.

We learn that no action has yet been taken on the recommendations.

Electricity Supply.

At Blackpool the electrical enginner (Mr. Charles Furness) has also put in similar plant, and 80 per cent. of oil and 20 per cent. of coal are used as fuel.

The Electricity Commissioners have submitted to the Minister of Transport for confirmation a Special Order for the supply of electricity by Bedwas and Machin Urban Council.

Hammersmith (London) Council is applying to London County Council for a loan of £150 000, which has been sanctioned by the Electricity Commission, for extensions of generating plant.

The Electricity Commissioners have again extended the time until July 30 for submitting schemes and for making representations in regard to the organisation of electricity supply in the Mid-Lancashire Electricity District. This is the second extension of time granted for this area.

The Minister of Transport has revoked the Herne Bay Gas and Electricity Act, 1913, as to the whole area for the supply of electricity thereunder, as from May 12, 1921, and also the Mid-Sussex Electric Lighting Order, 1913, as to the whole area of supply, as from the same date.

Matlock Urban Council has had placed before it a scheme for generating electricity by the water power of the river Derwent, and the Clerk has been directed to ascertain the Council's legal position before consulting an engineer. The Nottinghamshire and Derby Electric Power Company has supply powers in the area, but they have not been exercised.

For the past year there was a net profit of £3 111 on the Darwen Electricity Department, an increase of £1 790 over 1919-20. The units sold were 2 808 865, compared with 2 530 000. For power 2 019 343 units were sold (increase 11 per cent.), traction 501 309 (20 per cent.), private lighting, 233 693 units (35 per cent.), and for public lighting 54 520 (11 per cent.).

The accounts of Stafford Electricity Department for the year ended March 31, 1921, which have just been issued, show revenue £16 810, expenditure £12 992, gross profit £3 818, and after providing for capital charges the net deficit is £302. Units generated were 2 375 048, sold 1 989 117, and used for public lighting 10 086. Total revenue was equal to 2·016d. per unit sold, and working expenses were 1·437d.

Oil fuel is now used at many electricity stations, owing to the impossibility of getting coal, but the Blackburn electricity department claim to be pioneers in the use of oil as fuel. Large reserves of oil were purchased by the department last October and special oil plant was installed. In the circumstances this has proved to be very fortunate, for it has enabled the department to maintain the supply of electricity for all purposes.

The Stoke-on-Trent Corporation has received sanction to borrow £2 467 for the purchase of a sub-station site.

Colwyn Bay Urban Council has secured the approval of the Electricity Commissioners to the arrangement made with the North Wales Power Company for the supply of electricity from the hydro-electric station at Dolgarrog, and application has been made for sanction to borrow £25 000, which will be lent to the Power Company for the erection of the transmission lines from Dolgarrog to Colwyn Bay, and of £48 348 for the erection of the transforming and distributing stations and additional distributing mains in the urban district.

The output of the Blackpool Corporation electricity works for the year ended March 31 was over 8½ million units, an increase of 1⅓ million units over the previous year, or 20 per cent. For the first time in its history the department has been compelled to keep a waiting list of consumers, and the number of new connections last year (476) was a record. The electrical engineer (Mr. C. Furness) states that last year 22 381 tons of coal were used at a cost of £41 596, an average of £1. 17s. 2d. per ton, against an average in 1913 of 12s. 8d. per ton. In consequence of the disturbed conditions of the coal industry, four boilers are being adapted for auxiliary firing with oil fuel.

On the 18th inst. the Glasgow Electricity Department started a new 18 750 kW turbo-alternator set at the Dalmarnock power station. The set consists of a steam turbine made by Fraser and Chalmers Engineering Works, coupled to a Metropolitan-Vickers alternator. The station is being constructed in two main sections and the first section is nearing completion. The turbine room will contain five turbo-alternators of 18 750 kW each, and the present set is the second to be put into commission at Dalmarnock. When the station is fully equipped the problem of providing a cheap and abundant supply of electrical energy for all purposes within the Glasgow area will be well on the way to solution. The Electricity Department has installed oil burners at Port-Dundas Station and an extension of the use of oil fuel is in contemplation.

The whole of the public lighting standards in the main streets of Taunton have been fitted with 200-watt gasfilled lamps in Holophane "Refractor" fittings. The illumination is quite equal to the old seven ampere open type d.c. arc lamps. The boilers at the electricity works are being fitted with "Scarab" burners to burn liquid fuel in place of coal, and it is expected to effect a saving in the fuel bill as well as to make the department independent of coal supplies.

The Council are applying for an order authorising a supply to certain farms and residences in the Norton Fitzwarren and Bishops Lydeard districts through 2 200 volt single-phase overhead mains. These activities indicate that the borough electrical engineer (Mr. A. J. Howard) is animated with a true spirit of progress and a desire to get over temporary difficulties.

Electric Traction.

The first of the new electric vehicles ordered by Bath Corporation for the collection of house refuse was put into service on Monday last.

Edinburgh Tramways Committee has resolved to carry out the work of erecting the overhead equipment for the electrification of the tramways by the Council's own department.

Walthamstow Urban Council has been authorised to borrow £1 365 for an electric tower wagon for the tramways. The period allowed for repayment of the loan is 20 years, but the Council has decided to repay it within 10 years.

Though the figures of the ballot of the L.C.C. Tramway employees as to whether they should cease work in sympathy with the strikers at the Greenwich power station have not yet been announced, it is stated that there is a large majority against the strike.

As the oil fuel set at the Preston tramway power station is working satisfactorily a full service of tramcars is being run. The conversion of the boilers at the Nelson Electricity Works for consuming oil fuel is so well advanced that the tramway service has also been restored.

Like other tramway and electricity undertakings, the Bath Electric Tramways, Ltd., have installed apparatus for using oil fuel at their power station, with excellent results, and the company have found it possible to maintain their service with the use of only one of their three boilers.

Miscellaneous.

It is satisfactory to be able to record the termination of the strike of the members of the Electrical Trades' Union which recently occurred in consequence of the agreed reduction in the wages of engineers and other workers employed in shipyards. Though all the men presented themselves for work on Monday, many of them were informed that there was no work available, owing to orders having been cancelled in the interim.

At the South Western (London) Police Court last week, Frederick Newington, a branch secretary of the E.T.U., was summoned for doing an act likely to cause disaffection among H.M. forces. It appeared that one of the members of the branch, named Freeman, who had joined the Defence Force, received a communication from defendant asking for his reasons for "taking a course so violently opposed to the traditions of trade unionism and the interests of our class in general," and adding that the branch had already expelled one member for taking similar action. Later, defendant conveyed the terms of a resolution passed by the branch expelling Freeman from membership for conduct contrary to the interests of the union. For the defence, it was stated that the expulsion was due to the contributions being in arrears. The case was adjourned until June 2.

A strong and representative Advisory Committee was recently formed by the Faculty of Engineering of Liverpool University, to advise on the best course of training for prospective electrical engineers, and the first meeting of the Committee was held on Friday. The members present included the Vice-Chancellor, the professors representing the Engineering Faculty and the Department of Electrical Engineering, and the following gentlemen: Mr. H. Dickinson, City Electrical Engineer Mr. A. P. M. Fleming, C.B.E., Metropolitan-Vickers Company; Mr. H. H. Harrison, Automatic Telephone Company; Mr. A. Bromley Holmes, Mr. R. D. Livingstone (English Electric Company), Colonel E. O'Brien (L. & Y. Railway Company), and Mr. B. Welbourn (British Insulated and Helsby Cables, Ltd.) It is expected that the committee will form a closer link between the University and the electrical engineering industry in the district.

Bankruptcies and Liquidations.

Samuel Horace Dougherty, trading as the Mersey Electric Company, 106, Kensington, Liverpool, has been adjudicated bankrupt.

A receiving order has been made against Philip Downie, electrical engineer and factor, 355a, Westborough-road, and 88, Ronald Park-gardens, Southend-on-Sea.

Amalgamated Electric Works, Ltd., is being wound up voluntarily, and Mr. J. L. Mahon, Windsor House, Kingsway, W.C.2, has been appointed liquidator.

Claims against Jas. Sherret Denley, trading as Denley & Company, electrician, &c., 69, Regent-st., Cheltenham, are to be sent by June 4 to Mr. T. Easton, 26, Baldwin-street, Bristol.

R. B. Hand & Company, Ltd. (electrical and mechanical engineers), is being wound up voluntarily, and Mr. P. J. Hooper, 53, The Broadway, Wimbledon, S.W., has been appointed liquidator. A meeting of creditors will be held at 175, Lavender-hill, S.W.11, on June 25.

The Gröndal Kjellin Company (1917), Ltd., is being wound up voluntarily, and Mr. F. W. Paddon, 20, Abchurch-lane, London, E.C., has been appointed liquidator. A meeting of creditors will be held at 20, Abchurch-lane, on June 1. Claims to Mr. Paddon by June 18.

Horace Edgar Carr, electrical contractor, Carlisle-street, Goole, has been adjudicated bankrupt. The first meeting of creditors will take place to-day (May 27) at the Station Hotel, Goole, and the public examination on July 7, at the Court House, Wood-street, Wakefield.

A meeting of the creditors of the Amalgamated Electrical Works, Ltd. (in vol. liq.), will be held at Winchester House, Old Broad-street, London, E.C., on May 31. Claims are to be sent to the liquidator, Mr. J. Lindsay Mahon (Messrs. Spooner, Bourke & Co.), Windsor House, Kingsway, W.C.2, by June 18.

Institution Notes.

The following have been elected officers of the Association of Teachers in Technical Institutions for the year 1921-1922 :—*President :* Principal G. Knox (South Wales School of Mines) ; *Vice-President :* Mr. J. Paley Yorke (L.C.C. School of Engineering, Poplar) ; *Ex-President :* Mr. E. L. Rhead (School of Technology, Manchester) ; *Hon. Secretary :* Mr. W. W. Sirman (Technical School, Handsworth) ; and *Hon. Treasurer :* Mr. J. W. Riley (Technical Institute, Rochdale).

An exhibition of radiographs will be held by the Röntgen Society, at the rooms of Royal Photographic Society, during the whole of June being open daily, Sundays excepted, to the public between the hours of 10 a.m. and 5 p.m. Dr. Robert Knox, the President, is offering silver and bronze plaques for the best and second-best collection of four prints, the work of an assistant employed at a hospital or working for a qualified radiologist. Prints should be sent in not later than May 24, to the Secretary, Röntgen Society Exhibition, 35, Russell-square, London, W.

We are glad to see that the possibilities of electricity are being brought to the attention of the various Rotary Clubs. The latest to receive education in this respect is the one at Sheffield, where Mr. A. E. Jepson recently delivered a lecture on the Domestic Uses of Electricity. He laid stress on the importance of the development of electricity for domestic purposes, especially in view of the difficulties which frequently arise in regard to coal supplies.

The annual general meeting of the British Engineers' Association took place on the 12th inst., and at a subsequent meeting of the Council Mr. Nevile Gwynne, late Chairman of the Executive Committee, was elected President of the Association in place of Col. O. C. Armstrong, D.S.O., who has occupied the position of President for three years and to whom a hearty vote of thanks was accorded. Mr. E. W. Petter was elected Chairman of the Executive Committee.

Further particulars have now been issued regarding the annual autumn meeting of the Institute of Metals, which is to be held in Birmingham from September 21-23. On September 21 there will be an official welcome by the Lord Mayor, and a visit will be paid to the University Buildings at Edgbaston. Papers will be read and discussed on September 22, and a garden party has been arranged for the evening. The last day will be available wholly or in part to motor excursions.

In a communication issued by Mr. Alex. C. Cramb, the hon. secretary of the Incorporated Municipal Electrical Association, it is announced that the President and Council, having carefully considered the possibility of holding the Convention in Dundee and neighbourhood from the 13th to the 17th June, reluctantly came to the conclusion that, in view of the conditions prevailing, they had no other course open but to cancel the Convention for this year. Before coming south, the President discussed the matter with Councillor Hynd, chairman of Dundee Corporation Electricity Committee, and they agreed that it was not possible, for many reasons, to hold the Convention at a later date.

The Dundee Convention will, therefore, not take place, but the Annual General Meeting will be held in London on July 22, and in order that members may have an opportunity of meeting one another, the Council propose to hold the annual dinner (to which ladies are invited) the previous evening. The time and other details will be issued later. In view of the immense amount of trouble the President and the Dundee Local Committee have taken to ensure that the Convention should be a great success, the Council hope that members will show their appreciation of their efforts by supporting the President at the dinner and general meeting in full strength.

An X-ray and radium protection committee has been formed and a preliminary meeting was held last week. The Committee is composed as follows : Sir H. Rolleston, K.C.B., M.D., F.R.C.P. (chairman) ; Sir Archibald Reid, K.B.E., and Dr. Robert Knox, representing the British Association for the Advancement of Radiology and Physiotherapy ; Dr. S. Gilbert Scott and Dr. Stanley, representing the Electrotherapeutic Section of the Royal Society of Medicine ; Dr. Harrison Orton, Mr. Cuthbert Andrewes and Prof. S. Russ, representing the Institute of Physics ; Dr. G. W. C. Kaye, O.B.E., and Dr. J. C. Mottram. The Medical secretary is Dr. Stanley Melville.

The Committee intend to issue very shortly a considered statement as to the urgency of affording adequate protection to the worker, indicating the best means whereby this may be carried out. For this purpose a Sub-Committee has been appointed. The Committee will also collect data and carry out special research if necessary, &c.

The second annual general meeting of the Women's Engineering Society was held on the 20th inst., Lady Parsons presiding. The annual report was read by the Secretary (Miss Haslett) and stated that, in spite of general industrial troubles, the Society could look back on the year's work and feel that substantial progress had been made. Public interest was growing, and several lectures in the winter months had been enthusiastically attended. In answer to numerous inquiries, the Society had issued a pamphlet on training for the would-be woman engineer and the little quarterly magazine had also been well supported. The Society had been able to put several members into touch with good technical and administrative posts, and those had been successful both from the point of view of the firm and the employee. One of the most notable features of the year, however, had been the formation of Atalanta, Ltd., a small engineering works at Loughborough, run by women for women, and although it was, perhaps, negligible in size, work had already been accomplished on a commercial basis. An important and far-reaching event was the recognition of women to membership of the principal engineering institutions.

After the accounts had been adopted, there was an interesting discussion on " Women's Position in Engineering Management."

Telegraph and Telephone Notes.

It is announced that successful tests have been made in transmitting radio-telegraph messages on the ordinary telegraph wires between Paris and Nogent-le-Rotrou. The messages sent by wireless are received direct by the ordinary wireless apparatus and transmitted without the need of an intermediary. In recent experiments a speed of 7 000 words an hour, which is the ordinary rate of a wire system, was attained.

The Post Office has authorised the Midland Railway Company to establish Wireless Communication between certain points on their system, and Marconi's Wireless Telegraph Company has also been conducting tests between certain points on the L. & N.W. Railway system. An application from the company to carry out a more extended trial is at present under consideration. The stations are used solely for the purposes of the railway companies.

The London & District Association of Engineering Employers, acting on behalf of the Marconi International Marine Communication Company and Messrs. Siemens Bros. & Company, have proposed a reduction in the pay of wireless telegraphists, whose rates of pay are covered by an agreement entered into between the employers and the Association of Wireless Telegraphists. The matter will come before the Industrial Court for arbitration under the Industrial Courts Act.

The Postmaster-General has informed Captain Wedgwood Benn that the reduced charge of £1 17s. 6d. a quarter for the second and each subsequent telephone line was intended to apply when there is auxiliary working—that is, when the lines bear consecutive numbers, so that incoming calls can be passed, if one line is engaged, to another line in the group. There are only a few cases where additional lines are rented without auxiliary working, and it has been arranged that these subscribers shall be allowed the benefit of the reduced charge.

The new twin-screw cable-laying steamer " All America," which is being built by Messrs. Swan, Hunter & Wigham Richardson (Ltd.), for the All America Cables, Inc., of New York, was launched on Friday last. The steamer, which is about 295 ft. in length overall, is designed to carry a total deadweight of about 1 750 tons on about 18 ft. mean draught, but can carry a much larger deadweight in case of need. The propelling machinery consists of twin-screw triple-expansion engines of the builders' design and make, and the boilers are arranged to burn oil fuel. The naming ceremony was performed by Mrs. Merrill, wife of the President of the All America Company.

Post Offices in London and the Provinces will now accept wireless messages to persons on ships at sea (which are within range of the coastal wireless stations of the United Kingdom), without requiring the sender to specify the wireless station through which the message should be transmitted. This new arrangement removes a serious obstacle in the free use of wireless between this country and ocean travellers. There is now a special department for routing wireless messages, and counter-clerks in the London and Provincial offices will accept messages for ships of all nationalities provided it is known that those ships can be communicated with direct by the coastal wireless stations. The messages so accepted are sent to a " routing bureau " in London, whence they are distributed according to the movements of the vessels for which they are addressed.

Catalogues, Price Lists, &c.

A leaflet (F. 2481) on the Directive System of Street Lighting has been issued by the General Electric Company, Ltd., Magnet House, Kingsway, W.C. 2, and contains an illustrated description of the Harrison system of illuminating the long narrow rectangular areas represented by streets. Hitherto street lighting lanterns have been designed to distribute the light downwards, so that each unit illuminated a circular area, but with the directive system the minimum illumination is increased 10 to 20 times that obtained from existing types of lanterns and the cost of electrical energy and maintenance is reduced. A number of lanterns for use with Osram gas-filled are shown in the leaflet.

The Sun Electrical Company, Ltd., 118 & 120, Charing Cross-road, W.C. 2, proclaim themselves firm believers in the future development of the electrically equipped home. As the result of an investigation of 18 months on electric washing machines the Company state that they have decided to act as sole wholesale distributors of the " A.B.C. electric Laundress." The A.B.C. is the product of a pioneer company which claim to be the largest exclusive washing machine makers in the world, and the Sun Company are issuing a pamphlet and other literature which give a detailed specification and particulars of the A.B.C. super washing machine. A book is in preparation which will give the construction, application and general methods of washing by the machine. The mechanism rotating the cylinder is quite simple, and the action astonishingly effective. Some washers lift and dip the clothes and others rock and toss them, but the A.B.C. Super Electric combines both these methods. It is totally enclosed and therefore safe ; it consumes considerably less current than is taken by the average electric iron, and it is also economical in other respects. At present the Sun Company are in a position to supply white maple cylinders, as experience has shown these to be the best, but they are arranging for a supply of zinc cylinders of special construction. A further development, which will be ready in the course of a few weeks, is the A.B.C. 100 per cent. Ironer, which is operated from the A.B.C. super washer, making it the only complete electric laundress available. It is said that the factory has manufactured and sold 200 000 washing machines.

Obituary.

Sir James Pender, Bart.

We regret to record the death of Sir James Pender, Bart., which occurred on Friday, the 20th inst. Sir James was born in 1841, being the eldest son of the late Sir John Pender, G.C.M.G. (first Chairman of the Eastern and Associated Cable Companies) by his first wife. In 1867 he married Mary Rose, the third daughter of E. Gregge Hopwood, Esq., of Hopwood Hall, Lancs., who survives him. He was connected, from time to time, with a number of business concerns, and many years ago went out to South Africa as representative of the Eastern & South African Telegraph Company, where he carried out important negotiations.

In later years, Sir James was Chairman of the Aron Electricity Meter, Ltd., and the Direct United States Cable Company, a Director of the Globe Telegraph & Trust Company, the Telegraph Construction & Maintenance Company, Ltd., the Electric Construction Company, Pritchett & Gold & E.P.S. Company, and other electrical undertakings. He was also Chairman of the Kodak Limited from its inception in 1898 until July, 1913, when he retired from the Company. He was Member of Parliament for Mid-Northamptonshire from 1895 to 1900, and in 1897 a baronetcy was conferred upon him. He was also a Justice of the Peace for Linlithgowshire, Northants and Wiltshire, and for a time was associated with the King's Own Borderers. His country residence during the last 20 years was Donhead House, Donhead, St. Andrew, Salisbury. Sir James was very popular in society, and until recently was fond of hunting and yachting, having been a member of the Royal Squadron Yacht Club. He was also a Flag Officer of the Royal Thames Yacht Club, and for a time he was Rear-Commodore. During the last six months his health was failing, and on the morning of Friday last he passed peacefully away. There were no children of the marriage, hence the Baronetcy lapses.

We also regret to announce the death of Mr. Charles Louis Oechsner, manager of the advertising department of the British Thomson-Houston Company, whose genial personality made him a large circle of friends in the engineering world. Mr. Oechsner had been ailing for some time and went to Bournemouth at Easter to recuperate; a week later he took to his bed and passed away on the 15th inst. Born on March 26, 1866, at New Orleans, La (U.S.A.), Mr. Oechsner has been associated with various activities of the British Thomson-Houston Company since 1888, joining the London staff in 1899, and the Rugby Staff in 1901. He will be greatly missed, not only by his many friends in the B.T.-H. organisation, but by those who knew him during his long association with the company. The funeral took place at Bournemouth on the 19th inst.

Science has suffered a loss by the death of Dr. Edward B. Rosa, Chief Physicist at the Bureau of Standards, Washington, D.C. Dr. Rosa was connected with the Bureau for 17 years, and he died suddenly on the 17th inst. He was known in England from his attendance at meetings of the British Association, but mainly on account of his publications on electrical and scientific investigations. He had been secretary of the International Scientific Association.

Personal and Appointments.

Hammersmith (London) Electricity Committee has appointed Mr. Frank V. Jordan, of Biggleswade, as assistant mains engineer.

Dr. J. Russell Reynolds has been appointed radiologist at Charing Cross Hospital, in succession to the late Dr. Ironside Bruce, who died as the result of continued exposure to X-rays.

At the recent General Election in Italy Mr. A. S. Benni, Vice-Chairman of the well-known electrical firm, Messrs. Ercole Marelli & Company, S.A.I., Milan, and a director of Messrs. Ercole Marelli & Company, Ltd., of London was returned for Milan as a member of the National Party.

At a recent meeting of the Bradford Technical Education Emergency Committee, Mr. Harold James Davis, M.A., was recommended for appointment to a lectureship in mathematics in the Bradford Technical College. Mr. Davis was educated at King's School, Chester, and proceeded with a mathematical scholarship to St. John's College, Cambridge, in 1908. He took his B.A. degree in Part II of the Mathematical Tripos in June, 1911; he was placed amongst the wranglers and gained the (b) mark of distinction in the advanced part of the examination. Mr. Davis is at present Senior Lecturer in Mathematics in the University College, Southampton, and has specialised on the theory of statistics.

Business Items, &c.

John Hy. Allport and Harry Davies, trading as Allport & Davies, motor and electrical engineers, &c., Underhill-street, Bridgnorth, have dissolved partnership.

We are advised by Messrs. Johnson & Phillips, Ltd., Charlton, S.E.7, that their boiler plant has been converted to burn oil fuel. Ample stocks of raw materials are on hand at Charlton, and therefore the firm can assure their customers of uninterrupted supplies of J. & P. cables, switchgear, transformers, instruments, &c., irrespective of the duration of the coal strike.

We are informed that, by arrangement with the United Water Softeners, Ltd., Mr. J. J. Lassen has taken over the meter department. of that company, and has formed a separate concern under the title of the Lassen Meter & Engineering Company, Holders Hill House, Hendon, London, N.W.4, which will specialise in the manufacture of the Rheograph water flow recorder and the Lassen patent tipper meter for use in connection with boiler installations.

Tenders Invited and Accepted.

Hackney (London) Guardians want tenders by June 11 for the supply of a petrol or electric ambulance. Quotations to the Clerk, 2, Sidney-road, Homerton, E. 9.

West Ham Guardians want tenders by June 16 for three months' supply of electrical fittings, engineers' oils, &c. Forms of tender from the Clerk, Union-road, Leytonstone, E. 11.

Dundee Corporation invite tenders for a motor-generator consisting of a 400-V d.c. motor, and a generator to give 75 V 130 A at 800 revs. per min., with starter and regulator. Tenders to the City Architect, 81, Commercial-street, Dundee, by June 6.

Greenock Corporation require tenders by June 6 for electric lighting work in 18 tenements and 6 double cottages in connection with their Upper Cornhaddock housing scheme. Schedules, &c., from the Office of Public Works, Municipal Buildings, Greenock.

It is notified that the date on which all tenders for the supply of plant and material for the electrification of the Cape Town-Simonstown & Durban-Pietermaritzburg Railway lines has been extended to noon, July 5. Tenders to the High Commissioner for the Union of South Africa, Trafalgar-square, London, W.C.

The District Committee of the Lower Ward of the County of Lanark require tenders by May 30 for electric wiring, &c., of 198 houses comprised in the Eastfield, Auchinairn and Carmannock housing schemes. Forms of tender, &c., from the Clerk of the District Committee, 15, West George-street, Glasgow.

The Victorian Government Railway Commissioners invite tenders for the supply and delivery of 50 oil-immersed single-phase track and signal transformers for power signalling (contract No. 33 901). Tenders to the Commissioners, Spencer-street, Melbourne, by June 15. Specifications may be consulted at the Department of Overseas Trade.

The New Zealand Public Works Department invite tenders for the supply and delivery at Lyttelton of two 50-kVA, two 100-kVA and two 200-kVA condensers, in connection with the Lake Coleridge electric power supply scheme (Section 116); and also for 10 single-phase oil transformers for the Waikato power scheme for converting three-phase current at 50 cycles, the voltage ratio being 50 000/11 000. Tenders by June 28 to the Secretary of Public Works, Tenders Board, Wellington.

New Zealand public works department also invite tenders for suspension type porcelain insulators to carry 110 000 V 50-cycle transmission lines in connection with the Waikato power scheme. Tenders by August 9 to the Secretary, Public Works Tenders Board, Wellington. Specifications may be seen at the Department of Overseas Trade.

The New Zealand Post and Telegraph Department, Wellington, require tenders by June 14 for 7 460 lamps for various voltages and 12 bulbs for hand accumulator lamps. Specifications may be seen at 35, Old Queen-street, S.W.1.

The Victorian Government Railways Department invite tenders for the supply and delivery of a lifting magnet and motor generator with control apparatus (Contract No. 34 072), machines (including lathes, drills, &c.) (No. 34 028), an industrial storage battery truck and battery charging equipment (No. 34 070), varnish and compound for impregnating plant (No. 34 084), copper rod (10 ton $1\frac{1}{8}$ in. and 10 ton $1\frac{1}{16}$ in.), &c. Tenders to the Victorian Railway Commissioners, Spencer-street, Melbourne, by June 22, in the case of the first two items, and by June 29 in the case of the remainder. Specifications may be consulted at the Department of Overseas Trade.

Tenders are invited for the supply of the following plant and material for the Municipality of Bulawayo (Rhodesia):—(a) two sets of gas-producing plant, (b) gas engines, (c) 3, with alternative of 4, three-phase 300-kW generators, (c′) alternative steam plant, (d) main switchboard, (e) switchgear distribution and transformer houses, (f) poles and cross-arms, (g) insulators and shackles, (h) h.-d. copper wire, (j) three-core cable, (k) insulated cable, (l) lighting arresters and choke coils, (m) transformers, (n) bus-bar copper, insulators and Crosby clips, (p) stay rods, stay wires and swivels. Specifications from Messrs. Davis & Soper, 54, St. Mary Axe, London, E.C. 3, to whom tenders by Aug. 3

Leeds Electricity Committee has placed an order with W. T. Henley's Telegraph Works Company for the supply of cables at £7 568.

Sheffield Corporation has accepted the tender of Agricultural & General Engineers, Ltd., for the supply of 10 $2\frac{1}{2}$-ton electric vehicles at £1 015 each, and that of the General Vehicle Company for four $3\frac{1}{2}$-ton electric vehicles at £1 299 each.

The half-yearly contract for the supply of metal gas-filled and carbon filament lamps to H.M. Office of Works has been secured by the General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2. This important contract runs into many thousands of lamps, and the fact that it has been again passed to the General Electric Company is a testimony to "Osram" quality and service.

Important contracts for electrical plant and apparatus have been let by the Electricity Commission of Victoria in connection with the Morwell brown coal scheme. The tender of the International General Electric Company has been accepted at £379 000 for switchgear and transformers, and that of the American Aluminium Company for aluminium steel conductors at £91 416 at port of shipment. At the present rate of exchange the cost in Melbourne will be £30 000 less than the lowest tender for copper conductors. The whole equipment will be manufactured and shipped from Canada. The tender of the International Company is said to have been less by £200 000 than the lowest possible combination of British tenders!

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications

136 156 **Colner Elektromotorenfabrik Johannes Bruncken.** Induction motors. (7/2/19).
145 1[illegible] **Bosch (Firm of).** [illegible] (11/[illegible]/19)
145 527 **Bosch Akt-Ges.** Electric starting devices for internal combustion engines. (26/5/19).
147 447 **Ges. Fur Drahtlose Telegraphie.** Conveyance and distribution of high-frequency electric currents. (28/5/19).
147 571 **Siemens-Schuckertwerke. Ges.** Manufacture of composite conductors for dynamo-electric machines and other electric apparatus. (14/12/17).
147 596 **Krupp Akt-Ges.** Electrically-controlled valve gear of a hydraulic gun-laying mechanism. ([illegible]/11/17)
151 612 **Akt. Ges. Brown, Boveri et Cie.** Process for regulating the voltage in metal vapour rectifier installations. (22/9/19).

Relates to a process for regulating the voltage of metal vapourrectifier installations by means of choking coil inserted in the anode circuit, characterised by the feature that each choking coil, in addition to being excited by the anode current, is also excited by a direct current voltage independently of the value of the main direct current in the same sense as by the anode current, and that the regulation of the rectifier voltage is effected by regulating this direct current excitation.

152 325 **Siemens Schuckertwerke Ges.** Cooling arrangements for dynamo-electric machinery. (8/10/19). Addition to 138 342).
154 537 **Hanson.** Wireless transmission of speech. (18/6/17).
154 878 **Locknitzer Eisenwerk. Ges.** Dynamo Electric machines. (2/12/19).
156 086 **Fabriques des Montrose Zenith.** Magnetos for internal combustion engines. (29/12/19).
160 844 **Quain.** Electric heaters. (27/7/18. Cognate Application, 13 733/18).
160 846 **B. T.-H. Co., Ltd.** (General Electric Co.). Undirectional radio-receiving systems. (18/3/19).

Comprises two receiving antennæ with their centres of distribution spaced apart associated with a receiving circuit and means for adjusting at will the phase of currents impressed upon the receiving circuit from the two antennæ so that currents produced by waves coming from a desired point may be neutralised in the receiving circuit, while currents produced by waves transmitted by another predetermined station may act cumulatively in the receiving circuit.

160 860 **Westrup & Westrup.** Electrical and other wire or cord or flex adjusters. (12/9/19).
160 863 **Watson** Combined double pole electric switch and plug. (19/9/19).
160 888 **Siemens Bros. & Co., Ltd., Grinsted & Petithory.** Electric relays. (28/10/19).
160 890 **Deakin.** Insulating and anchoring device for electric lamp holders and other electric fittings. (29/11/19).
160 894 **Colner Elektromotorenfabrik Johannes Bruncken.** Induction motors. (17/7/19. Addition to 136 156).
160 916 **Automatic Telephone Mfg. Co., Ltd., Harrison & Smith.** Telegraph printing systems. (29/12/19).
160 931 **North & Allen.** Magneto-electric machines. (30/12/19).
160 932 **Ely & Foster Engineering Co.** Audible and visible electric signalling systems for calling attendants. (30/12/19).
160 941 **B.T.-H.Co.,Ltd.** (General Electric Co.). Radio-receiving systems. (31/12/19).

A system provided with apparatus for generating undamped high frequency oscillations, which apparatus is adjusted so as to be normally inoperative but is arranged to be set into operation by received high frequency waves in order to produce high frequency oscillations at the receiving station, in which a current which changes at a frequency below audible frequency is produced by the high frequency oscillations locally produced and actuates apparatus for producing a desired indication of signals.

160 957 **Quasi-Arc Co., Ltd., & Strohmenger.** Electrodes for use in electric welding or fusion deposition of metals. (7/1/19).
160 971 **Electric Heating & Hardware Co., Ltd., and Wineberg.** Electric heating device. (10/1/20).
160 975 **Murphy.** Wireless direction finding systems. (13/1/20).
160 978 **White.** (Toledo Standard Commutator Co.). Commutators for dynamo-electric machines. (13/1/20).
160 981 **Radio, Ltd., & Donisthorpe.** Portable radio telegraphic and telephone apparatus. (14/1/20).
161 011 **B. T.-H. Co., Ltd.** (General Electric Co.). Electric resistances. (28/1/20).
161 026 **Osborn.** Incandescent electric lamps. (6/2/20).
161 115 **Crowther & Makower.** Thermionic valves and the like. (2/2/20. Divided Application on 30 355/19).
17733/14 **Kende.** Electric metallic filament incandescent lamp. (27/7/14).

APPLICATIONS FOR PATENTS.

November 15, 1920.

32 159 **Bosch.** High-tension electric ignition devices.
32 202 **Glanzer (Bormann).** Arrangement for avoiding injurious effects of diffusion in galvanic batteries.
32 208 **Harrison (Dow Chemical Co.).** Electrolytic cells.
32 217 **Maschinenfabrik Oerliken.** Electric heating device. (13/11/19, Switzerland.)
32 2[illegible] **Taylor.** Superposing currents of different frequencies upon existing a.c. systems.
32 225 **Morris-Airey, Shearing & Macrorie.** Transmission circuits for wireless telegraphy, &c.
32 226 **Appleton & Macrorie.** Reception of continuous waves in wireless telegraphy, &c.
32 227 **Von Essen.** Switches. (23/12/19, Sweden.)
32 232 **Fabriques des Montres Zenith.** Alternating current meters. (13/3/18 Switzerland.)
32 233 **Morshead & Selvey.** Cooling electric machines.
32 235 **Elwell & Mamlok.** Thermionic valves.
32 247 **Oldham.** Galvanic batteries.
32 248 **Oldham.** Magnetic locks.
32 249 **Krist & Rasch.** Utilisation of cosmic electricity.

November 16, 1920.

32 278 **Taylor.** Working reverse-current relays under short-circuit conditions.
32 281 **Crabtree.** Switches.
32 288 **Automatic Telephone Mfg. Co. & Roseby.** Relays, &c.
32 2[illegible] **Leitner.** Electric accumulators, &c.
32 306 **Robinson.** Electric heating units.
32 307 **Rossi** Automatic control of heating elements.
32 328 **B. T.-H. Co. (G.E.Co.).** Electric machines.
32 348 **Thermal Electric Works & Swainson.** Electrically connecting pipes, &c.

November 17, 1920.

32 366 **Watts.** Switch.
32 378 **Walker.** Inductance coils and electric harmonic analysers.
32 421 **Nelson.** Device for disconnecting and replacing electric lamps, &c.
32 422 **Legge.** Magnetic fuses.
32 432 **Schaftner.** Excess-current indicators.
32 451 **Read.** Control of electric supply plant.
32 464 **Willmott.** Electrical apparatus.
32 469 **M. L. Magneto Syndicate & Watson.** Magnetos.
32 495 **Fisher.** Electric lamps and switches for automobiles.
32 500 **Naamlooze Vennootschap Philips' Glocilampenfabriken.** Incandescent lamps (21/11/19, Holland.)

November 18, 1920.

32 507 **Telford, Grier & Mackay.** Indicating in chart-room, &c., whether navigation lamps are burning.
32 514 **Lomax.** Connecting electric conductors, &c.
32 515 **Lomax.** Electric lamp-holders.
32 522 **Creasey.** Electric indicating devices for showing state of distant circuits.
32 523 **Scott-Taggart.** Combining effects of electric potentials.
32 554 **Johnston.** Method of eliminating interference in radio-communication.
32 558 **M. L. Magneto Syndicate & Lister.** Magnetos.
32 569 **Potter (Pernot & Rich).** Selective reception of alternating currents.
32 570 **Potter (Pernot & Rich).** Apparatus for electric transmission of intelligence.
32 589 **McKenzie, Holland & Westinghouse Power Signal Co.** Alternating-current relays. (6/8/20, France.)
32 606 **York.** Portable electric lamps.
32 609 **Kendall.** Three-position relays. (18/8/20, U.S.)

November 19, 1920.

32 681 **Wilson.** Electric lamp shade inverter.
32 691 **Bleriot & Stephenson.** Magnetos.
32 709 **Bullimore.** High-frequency electrical apparatus.
32 733 **B. T.-H. Co., Wedmore & Trencham.** Switches
32 744 **Carman.** Gasfilled incandescent electric lamps.
32 746 **French.** Electric machines.
32 747 **Spencer.** Tramcar brakes.
32 748 **Kuhlo.** Electric cooking apparatus

November 20, 1920.

32 781 **Smith (F.) & Son & Keitley.** Electric plugs or contact members.
32 788 **Mohl.** Aerial masts for wireless telegraphy, &c.
32 807 **Daimler Co. & Berriman.** Electric-lighting systems for motor vehicles
32 808 **Beeton.** Apparatus for converting heat into electrical energy.
32 809 **Ford.** Miners' electric lamps.
32 813 **Henley's Telegraph Works Co., Dunsheath & Grover.** High-tension cables.
32 820 **Edison Swan Electric Co. & Elliott.** Holders for electric candle-lamps.

November 22, 1920.

32 836 **Valentine.** Wind-power electric lighting plant
32 838 **Parsons.** Selector switches.
32 869 **Barber.** Electric switches, fuses, &c.
32 890 **Pintsch (J.) Akt.-Ges.** Electric luminous discharge lamps. (21/11/19, Germany.)
32 909 **Haddan** (Atlantis Akt.-Ges.) Tramway rails and tracks.
32 934 **Edison-Swan Electric Co. & Raphael.** Bonding and fixing metal covered cables, &c.
32 936 **Garde.** Switches.
32 940 **Roots.** Electric power transmission from fluid pressure engine to driving shaft, &c.

November 23, 1920.

32 976 **Coxon & Williams.** Renewal of valve filaments for wireless telegraphy, &c.
32 981 **Letondu.** Focussing vehicle electric lamps.
32 992 **Horn & Tessrugun.** Overhead electric lines.
32 995 **Western Electric Co.** Insulated tubes.
33 004 **Fiedler & Hopfner.** Electro-magnetic arrangements. (5/2/20, Germany.)
33 015 **Bransom & Read.** Control of electric generating plant.
33 017 **West & Co. & Wise.** Controlling circuits of electro-magnets.
33 028 **Waygood-Otis, Ltd.** Push-button control lifts, &c
33 048 **Metropolitan-Vickers Electrical Co.** Electric speed regulator systems. (12/1/20, U.S.)
33 056 **Hanson.** Wireless transmission of signals. (27/8/17, U.S.)
33 057 **Hanson.** Wireless phonographs, &c. (4/6/18, U.S.)
33 058 **Hanson.** Directing and controlling self-propelled torpedoes, &c. (4/6/18, U.S.
33 059 **Hanson.** Radio-signalling systems for life-boats. (20/2/19, U.S.)
33 060 **Hanson.** Locating ore bodies by electrical means. (7/5/19, U.S.)
33 061 **Hanson.** Electro-therapeutic apparatus. (12/7/19, U.S.)
33 062 **Hanson.** Telephone apparatus for the deaf. (11/6/19, U.S.)
33 063 **Hanson.** Wireless transmission of speech. (18/6/17, U.S.)
33 068 **Bransom & Read.** Electric lighting, heating and power installations

November 24, 1920.

33 093 **Dennis.** Electric switches for use on ships.
33 099 **Tregoning.** Connecting fittings for electric lights, &c.
33 107 **Hanmer.** Electric tail-lamp for cars, &c
33 116 **Raven.** Arc lamps.
33 122 **Timmins.** Fuse-contact.
33 1[illegible]3 **Donovan.** Automatic switch.
33 141 **Nakao & Tsuji.** Inverted pole accumulator.
33 158 **Lucas & Turner.** Electric starting mechanism for engines.
33 16[illegible] **Ferranti.** Accumulators for operating engines, &c.
33 169 **Platschick.** Mounting brush holders on motors.
33 188 **Wood.** Recording telephone calls.
33 192 **Ferguson.** Portable electric light and power plant.

November 25, 1920.

33 267 **Keeling.** Typing by wireless.
33 277 **Crick.** Arc lamps.
33 289 **Ellis.** Aerials for wireless signalling.
33 292 **Ainsworth, Hopkinson & Bailey.** Electric junction boxes, &c.
33 319 **Stone (J.) & Co.** (Heaton.) Train lighting, &c., dynamos.

November 26, 1920.

33 364 **Hammond.** Devices for testing sparking plugs and magnetos.
33 369 **Bassett.** Electric iron.
33 393 **Crompton, Smith & Church.** Alternating current generators.
33 397 **Comber.** Electric window cleaner.
33 437 **Akt.-Ges. Brown, Boveri et Cie.** Transformers for feeding metal vapour rectifiers. (27/11/19, France.)
33 478 **Ingle.** (Speight.) Contrivance to ensure secrecy of telephone conversations.
33 489 **Hodgkinson.** Direction finding foround waves.

November 27, 1920.

33 500 **Adams.** Fitting for mechanical or electrical horns.
33 509 **Bosch (R.) Akt.-Ges.** High-tension ignition devices.
33 515 **Haddow & Rutherford.** Lamp and switch holder.
33 523 **Barker, Wilde & Moore.** Control of electric heating apparatus.
[illegible] **Leitner.** Electric accumulators.
33 562 **Pepper.** Batteries. (29/11/19, U.S.)
33 570 **McCar.** Electrical communication. (4/12/19, U.S.)

November 29, 1920.

33 626 **Railing, Owen & Quance.** Electric wiring systems.
33 648 **B. T.-H. Co.** (G. E Co.) Meters.
33 649 **B. T.-H. Co.** (G. E. Co.) Motor control systems.
33 684 **Henley's Telegraph Works Co. & Wakefield.** Spring contacts for fuse carriers, &c.
33 703 **Defour.** Electro-mechanical utilisation of tides.

November 30, 1920.

33 773 **Cooper.** Dynamo-electric machine.
33 796 **Metropolitan-Vickers Electric Co. & Fletcher.** Control of motors.
33 799 **Barron.** Electric lamp fittings.
33 805 **Comboni.** Switches.
33 806 **Holslag.** Arc welding.
33 813 **Round.** Heating filament contained in vacuous bulb.
33 831 **Igranic Electric Co.** (Cutler-Hammer Mfg. Co.) Motor control.
33 832 **Igranic Electric Co.** (Cutler-Hammer Mfg. Co.) Relays.
33 833 **Igranic Electric Co.** (Cutler-Hammer Mfg. Co.) Motor controllers.
33 846 **Fienberg & Wakeham.** Electrically-operated door latch control.

Companies' Reports, &c.

BRITISH THOMSON-HOUSTON COMPANY.

Mr. H. C. Levis presided over the annual meeting of the British Thomson-Houston Company, Ltd., on the 18th inst., and in moving the adoption of the report and accounts stated that the Company had completed the first quarter-century of its existence. For many years the growth of the company was very slow, because of the depressed state of the electrical business in this country and of the competition which existed. About 1912, however, matters commenced to improve, and that improvement had been steadily maintained up to nearly the end of the year under review, when a reaction began. Notwithstanding that falling off, the year, as a whole, was a record one, and as a result, the volume of orders on hand on January 1 last was larger even than in 1920, particularly in heavy plant. The depression which began towards the end of last year had continued, but it was to be hoped that the present industrial conditions would be so settled in the near future that a revival of trade would take place, and he could not help feeling that such a revival would take place soon after the present strikes were settled, for the reason that the number of important inquiries they were receiving was large. It must also be remembered that there was a great shortage of electrical machinery which must be made up when prospective purchasers were in a better position to finance their requirements.

The Increased Capital and Extensions.

The issues of shares had been substantially completed, with the result that they had outstanding on Dec. 31 last, 2 000 000 ordinary shares and 1 500 000 cumulative preference shares of the par value of £1 each, making the total shares issued £3 500 000. The proceeds were used to liquidate debts and for other purposes. The only cost of issue was the Government tax on the new shares, which, although a heavy item, had been written off. The Debenture stock outstanding amounted to £152 295; £5 300 was retired annually by drawings at 105, and the total amount redeemed was £59 705. During the year, there was expended on factories the large sum of £595 000. That included payment for the factory at Birmingham, certain additions at the Willesden factory which had considerably increased their manufacturing facilities, and also work on important additions to the Rugby factory, and, finally, in connection with new works now being constructed at Chesterfield. Building progress, particularly on the extensions at Rugby, had been painfully slow. The total floor space of the various plants was about 1 650 000 square feet, and the number of employees was over 9 000.

Increased Profits.

The year's profits after deducting all expenses and charges other than interest on debentures and loans, and after making provision for estimated war taxation for 1920, were £470 470, an increase of nearly £60 000 over those of 1919. That was realised because the unfilled orders on the books at January 1, 1920, were, up to that time, the largest in the history of the company, and further, that the volume of orders received during the year formed a new record. With the amount brought forward (£208 431) the total to be dealt with was £678 901. After deducting interest on debentures and loans (£179 990), plant depreciation (£60 000) and reserve (£150 000) there was a balance of £288 910, subject to adjustment of reserves made for Excess Profits Duty for 1918, 1919 and 1920. It was proposed to pay dividends aggregating £63 019, and to carry to the new account £225 891, about £17 000 more than was carried forward last year. After dealing with the proposed dividends, Mr. Levis stated that as many of their employees had expressed a desire to become financially interested in the company, the directors had arranged to offer to them Savings Certificates in multiples of £10, bearing interest at 7 per cent. per annum (tax free) and with a right of participation in the earnings of the company under certain conditions. They were to be paid for on an instalment plan, which would spread the payments over nearly two years. At any time an employee could apply for repayment, and, on the other hand, the company could pay off the certificates. They were personal to the employee and were not negotiable or assignable. Later on, the company might decide to offer some of its shares to its employees on a deferred payment basis. All the welfare arrangements to which he alluded last year were being continued with success. The Memorial, which the company had decided to erect at Rugby to those of its employees who fell in the Great War, would be completed during the current year.

SIEMENS BROTHERS & COMPANY, LTD.

At the annual meeting of Siemens Brothers & Company, Ltd., on Tuesday, the chairman (Mr. G. Mure Ritchie) stated that the total assets amounted to £3 552 341, but the actual liabilities (other than share capital), consisting of 4½ per cent. debenture stock, debt to the Public Trustee and sundry creditors, amounted to only £1 561 282, leaving assets of £1 991 069 (subject to certain duties) to represent the paid-up share capital of £1 259 062. The net profit for the past year was £253 254 (against £211 209 for 1919), and with £315 776 brought forward the balance available was £569 030. They had already paid an interim dividend of 5 per cent., and had transferred £30,000 to the special surplus fund, and they recommended a final dividend of 1s. per share (tax free), making 10 per cent. for the year, leaving £435 218 to be carried forward to meet liability for excess profits duty for the past three years, &c. With regard to the proposed increase of capital and bonus distribution, the chairman stated that the creation of £1 000 000 10 per cent. preference shares would place at the disposal of the board capital powers for future requirements. In a progressive and prosperous business the necessity for additional capital recurred, and it should be provided in order to expand operations and augment profits. The preference shares proposed to be created would rank for dividend as from July 1 next, and he wished to make it clear that the bonus distribution did not trench upon the company's various reserve funds.

Heavy Cable Orders.

The chairman said the total value of orders received in 1920 amounted to £4 025 685, against £2 834 712 in 1919. They were fortunate in having a world-wide reputation and far-reaching trade connections in Britain, in her dominions overseas, and in foreign countries, and the variety of their more important manufactures was such that, as was the case in 1920, though orders fell off in some lines they increased in others, and so on balance the business and the profits had grown. He was pleased to say that, while 1920 was substantially better than 1919, they expected 1921 to be better than 1920, and that they anticipated no difficulty in maintaining in respect of 1921 the 10 per cent. (tax free) ordinary dividend. The cable departments had been fully occupied, particularly those sections dealing with the manufacture of submarine telegraph cable, underground super-tension power mains and telegraph trunk lines. With regard to submarine cable, the manufacture of which had been the principal feature of the Woolwich works for more than half a century, the 1920 output was greater than that in 1919. and submarine telegraph and telephone cables were manufactured for use in many parts of the world—for the Atlantic and Pacific Oceans, the Mediterranean, Red and Baltic Seas, the Sea of Japan, and along the coasts of Peru and Chile. Their cable steamer "Faraday" was occupied from April to September laying submarine telegraph cables along the coasts of Peru and Chile, and in October in laying a telephone cable in the Baltic for the Swedish Government. The ship, which would soon leave to lay cables in the Gulf of Mexico, was approaching the end of her career, having been launched in 1874, and they might find it necessary to replace her in the not remote future. A considerable quantity of submarine telephone cables had been ordered, and the new machinery installed for producing continuously loaded cables had been fully occupied. Several schemes for international cables were now under consideration, and there was every sign of a considerably increased demand. In those parts of the factory devoted to the production of electric cables and wires, their manufacturing facilities had been taxed to their utmost limit, and to complete contracts within reasonable time they introduced a three-shift system of working in some shops, thus giving employment for 200 additional men and 100 extra women.

Underground Telephone Cables, &c.

Mr. Ritchie said the demand for the paper-insulated type of underground cable had increased, and the factory had been fully occupied, chiefly in the production of trunk mains. The export business in loop cables had also increased. The volume of business in the apparatus department was considerably greater than in the previous year, and that applied to telegraph, marine and mine signalling apparatus, measuring and scientific instruments and wireless telegraphy. Close co-operation had been effected with the associated firm of Elliott Brothers. Telephone business, both automatic and manual, had also increased satisfactorily. In manual exchanges they obtained contracts for no fewer than 14 public telephone exchanges for the British Post Office. They had also been entrusted with considerable extensions to the automatic exchanges already made and installed for the Post Office, and, in addition, they had in hand a large new exchange for public service and a large automatic exchange for service at one of the naval dockyards. An extension of the workshops for the better production of telephone apparatus would soon be completed. Orders for land-line material, wet and dry batteries, ebonite, &c., greatly exceeded those for 1919.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY, LTD.

The twenty-fourth ordinary general meeting of this company was held on Monday, Mr. Emile Garcke, M.Inst.E.E. (the Chairman), presiding.

The Chairman, after giving an account of the year's working, said: I will now refer to the question of the sale of the undertaking. You are aware that the undertaking is held by us under the Tramways Act of 1870, and under sec. 43 of that Act the local authorities have the right, upon the expiration of 21 years, to purchase the undertaking upon giving six months' notice. The purchase price, failing agreement, has to be settled by arbitration.

Sale of Undertaking.

Notice to purchase was given by the local authorities as at May 1, 1918. Owing to circumstances arising out of the war, the arbitration was considerably delayed, and, in fact, did not take place until from July 21 to 28, 1920, and the arbitrator's award was issued on September 13, 1920. On October 5, 1920, the Directors issued a circular to the shareholders, stating that the amount awarded to the Company was £142 174, subject to several items being referred to the High Court for decision on legal points. The points raised were argued before Mr. Justice Rowlatt on October 26 and 27, 1920, when the Judge decided some points in favour of the Company, and some points in favour of the purchasing authorities, and referred one point back for reconsideration by the arbitrator. The result of that decision was that the award of £142 174 was reduced to £132 641, and the point referred back to the arbitrator involved a sum of £2,880. The Directors carefully considered this decision and, after taking legal advice, they appealed, but the Court of Appeal decided, by a majority, to confirm the points decided against the Company. The points decided in favour of the Company by the Court of King's Bench had not been appealed against.

The Directors decided to accept this finding as final. The position, therefore, is that we are entitled to £132 641, plus the whole, or part, or nothing of the £2 880 —the item referred back to the arbitrator—plus also the taxed costs of the arbitration, less the costs of the appeal; and, of course, we are entitled to the value of stores and sundry other assets. The local authorities have advanced a claim that, inasmuch as the value of the undertaking was fixed by the arbitrator as at May 1, 1918, they are entitled to some deduction from the purchase price in respect of depreciation since May, 1918, regard being had to the fact that the company has had the benefit and the obligations of working the undertaking since that time. The purchasing authorities offer to pay £125 000 in settlement, and they say that if the Company does not accept their offer they will pay the larger amount without prejudice to their claims for depreciation. The Directors have given the matter serious consideration, and on balance of all the pros and cons they are prepared to advise the shareholders to accept the offer.

Distribution of Assets.

Mr. Garcke went on to say that the best estimate he could make at the moment was that there would be something like 24s. per share available as return of capital to the shareholders. On the whole he thought the shareholders might be congratulated upon the position. The Ordinary shareholders had had a regular return of about 6 per cent. per annum since the formation of the Company, and both they and the holders of the Preference shares had the prospect of receiving the return of the whole of their capital, with an appreciable premium, which was a better result than was expected a few years ago. The improved result was entirely due to the fact that the undertaking had been sold at a time when prices are high.

The report and accounts were adopted, and the meeting unanimously resolved to accept the offer of the purchasing authorities.

The directors of the Chloride Electrical Storage Company, Ltd., have declared a dividend of 5 per cent., actual, free of tax, on the ordinary shares, making 10 per cent. for the year.

The lists of the Metropolitan Electric Supply Company's issue of £500 000 7½ per cent. extension debenture stock were closed at 1 o'clock on Monday, although they were to have been open until Saturday next.

The net profit of the South Wales Transport Company, Ltd., was £2 583 after meeting interest charges and setting aside £7 500 for renewals. A dividend of 10 per cent. is proposed on the ordinary shares, carrying forward £2 174 (against £2 591).

The profit of the Cleveland & Durham Electric Power Company for 1920 amounted to £24 694. After placing £5 000 to reserve, adding £13 331 brought forward, and paying debenture interest (£32 665), a sum of £5 360 is carried forward.

The directors of the Hart Accumulator Company, Ltd., have declared a dividend of 8 per cent., less tax, on the ordinary shares for the past year. A sum of £10 580 is reserved for income tax and Corporation profits tax, and £25 616 is carried forward.

The directors of the Altrincham Electric Supply, Ltd., have declared a dividend of 7½ per cent. on the ordinary shares and of 10s. per share for the year (against 5s. in the previous year) on the preferred shares, carrying forward £1 034.

The directors' report of the Jarrow & District Electric Traction Company, Ltd., states that, after meeting debenture interest and providing £800 for renewals, the net profit for 1920 was £2 595. A sum of £4 620 was brought forward, and a dividend of 5 per cent. is proposed on the ordinary shares, carrying forward £4 219.

The 1920 accounts of the Constantinople Telephone Company have decided, after providing for interest on obligations and debt certificates and debiting 5 per cent. interest on share capital, full amount of amortisation, together with reserves for renewals, &c., show a loss of £T18 431, making a total deficiency of £T74 025.

A dividend of 4s. per share, tax free, has been declared on the ordinary shares of the Brisbane Electric Tramways Investment Company, Ltd., for the half-year, making 8 per cent. for the year. A sum of £20 000 is placed to reserve, and £8 000 to depreciation of investments fund, the balance (£42 837) being carried forward.

The directors of the Great Northern Telegraph Company, Ltd., propose to pay for the year 1920 a total dividend and bonus of 24 per cent. (including the 5 per cent. already paid). A sum of £50 000 is to be placed to reserve and renewal fund, £83 333 to pension fund; £416 667 is reserved for extraordinary taxes, carrying forward £285 892. The date of the general meeting has not yet been fixed.

The net profit of the Lancashire Dynamo & Motor Company, Ltd., for the year 1920 was £26 493, and with £5 542 brought forward, the total is £32 035. A final dividend of 6¼ per cent. is proposed on the ordinary shares, making 10 per cent. (tax free) for the year, reserving £10 000 for investment depreciation and carrying forward £2 444.

The directors of the Rangoon Electric Tramways & Supply Company have declared a dividend of Rs1.8 per share on the ordinary shares for the past year. A sum of £27 500 is placed to reserve for renewals, £3 115 to depreciation on sundry assets in Rangoon, £4 151 for Indian income-tax, £1 932 to employees' provident fund, £22 980 for repairs, renewals and maintenance, and £9 303 is carried forward. The Board were advised that dividends could only be paid legally at the current rate of exchange, and it is on this account that the present dividend will be declared in rupee currency.

The profit of the Shanghai Electric Construction Company, Ltd., for 1920, was £174 637, and with £3 778 from 1919 the total was £178 415. After transferring £10 000 to reserve for renewals, £50 000 to reserve for taxation, and £45 000 to general reserve, the balance is £73 415. The directors recommend a final dividend of 8 per cent. (making 20 per cent.), carrying forward £9 415. Share capital has been increased to £400 000 and £80 000 of general reserve has been capitalised and applied in paying up in full 8 000 new shares of £10 each, which are distributable as bonus in ratio of one new share for every four shares held.

Presiding over the meeting of the West London & Provincial Electric Supply Company, Ltd., last week, Mr. H. Kahn stated that the company's revenue was derived from its holding in the Chiswick Electricity Supply Corporation. There was a dividend of 8 per cent. on their shares in the Chiswick Corporation, or ½ per cent. over that of 1919. They had £5 202 for distribution and the directors proposed to pay the dividend on the cumulative preference shares for 1920, and the arrears of interest on the Funding certificates for the years 1917, 1918 and 1919, as well as interest on the Funding certificates for 1920, carrying forward £229 18s. 4d.

At the annual meeting of Babcock & Wilcox, Ltd., last week, the chairman (Sir John Dewrance) said that they had been able during the past year to maintain the prosperity which it had been the good fortune of the company to enjoy in the past, in spite of the exceedingly difficult times through which they had passed. The present was a very difficult and dangerous period in the history of the nation. A large part of their works was closed down for want of coal, and they were unable to obtain steel and other raw materials. Whatever the difficulties of the future might be, he could assure the shareholders that with the organisation which the company possessed and with a staff wholeheartedly working in their interests they would be capable of facing any situation.

The revenue of the Swansea Improvements & Tramways Company for 1920 was £119 495, and the working expenses (including provision of £10 000 for renewals) were £108 097. After paying debenture interest (£1 181), and amount payable to the Corporation in respect of tramways and light railways leased (£7 967), the balance (with £2 447 brought forward) was £4 697. The year's dividend on the 5 and 6 per cent. preference shares was declared, and £2 099 carried forward. The strike of running staff, causing stoppage of tramway services from April 23 to May 30 last materially affected the revenue. The expenditure on capital account amounted to £374, and £21 701 expended on renewals of permanent way, electrical equipment, cars and plant has been charged to renewals fund.

The report of Mirrlees, Bickerton & Day, Ltd., for the year ended March last, states that, after providing for depreciation and directors' fees, there is a loss of £9 781, against which there falls to be credited £7 510 brought forward, leaving an adverse balance of £2 271. Substantial sums have been paid in previous years in excess profits duty, and it is estimated that not less than £20 000 will be recovered under this head, making a balance of £17 728. £1 406 has been paid as dividend on preference at rate of 5½ per cent. for half-year ending September, which, being deducted from above £17 728, leaves a credit balance of £16 321. The directors recommend payment of a dividend at rate of 5½ per cent. on the preference shares for half-year ending March, and that £14 369 be carried forward, no dividend being paid on the ordinary shares.

Mr. James W. Hill, J.P., presided over the 71st ordinary general meeting of the Dublin & Lucan Electric Railway Company last week and stated that if the Government withdrew the subsidy from the company, without making adequate arrangement for the carrying on of the line, the position would be that their line must be closed down immediately. The receipts had again increased largely, but that amount had been made by including the Government subsidy of over £8 000 to meet the loss of working. Owing to the Curfew regulations and coal supplies, the mileage run during the year was only 97 384 miles, or over 40 per cent. less than the pre-control average. On the expenditure side there had again been a very considerable increase (24·4 per cent.), caused by the cost of wages and coal. As compared with 1913, the expenditure increased by 184 per cent., while their coal bill last year was £5 397, against £1 575 in 1913.

New Companies.

The following list is compiled from information supplied by Messrs Jordan & Sons, Ltd., company registration agents, Chancery-lane London, W.C.2 :—

ELECTRIC TRACTION DEVELOPMENTS, LTD. (174 549).—Reg. May 4, capital £4 000 in £1 shares, to acquire any interests in any patents and concessions in relation to railways, tramways and any method of traction. Directors: P. Horsfall and T. H. Minshall. Reg. office: 34, Victoria-street, Westminster, S.W. Private company.

REEVE & BAYMAN, LTD. (174 494).—Reg. April 30, capital £10 000 in 10 000 shares of £1 each, to acquire and carry on the business of electrical and mechanical engineers. Directors: W. T. Reeve and W. G. Bayman. Reg. office: 13, Russell-street, Plymouth.

VAUGHAN & DYMOND, LTD. (174 497).—Reg. April 30, capital £10 000 in 10 000 shares of £1 each, to acquire and carry on business of engineers. Directors: C. J. Dymond, W. A. Vaughan and C. H. Dymond. Reg. office: Milburn House, Dean-street, Newcastle-upon-Tyne.

YOULDON & KEELING, LTD. (174 676).—Reg. May 5, capital £600 in £1 shares, to carry on the business of general engineers, motor and dynamo manufacturers. Directors: C. A. Youldon and T. H. J. Keeling. Reg. office: 26 to 31, Eyre-street-hill, Clerkenwell-road, E.C. Private company.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"The Cabinet Maker."—"Furniture for R.A.F. Officers' Quarters"; "Retail Furniture Prices"; and "Annual Dinner of the Furniture Warehousemen and Removers' Association."

"Chemical Age."—Special Number on Soap, Oils and Fats. "Colloidal Clay and the Hydrolysis of Oils and Fats," by F. E. Weston; and "Development of an Oil By-Product Industry," by Dr. E. K. Rideal.

"Farm and Home."—"New Ways of Hay-Making"; "Our Dairy Breeds of Cattle"; and "Opening of the Show Season."

"The Fruit-Grower."—"Commercial Carnation Growing"; "Fruit Crop Outlook"; and "Insect Pests and Young Nursery Stock."

"Gardening Illustrated."—"Staking Hardy Plants"; "Propagating Banksian Roses"; and "Spraying in the Routine of Garden Work" (illustrated).

"Hardware Trade Journal."—"Notes on Pumps (II.)" by Joseph Horner; "'Save Coal' Cookers"; and "The Export Outlook."

Forty Years Ago.

THE ELECTRICIAN, MAY 28, 1881.

A GASEOUS ECLIPSE.—"L'Electricité" says: "The electric light is not alone in its liability to sudden inexplicable eclipses. We read in the *American Gas Light Journal* of the 2nd May, that, during the night of the 18th April, all the gas lights in the town of Selma (Alabama State) went out without warning.

THE NEW ATLANTIC CABLE.—We hear that ss. "Faraday" has successfully landed the shore end of the new Atlantic cable in Dover Bay, near Canso, Nova Scotia, and that those on board hope to lay the 1 000 miles of cable she has with her this week, after which she will buoy and return to England for the remaining portion.

LONG-DISTANCE TELEPHONY.—From America it is reported that the telephone has been worked between Bangor, Me., and St. John's, New Brunswick, a distance of 214 miles. Every word is said to have been heard distinctly. We also hear that Vicksbury is connected with New Orleans, a distance of 230 miles, and that conversation is carried on with much distinctness.

A GLANCE INTO THE FUTURE.—"Professor Loomis appears still to be experimenting in aerial telegraphy—telegraphing without wires—and it is now said that he proposes to establish communication, through the current which he claims is always found at a great altitude, between one of the highest peaks of the Alps, in Switzerland, and a similarly situated station on the Rocky Mountains, on this Continent." Such, according to the *Operator*, is the future that *loom's* before us!

Prices of Metals, Chemicals, &c.

TUESDAY, May 24.

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£75 15 0	£2 5 0	—
Electro Wirebars	,,	£77 0 0	£2 0 0	—
H.C. wire, basis	per lb.	0s. 11¾d.	$\frac{3}{16}$d.	—
Sheet	,,	1s. 0½d.	¼d.	—
Phosphor Bronze Wire (*Telephone*)—				
Phosphor-bronze wire, basis	,,	1s. 3¼d.	$\frac{3}{16}$d.	—
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1d.	—	—
Wire, basis	,,	1s. 1d.	—	—
Pig Iron—				
Cleveland Warrants	per ton	£6 10 0	-	—
Galvanised steel wire, basis 8 SWG	,,	£27 0 0	—	—
Lead Pig—				
English	,,	£25 10 0	£1 0 0	—
Foreign or Colonial	,,	£24 7 6	£1 2 6	—
Tin—				
Ingot	,,	£184 5 0	£5 10 0	—
Wire, basis	per lb.	2s. 6d.	¾d.	—

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £14 10s.

,, (Roll-Brimstone).—Per ton £14 0s.

Sulphuric Acid (Pyrites, -168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £30.

Boric Acid (Crystals).—Per ton £69.

Sodium Bichromate.—Per lb. 7½d.

Sodium Chlorate.—Per lb. 4¼d.

Rubber.—Para fine, 10d.; plantation 1st latex, 9d. lb.

The metal prices are supplied by British Insulated & Helsby Cables:

The Editorial, Advertisement and Publishing Offices of "THE ELECTRICIAN" *are at* 8, *Bouverie Street, London, E.C.* 4. *Telegrams: Benbrotic, Fleet, London. Telephone: City* 9852 (5 *lines*).

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Arrangements for the Week.

FRIDAY, May 27th (to-day).

ROYAL SOCIETY OF ARTS.—INDIAN & COLONIAL SECTIONS.

4.30 p.m. At John-street, Adelphi, London, W.C. Paper on "Industrial (including Power) Alcohol," by Sir Charles H. Bedford, Ll.D., D.Sc.

PHYSICAL SOCIETY.

5 p.m. At University College, Gower-street, London, W.C. Papers to be read on "A Method for the Micro-analysis of Gases by the use of the Pirani Pressure Gauge," by the General Electric Company (communicated by Mr. C. C. Paterson, O.B.E.); "On the Reflection of the X-Ray Spectrum of Palladium from Fluor-Spar," by Mr. H. Pealing, M.Sc.; "The Intensity of X-Rays Reflected by the Diamond," by Sir W. H. Bragg, F.R.S. Exhibits of Crystal Models and of Photographs by the Duc de Broglie of Cathode Ray Spectra attendant on the Production of X-Rays will be shown by the President.

INSTITUTION OF MECHANICAL ENGINEERS.

6 p.m. At Storey's-gate, London, S.W. Lecture on "The World's Money System," by Mr. J. G. Graves.

JUNIOR INSTITUTION OF ENGINEERS.

8 p.m. At Caxton Hall, London, S.W. "Notes on Electrical Transformer Breakdowns," by Mr. S. A. Stigant.

ROYAL INSTITUTION.

9 p.m. At Albemarle-street, Piccadilly, London, W. Discourse on "Elasticity," by Mr. A. Mallock, F.R.S.

MONDAY, May 30th.

NATIONAL UNION OF SCIENTIFIC WORKERS.

8 p.m. At University College, Gower-street, London, W.C. Public Meeting. Chairman: The Rt. Hon. Viscount Haldane, O.M., F.R.S. Speaker: Prof. L. Bairstow, C.B.E., F.R.S.

TUESDAY, May 31st.

FARADAY SOCIETY.

4.30, 6 & 8 p.m. At the Chemical Society, Burlington House, London, W. General Discussion on "Physico-Chemical Problems Relating to the Soil."

INSTITUTION OF ELECTRICAL ENGINEERS.

5 p.m. At Savoy-place, Victoria Embankment, London, W.C. Annual General Meeting.

5.45 p.m. Special General Meeting.

6.30 p.m. Lecture on "Research Work in the United States," by Dr. F. B. Jewett.

ILLUMINATING ENGINEERING SOCIETY.

8.15 p.m. At the Royal Society of Arts, John-street, London, W.C. Discussion on "The Use of Artificial Light as an Aid to Various Games and Sports," by Mr. J. S. Dow.

WEDNESDAY, June 1st.

INSTITUTION OF RAILWAY SIGNAL ENGINEERS.

3.0 p.m. At the Midland Grand Hotel, St. Pancras, London, N.W. Resumed discussion on the Reports of the Sub-Committees on "Track Circuit Nomenclature" and "Track Circuit Record Forms."

UNIVERSITY OF LONDON.

5 p.m. At Gower-street, London, W.C. Lecture on "Wireless Telegraphy and Telephony," by Prof. J. A. Fleming, F.R.S. (Lecture VI.).

THURSDAY, June 2nd.

ENGINEERS' CLUB.

2.30 p.m. At the Hotel Cecil, London, W.C. General Meeting of supporters.

ROYAL SOCIETY.

4.30 p.m. At Burlington House, Piccadilly, London, W. Bakerian Lecture on "Optical Rotatory Dispersion," by Dr. T. M. Lowry, F.R.S., and Dr. C. P. Austin.

Books Received.

[Copies of the undermentioned works can be had from THE ELECTRICIAN Office on receipt of published price, plus postage.]

"Three-Phase Induction Motors." By L. E. Wood. (London: Electrical Review.) Pp. iv.+130. 6s. 6d. net.

"Die Symbolische Methode zur Lösung von Wechselstromaufgaben." By H. Ring. (Berlin: Julius Springer.) Pp. vi.+51. M.12.

Abridged Callendar Steam Tables—Centigrade Units. (Pp. 8, 1s. net.) Abridged Callendar Steam Tables—Fahrenheit Units (Pp. 8, 1s. net.) Callendar Steam Diagram—Centrigrade Units (6d.), and Callendar Steam Diagram—Fahrenheit Units (6d.). By H. L. Callendar, F.R.S. (London: Edward Arnold).

"La Coexistence des Lignes Electriques à Courants Fort a Courant Fablie. By I. Van Dam. (Holland: N. Veerstra). Pp. xi+204.

"Electric Welding." By E. Viall. (London: Hill Publishing Company.) Pp. xii+417. 22s. net.

"Heating Systems, Design of Hot Water and Steam Heating Apparatus." By F. W. Raynes. (London: Longmans, Green & Company.) Pp. xvi+324. 21s. net. 2nd Edition.

"Elements of Direct Current Electrical Engineering." By H. F. Trewman and G. E. Condliffe. (London: Sir Isaac Pitman & Sons.) Pp. vii+219. 7s. 6d. net.

THE ELECTRICIAN

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Notes.

The West Riding Electricity District.

After an Inquiry lasting nine days the Electricity Commissioners concluded last Friday their investigation of the three schemes submitted for the reorganisation of electricity supply in the Aire and Calder district. Throughout the proceedings the Commissioners, and especially the Chairman and Sir H. Haward, have shown a complete grasp of the situation and of the sort of scheme required to meet the present conditions. We await with interest the decision of the Commissioners upon the evidence. This appears to have been, on the whole, favourable to the Yorkshire Electric Power Company's proposals. The engineering details put forward by the Leeds Corporation were severely criticised and objection was also taken to erecting a capital station at Esholt near Bradford, as had been proposed by the Conference of local authorities, on the ground that there was not sufficient condensing water available in the summer. Many witnesses, representing the Coal Owners' Association and manufacturers in the district, expressed themselves in favour of private enterprise and warmly supported the Company's proposals; and these views were reinforced by the opinions of the West Riding County Council and of several district councils in the area. The balance of evidence, therefore, seems to have been in favour of private ownership, although no exception was taken to the enterprise and progressive spirit shown by Bradford, Leeds and other local authorities. Some of the witnesses seem to have been obsessed by the bare possibility of a call upon the rates, but, as we have frequently pointed out, this is a remote contingency in any well-devised scheme. It seems to us that the cry of increased rates is due to a nightmare ensuing upon an undigested perusal of the Electricity Act and it is fostered by the enemies of progress both within and without the industry and especially by the gas interests.

The Lower Severn Electricity District.

We regret to learn that the attempt to form a Joint Electricity Authority in the Lower Severn District has been abandoned. It will be remembered that the Inquiry opened by the Electricity Commissioners into the matter in January last was adjourned to give the Organising Committee an opportunity of circulating the details of the technical scheme and of reconsidering the portions of that scheme which related to the constitution of the Joint Authority and the representation of various interests upon it. From the correspondence between the parties, which has now been published, we learn that, apart from the engineering aspect of the question, trouble arose over the impossibility of restricting representation to those willing to assume financial responsibility. Apparently, the Commissioners desired the basis to be widened by including Urban and Rural Councils, consumers, &c. There were also difficulties regarding the nature of the control to be exercised over such generating stations and main transmission lines as were not transferred to the Authority, the standardisation of systems and methods of charging as well as in such matters as the distribution of electricity in areas not forming part of the area of supply of the authorised distributors. Quite an imposing list and one sufficient to wreck any scheme!

An Unwise Requirement.

We are not surprised that Mr. Faraday Proctor, who was mainly responsible for the preparation of the scheme, and the members of the organising committee did not view with favour a requirement which would impose an obligation upon the Joint Authority to lay down distributing mains in the rural parts of a district which is mainly agricultural and where there is, therefore, small possibility of an industrial load or other substantial demand being built up within a reasonable period. There is so much else to be done that no Authority will have the capital necessary for embarking upon this class of venture wholesale within the next six or ten years, much as we agree that everything possible should be done to develop a rural load.

The Financial Situation.

Finance seems, however, to have been the real stumbling block. From the summary of the estimated financial results of giving a bulk supply to Bristol, Bath, Bradford-on-Avon and other places in the southern part of the district it appears that only a net saving of £19 521 per annum would be effected if the total load were dealt with, and that there would be a loss of over £11 000 a year if only the load over and above that which the present stations can deal with were supplied. In the estimates the annual capital charges are taken at 10 per cent. and an extra rate of interest of 3 per cent. is included because of the absence of the security of the rates of local authorities. This is certainly looking on the pessimistic side. The cost of altering the existing systems to the standard three-phase 50 period supply would be appreciable and might result in an actual loss instead of a saving. Though we think the estimates are on a very conservative basis and the estimated annual charges are not too low, yet we are not, under the circumstances, surprised at the decision of the Organising Committee. Nevertheless it is only putting off the evil day, for the re-organisation of supply in the district will have to be tackled sooner or later. It might, therefore, be well for a committee of engineers to consider the possibility of a partial or compartment development as an alternative to the original scheme. The area is not an industrial one and is therefore not a *prima facie* one where extensive schemes of linking up can be light-heartedly undertaken.

History Repeating Itself.

There is a well-known saying of Newton's that he was only a child picking up pebbles on the wide shores of knowledge. To-day not only have the shores of knowledge widened, but there is a tendency among the pebble searchers to burrow rather than to remain on the surface. The result is that they lose sight not only of the expanse of the shore, which is a bad thing, but of the fact that they, so to speak, are not the only pebbles on the beach, which is a worse. An excellent example of this tendency is to be found in the account which we give of the lecture delivered by Messrs. A. Johnsen and K. Rahbek before the Institution of Electrical Engineers last week and in the letters from Mr. Campbell Swinton and Mr. Rollo Appleyard which appear in our Correspondence columns. While the lecturers described what to them is evidently a new phenomenon, both Mr. Campbell Swinton and Mr. Appleyard point out that the same or very similar results have already been investigated and published. Mr. Appleyard himself published something on the matter in 1905, Mr. Campbell Swinton mentions that an instrument using this principle as a basis for a loud-speaking telephone was described before the Royal Society of Arts as long ago as 1879, while Sir William Barrett in a letter in Tuesday's "Times," mentions that he discovered Mr. Appleyard's principle in 1880. This is certainly unfortunate. If for no other reason than that they have wasted a great deal of time we must condone with the two Danish engineers who have so generously laid their discovery before the electrical engineers of this country and especially on the way they have adapted the phenomenon to practical uses. But the whole episode points to the necessity for greater publicity and wider dissemination of the results of research work, so that those who are desirous of branching out into new fields of discovery may know exactly what has been done before and not disappoint themselves by trying routes which have already been explored. At present it would not only require a super-Pelmanist to remember what has been published on each particular subject, and often important facts are not published at all.

The Abermule Accident.

As was to be expected, Col. Pringle's report to the Minister of Transport on the accident which took place near Abermule on the Cambrian Railway last January, discloses nothing fresh as to the cause of the disaster. It was clear from the evidence that the human factor had failed and we are, therefore, glad to see that Col. Pringle recommends that at stations on single lines of railway which are passing places for trains, as well as electric tablet or staff posts, and where it is not feasible to locate the single line instruments in the signal box, electric interlocking should be provided between the single line box and the starting or advance starting signal giving access to the single line section, and that, in special circumstances, even where instruments are placed in signal boxes, similar interlocking should be provided. We hope that these recommendations will be carried out and that even where, at first sight, the circumstances do not seem to justify complete interlocking between tablet instruments and signals it will be adopted as an additional precaution. As Col. Pringle rightly points out this deplorable accident is unique in the annals of British railways and it is therefore due to those concerned to take every precaution against its recurrence.

An Example of Reaction.

Another interesting point about the accident, to which, however, reference is made in the report, is that of the 13 coaches of which the two trains were made up only four were lighted electrically. It is, therefore, fortunate that fire did not break out to add an additional horror to the disaster. That it did not must have been more a matter of luck than anything else. It would be interesting to know the real cause of the reluctance of British railway companies to adopt electric lighting for illuminating their vehicles. Such a course has often been recommended by Board of Trade inspectors and would only be in accordance with modern practice in these matters. It seems once again to be the case of British indifference to the development of their own interests, for, as Dr. Rosenberg in the article which we publish on another page of this issue points out, electric train lighting was a British invention, though its development and a good deal of the financial advantages that have been obtained from it have passed away to other countries.

Misunderstanding and Ignorance.

In describing, in the course of his Presidential Address to the Association of Teachers in Technical Institutions, misunderstanding and ignorance as being the two greatest obstacles to the proper development of technical education, Principal G. Knox stated what is becoming to be recognised as an essential truth. This ignorance is equally evident among state, county and municipal authorities, and may be summed up as a failure to realise the true meaning and importance of technology in the social system. One of the principal missions of the Association of Technical Teachers may well be to convince education authorities of the need for higher education, to make evident to the workers' associations their indebtedness to the pioneers of science, and to prove to the captains of industry that, without the continued and progressive application of science to industry, successful developments cannot be maintained. It is regrettable, and to us it seems almost incredible, that such fundamental truths should not be known to all the bodies mentioned, yet we feel that this Association must have real knowledge of the state of affairs since it is necessarily in close touch with employers, employees and education authorities.

Need for Royal Commission.

Amongst other things the Conference urged the necessity of the appointment of a Royal Commission or other suitable body to investigate the whole field of technical education in its relation to the great problems of national reconstruction, and to make recommendations thereon. It was pointed out in all recent educational enquiries that technical education had not received consideration, and that in view of its fundamental economic importance to industry the time had come when it was desirable to review its present position in our national scheme. In this connection the President referred to the Adult Education Committee which had been appointed by the Ministry of Reconstruction in view of the preparations which were being made for industrial and social reconstruction, and stated that its terms of reference were "to consider the provision for and the possibilities of adult education (*other than technical or vocational*) in Great Britain, and to make recommendations." The italics are ours. For the phrase in question must either be taken as an indication that some other committee is going to consider the possibilities of technical or vocational education in the scheme for industrial and social reconstruction, or it must suggest that the majority of our rulers and administrators are completely out of touch with the modern spirit of science. We feel sure it is the latter. Indeed it is, we believe, common knowledge that the majority of our rulers and administrators were on the classical side of their schools and universities, and therein lies much of the reason for their obtuseness. It is to be hoped that those concerned will realise that it is just as fatal to adopt a system of education which, professing to be humane, only turns out linguistic pedants, as it would be to adopt one which only turned out soulless mechanical practicians—human beings with the minds of machines.

Col. R. E. B. Crompton.

On other pages of this issue will be found two interesting announcements about that pioneer of the electrical industry, Col. R. E. B. Crompton. Under the heading of "Forty Years Ago" the "Journal" of the Royal United Services Institution is said to contain a Paper by Mr. R. E. Crompton on "The Progress of the Electric Light." In our Personal column we announce that to-morrow Col. Crompton is to celebrate his golden wedding. In the intervening years not only has electric light progressed, but so has Col. Crompton, and if in his progress his movement has been away from rather than in the electrical industry, that is the industry's loss. For we can ill spare such workers from the electrical field, workers who, like Col. Crompton, possess not only knowledge and initiative but, what is more important, enthusiasm. His is an enthusiasm undamped by failures, of which in the ordinary course of events there must be many, but which seems to derive from these temporary set backs a further supply of energy which enables success to be finally achieved. We heartily congratulate both Col. and Mrs. Crompton on this festival in their lives.

The Coal Dispute.

The resumed negotiations in the coal dispute have, so far, brought us no nearer settlement. There is little reason why they should. The new or re-hashed proposals are obviously not understood by the miners; and we doubt whether they are really understood by anyone else. At any rate, they may be read in so many ways as to be more likely to lead to confusion than to a resumption of work. What Mr. Frank Hodges said in a recent speech is therefore important: "We must have a settlement which will give the men a decent living wage and we must have in the industry a maximum point of efficiency. We want a peace not for three months or 12 months but for a couple or three years at the least which will enable the mines and the country's trade as a whole to get back to normality. . . . But we will not agree in advance to accept proposals without knowing what the ultimate consequences will be." This at any rate is frank. Cannot the mine-owners and the Government too, now they have been brought into the matter exhibit equal frankness? To do so is the only way to obtain the necessary agreed solution.

A New Tax on Industry.

It is an axiom even among politicians that to regain our pre-war industrial supremacy we must develop our foreign trade. But it is unfortunately equally axiomatic that, with politicians, deeds do not correspond with words. For how else are we to explain the latest proposals of the Postmaster-General for liquidating the deficit which has been suddenly discovered in his department? To increase the postage rates on newspapers and printed matter sent abroad may be beneficial to the Post Office (which we doubt) but it will certainly reduce to a trickle that stream of information about British goods and about British work in the scientific and technical fields which is necessary to the building up of our export trade. For trade is not only a matter of buying and selling but of information too. And, therefore, to interfere ever so little with that flow of knowledge is seriously to affect the volume of business that we do abroad. Various ingenious methods of counteracting this new tax on trade are being suggested, but the only sound policy is to drop the idea of making the increases. Both as electrical engineers and as publishers we therefore add our voice to the protests which are every day gathering strength, and hope that they will be successful. We agree that the deficit on the Post Office operations must be reduced, but there are other ways of doing that which at least might be tried. A reduction in the number of officials and a fair day's work by the remainder would be one.

The Candid Friend.

In these days when, as Lord Weir has truly said, we live on an island entirely surrounded by hot water, the critic, the reformer and the preacher are not only vocal but are generally listened to. For, much as we distrust and discount what they have to say, we still hope against hope that their outpourings may contain something from which we may derive some benefit. It is also true that the more unbiased and detached the critic the more probable his views are worthy of attention. For all these reasons the lecture recently delivered on the English electrical industry, by Dr. E. Rosenberg, before the Austrian Electrotechnical Society, an abstract of which appears on another page of this issue, is worthy of attention. Dr. Rosenberg himself needs no introduction to our readers. As is well known, he, for some time, occupied an important position with the, then, British Westinghouse Electric & Manufacturing Company and so obtained amidst much that to him must have been strange and unintelligible, a wide knowledge of British manufacturing and trading conditions, a knowledge which he is now using to expose our shortcomings.

The Industry in a Bad Way.

Though Dr. Rosenberg's criticisms apply to pre-war conditions, that does not make them less interesting nor less instructive. For, while conditions at the present time are in many ways profoundly different from what they were when Dr. Rosenberg was connected with the British electrical industry, these differences are superficial rather than essential. We gather from his remarks that he thinks the British electrical industry is in a bad way. If half of what he says is true it ought to be in a much worse way and he is rather puzzled because it is not. This state of affairs, he thinks, is not mainly due to lack of knowledge or to faults in management, but to

Free Trade, to the strong position of trade unions and their curious ways and to the large number of small firms which not only take in each other's washing, but cut each other's throats in the process.

But, bad as the effect of Free Trade has probably been and contrary to our own interests as has certainly been that sort of competition which he so rightly deplores, these are as nothing compared with the dual effect of the baleful workings of the trade union regulations against production and the personal idiosyncracies of those consulting engineers, who by evolving voluminous specifications full of strange penalties and insisting that certain peculiar details of design and construction should be embodied in all the plant they order, have, or so Dr. Rosenberg would have us believe, prevented not only standardisation but a real development in the British electrical industry both at home and abroad.

More in Sorrow than in Anger.

We feel that Dr. Rosenberg is really more sorrowful than angry with us. His graceful reference to the often unfruitful work of such pioneers as Parsons proves that. Such work is unfruitful because our trading methods, our cut-throat competition of pre-war days, our Trades Unions and our consulting engineers have been too influential; and, as a result, the balances of most English electrical firms were non-existent. Characteristically enough he feels that only war could alter this and he sees in the enormous fillip which even gave to the electrical trade a real but undeserved benefit conferred upon those who were too blind to see for themselves that the policy they were following was rapidly leading them to disaster.

Still though we are interested, our withers are not so wrung as perhaps they ought to be. The views which Dr. Rosenberg expresses about trade unionism will at once label him as reactionary in interested circles. Nevertheless, even Labour is beginning to see that certain restrictions on output are two-edged in their effect and that good work and increased production are the only ways in which high wages can be maintained. In the matter of competition we fear Dr. Rosenberg's imagination has rather run away with him. The British Electrical & Allied Manufacturers' Association, the formation of which he rightly views as a ray of light in an atmosphere of pure gloom, took place some years before the war and the operations of this body no less than its policy were beginning to have an effect in relieving those ills which he rightly stigmatises. The war was not responsible for the formation of the B.E.A.M.A. any more than the B.E.A.M.A. was responsible for the war.

A New Poison.

It is also very much to be doubted whether the consulting engineer virus, or what Dr. Rosenberg describes as their *Eigenbrodelei* (a queer looking word whose meaning is as pungent as its appearance), was really having such a detrimental effect on the health of the electrical industry as he would have us think. There were consulting engineers and consulting engineers. Some did harm and some did good. Those who hold in all its nakedness the theory that the consulting engineer is a person who is dangerous, useless and ought to be abolished, will enjoy the scorn which Dr. Rosenberg pours down upon the whole class of them—even consulting engineers will be gratified at the attention he pays them. But his invective is a little like flogging a dead horse and, presuming the consulting engineer were as black as Dr. Rosenberg would have us believe, we do not go all the way with him when he says that the manufacturer is quite capable of looking after the production of efficient and well-designed electrical apparatus. Or rather, we ask if he is capable of doing so why he does not do it. For, while there are consulting engineers and consulting engineers, so there are manufacturers and manufacturers. And while specifications have been silly, the articles turned out have been bad; and the faults of one class have re-acted on the faults of the other, leading to an increase of both in number and in value. We refer our readers to Dr. Rosenberg's lecture for illustrations of this thesis. It is a policy which has often resulted in both the consultant and manufacturer digging their own graves.

Faulty Psychology.

These little weaknesses in Dr. Rosenberg's argument do not, however, blind us to the essential importance of what he says, and the thanks of the British electrical industry are due to him for putting down so sympathetically and justly the defects which he sees in an industry with which he was so long connected. At the same time his psychology is not faultless, and while, on our part, we should do well to take to heart the lessons that can be learned from his strictures we give him friendly warning not to place too much reliance upon those surface indications from which he draws such definite conclusions. British industry, no less than the British workman, moves in a mysterious way. It is a way which, though beset with many self-erected obstacles, somehow sooner or later reaches its goal to its own satisfaction and to the confusion of those who have been watching its presumably unavailing struggles. The British electrical industry is not dead yet, though with the kind help of a sympathetic legislature it has more than once nearly committed suicide.

In concluding his lecture Dr. Rosenberg remarked that the industrial war which is about to break out between English and German electrical industries will pass through many interesting phases. We agree and, if forewarned is forearmed, he has done us a real service of which it will be well to take advantage. We can view with satisfaction what we have done in the past and, given certain conditions, we feel sure that we can do even better in the future. With a sensible policy, wise direction, and hard work, there is no reason why we should not supply the needs, fulfill the demands and solve the problems of the whole world. We must try and so do without raising our heating losses to an abnormal figure.

Institution Business.

Judging by recent events, the wave of criticism which recently threatened the Institution of Electrical Engineers, and especially the Council, has left the main structure and its foundations as stable as ever, and, to change the metaphor, the machine is now running smoothly, quite unaffected by the surges which at one time seemed likely to burn it out. No revolutionary scheme of reform has been outlined, and, as far as we can learn, no drastic changes have been made in the present policy. We are not sure whether we should rejoice or lament at this; but of this we are certain, that it is better to advance by slow, easy and well-considered stages than to follow the example of the wind (and many reformers) and to blow where we list only to change like the wind (and many reformers) on the first possible opportunity. Such divagations, though interesting and exciting to spectators, are dangerous to those taking part in them.

The New Council.

Certainly no indications of revolution are to be found in the result of the latest election for members of the Council announced by the President last week. Candidates for the higher offices of President and Vice-president have been elected without opposition and we congratulate Mr. J. S.

Highfield, no less than Prof. E. W. Marchant and Mr. C. C. Paterson, on this result. Sir James Devonshire remains honorary treasurer, while ordinary members of the Council who have been elected are Mr. Sydney Evershed, Lieut.-Col. F. A. Cortez-Leigh, Sir Andrew Ogilvie, Mr. A. Page, Mr. T. Roles and Mr. A. W. Tait. Of these, only one, Lieut.-Col. Cortez-Leigh, is an unofficial candidate, the other unofficial candidate, Mr. W. C. P. Tapper, being among the rejected. Official candidates who failed to secure election were Mr. A. L. C. Fell, Col. H. E. O'Brien and Capt. J. H. Round. This in itself, however, indicates no great opposition to the Council's nominees, for it is obvious that when six candidates are put forward to fill four vacancies someone must drop out. We understand that the number voting in the election was very much greater than usual, and we are glad to see this indication of increased interest in the affairs of the Institution.

Matters Relevant and Irrelevant.

The holding of the Annual General Meeting also offers an occasion for the unofficial member to have his say on matters relevant and irrelevant to the affairs of the Institution. How this opportunity is seized may be judged by the appearance of the lecture theatre on such occasions. It resembles the proverbial school cake, with those present representing the currants almost lost in the wide space of dough—or empty benches. We should like to ascribe the somewhat more crowded condition of the theatre on Tuesday last to the greater interest which is being taken in the policy of the Council by the general body of those belonging to it, but we fear it was really due to a desire to revisit our recently recovered building and to the fact that voting was to take place later on the question of applying for a Royal Charter. We are led to this opinion by the air of aloofness which characterised the proceedings, for, with the exception of Mr. Purse, no one criticised either the report or the accounts.

The Annual Report.

The annual report contains little that is not already common property. We are glad, however, to learn that, in spite of the large increase in membership the qualifications required by the candidates for elections are being maintained at a high level. This is eminently necessary if the new title of Chartered Electrical Engineer is to be of any value, and it is equally of importance in its bearing on the attitude which is being taken up by the Institution on the questions of the appointment of technical officers in the Civil Service and on the salaries of teachers in technical institutions. What is being done with regard to the former of these questions is a little vague, but as regards the latter the suggestion that corporate membership of the Institution should be accepted as equivalent to a first class honours degree is one that most of us will be disposed to accept. It is one, however, whose justification must depend on the qualifications necessary for membership.

Educational Matters.

We have often insisted that the continued education of both the younger and the more mature members should be one of the primary objects of the Institution. This object is to some extent fulfilled by the meetings which are increasing in number and usefulness as time goes on. It may be assisted in a less spectacular way by arranging that the facilities provided by the library and museum are of such a character that they can be taken advantage of by as large a number of members as possible. This point was raised at a recent informal meeting, and we are glad to see that it is proposed to open the library during the evening as soon as that course is possible. We hope that this experiment will amply be justified. Whether it is justified or not depends, of course, on the members themselves. For the great hopes we all entertain for the development of electricity—in all its branches—can only be realised by gradually raising the standard of knowledge of members of the Institution. To raise this standard of knowledge wide study is necessary, and to make wide study possible a library is a fundamental necessity. The same argument applies equally to the museum, and we hope that similar facilities will allow the widest use to be made of that interesting collection of historical apparatus. We trust also that those in a position to do so will increase the number of exhibits, thus leading to an increase in usefulness.

The Cult of Standardisation.

We are glad to see that the activities of the Institution on questions connected with the standardisation and regulation of electrical apparatus of all kinds are continuing with unabated vigour, and that the various Government departments have consented to avail themselves of the assistance of the British Engineering Standards Association in drawing up their specifications. As Mr. Wordingham recently said, the Association requires and deserves the support of the industry. Electrical engineers should be among the first to give this. There is, however, a danger from over-standardisation. In fact, what is required at the present time is something in the nature of the standardisation of standards. There are too many rules and regulations dealing with the same matters, and a determined effort should therefore be made to edit and combine these into one authoritative compilation. No work that the Institution could undertake would be of more ultimate use than this.

Financial Stability.

The question of the financial stability of the Institution has already been widely discussed, and the position is so well known that we need say little about it at this juncture, except to remark that it is not, at the moment, quite so satisfactory as it might be; but we have no doubt that, with the increased subscriptions and the larger membership, this is but a temporary phase. The number added to the membership during 1920-1921 was the largest ever known. It is, therefore, interesting to see that the amount in the accounts under the heading of entrance fees has fallen off by some £500. This, we take it, is due to the increase being largely in the students class, who pay no entrance fee. There is nothing to criticise in this, however, for it shows a pleasing realisation of the benefits membership can confer.

The Royal Charter.

To those who love sensation the proceedings at the Special General Meeting held to authorise the Council to apply for a Royal Charter must have been disappointing. It is, however, clearly a course which is supported by the main body of members. The post card vote showed that 63·5 per cent. of those eligible voted, and that only three, or 0·0003 of 1 per cent. of the total membership, were against the idea. We do not know whether it is proposed to hold an enquiry into the mentality of these gentlemen. But while there is overwhelming support in favour of the application there are still a number of members who are not quite sure of the uses and benefits of a Royal Charter. As the President truly said, however, such a document will change the Institution from a self-constituted to a State appointed body, and will so raise its prestige in the public eye. It will also help us, as Mr. Wordingham, the inaugurator of the idea of applying for a charter, pointed out, to extend the usefulness of the Institution. From both these points of view, it is well worth while.

Some Improvements in the Poulsen Arc.

By Prof. P. O. PEDERSEN.

In a series of investigations carried out during the years 1914 to 1918 the author tried to elucidate the operation of the Poulsen arc. The results of these investigations have been published in a number of papers in the English and Danish languages*. The insight thus obtained made it possible to improve the arc in several ways, and a brief description of these improvements may possibly be of interest to some readers of The Electrician. Before proceeding with this description, it will, however, be necessary to give a short *résumé* of the investigations as a knowledge of the main results of these is required in order to understand the nature of the said improvements.

General and Symbols.

The diagram of the circuit of the Poulsen arc used in the experiments is given in Fig. 1. The arc is burning in a hydrogenic atmosphere. The active part of the cathode C is made of carbon, and the whole cathode is rotated by means of a small motor. The anode Cu consists of a water cooled copper tube. The arc proper a is placed in a magnetic field of intensity H produced by the current I_m through the coils of the field magnet. The supply current I_0 is kept (approximately) constant by means of choke coils. The direct current voltage across the arc is denoted by V_0. The high frequency circuit is shown in heavy lines and contains the capacity C, the inductance L, and the resistance R. The effective value of the high frequency current is denoted by I. The instantaneous values of the current through and the voltage across the arc are i_1 and e_1, and i is the instantaneous value of the current in the h.f. circuit. The positive directions of these currents are chosen as shown in Fig. 1, and their values, therefore, satisfy the following relation:—

$$i_1=I_0+i. \qquad \text{(1)}$$

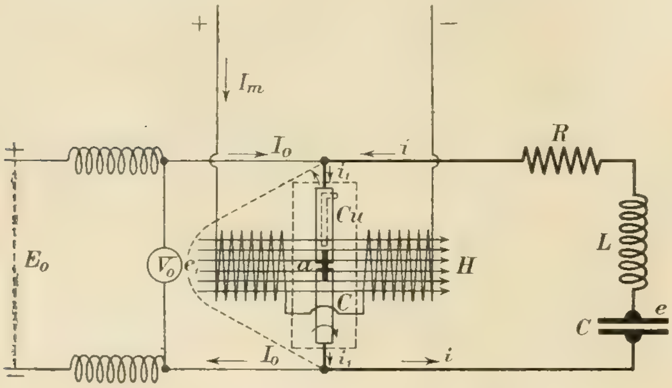


Fig. 1.—Diagram of Circuit.

The period τ of the oscillations is very nearly equal to $2\pi\sqrt{CL}$.

It has been found that the ratio of radio frequency current to supply current g for the normal Poulsen arc has the value

$$g=\frac{I}{I_0}=\sqrt{\tfrac{1}{2}}=0{\cdot}707. \qquad \text{(2)}$$

Under such conditions as are generally to be found in the larger arc stations, or when using similar laboratory arrangements, the formula (2) holds good with great accuracy. This value of the ratio g indicates that the radio frequency current is very nearly of a pure sinusoidal shape and that its amplitude is very nearly equal to I_0. (*See* Figs. 2 and 11.)

The Operation of the Normal Poulsen Arc.

The investigations have proved, that in the normal Poulsen arc the arc at the beginning of each period is struck at the edges of the electrodes and is then driven by the magnetic field at increasing speed out along the electrodes (away from the edges). In the course of the period the arc is thus getting longer and longer, and is, at the same time, travelling with steadily increasing speed. In consequence of this the arc voltage increases during the period and reaches at the end of the latter such a value—the extinguishing voltage—that the arc is extinguished. The whole operation then repeats itself.

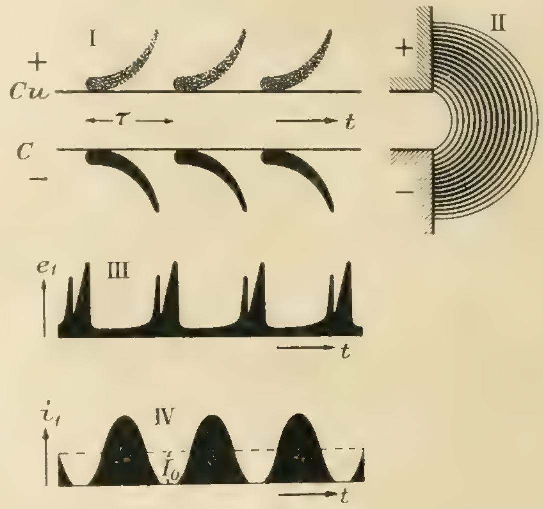
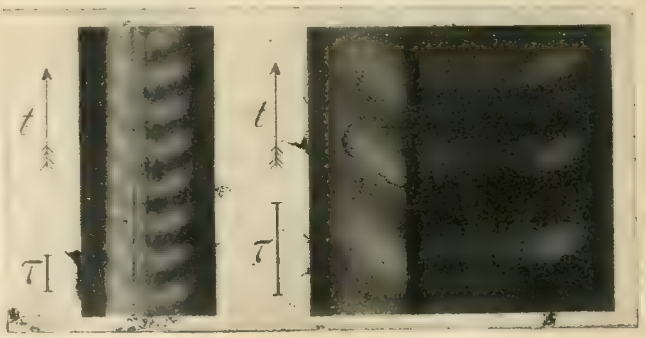


Fig. 2.—Diagrammatic Representation of the Operation of a Normal Poulsen Arc with Separate Extinguishing and Striking Voltages.

I. Crateroscillogram of the Oscillatory Arc taken with a Revolving Mirror.
II. Side View of the Arc.
III. Oscillogram of Arc Tension. The small peaks correspond to the extinction, the large ones to the re-ignition of the Arc.

Fig. 2 gives a diagrammatic representation of this operation. Part II. is a side view of the arc or—as a matter of fact—not of the arc itself, but of the entire space through which the arc travels during a period. Part I. represents the corresponding crater oscillograms obtained by photographing the oscillating arc in a rapidly rotating mirror. The negative crater near the electrode edges where the arc travels at minimum speed is largest and has the highest temperature, as seen in Fig. 3 (*b*). It is mainly the conditions in the negative crater which are of interest. Fig. 2, Part III., represents an oscillogram of the arc-voltage—the higher peaks representing the striking voltage. In consequence of the above-mentioned conditions



(*a*) (*b*)

Fig. 3.—Photographs of Oscillating Arcs taken with a Revolving Mirror (Crater Oscillograms). Cathode to the Left. τ is the Period.

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* (*a*) "Forhandlinger ved de skandinaviske Naturforskeres 16 Möte i Kristiania," July, 1916, p. 170-172. (Kristiania, 1918.) (*b*) "Om Poulsen-Buen og dens Teori." Mem. de l'Academie Roy. d. Sciences et d. Lett. de Danemark. 8me Série, t. II., No. 4 Copenhagen, 1917. (48 pp.) (*c*) "On the Poulsen Arc and its Theory." "Proc." Inst. Rad. Eng., Vol. V., p. 255-316. 1917. (*d*) Supplementary No. Vol. VII., p. 293-297, 1919. (*e*) "Poulsen-Buens Virkemaade." "Fysisk Tidsskrift." Vol. XVII., p. 45-66. Copenhagen, 1918. (*f*) "Magnetfeltet i Poulsen-Buen." L.c., p. 69-87. Copenhagen, 1919. (*g*) "On the Poulsen Arc in Coupled Circuits." Will shortly appear in "Proc." Inst. Rad. Eng.

the arc-voltage in each period has its minimum value immediately after the striking of the arc. By and by, when the speed of the arc increases, and the temperature of the crater accordingly decreases, the arc-voltage increases. Towards the end of the period when the current rapidly decreases the voltage rather suddenly rises to the extinguishing voltage.* Part IV. represents the arc current.

THE STRIKING VOLTAGE.

The *striking* voltage may either be higher or lower than the extinguishing voltage. In the first case, the arc is actually extinguished once in every period and the arc voltage shows separate extinguishing and striking peaks, as shown in Figs. 2 and 4. When the striking voltage is lower than—or, at most, equal to—the extinguishing voltage, the arc is not actually extinguished. The arc current in this case momentarily goes down almost to zero, but not quite, because a "new" arc strikes at the edges of the electrode before the "old" one is completely extinguished. In this case the arc tension has only *one* peak in every period. We will in the following speak of *one* and *two-peak working* respectively. We have until now mainly considered two-peak working. The conditions for one-peak working—which is the ideal and which is made possible through the improvements here to be described—will be dealt with later on in this Paper.

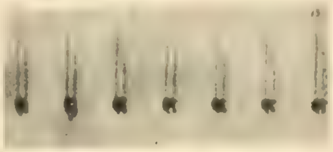

FIG. 4.—OSCILLOGRAM OF ARC VOLTAGE IN A NORMAL POULSEN ARC WORKING WITH SEPARATE EXTINGUISHING AND STRIKING VOLTAGES OBTAINED WITH GEHRCKE'S CATHODE GLOW OSCILLOGRAPH. TIME MEASURED FROM RIGHT TO LEFT.

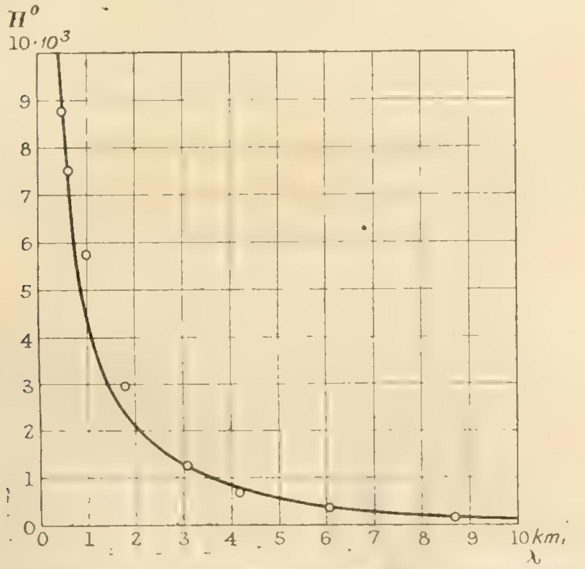

FIG. 5.—THE MOST ADVANTAGEOUS MAGNETIC FIELD H° AS DEPENDENT ON THE WAVE LENGTH (I_0 = 17 A).

It has further been proved that it is a vital condition for the proper working of the arc that the *extinguishing* voltage reaches a sufficiently high value. It has also been shown that the extinguishing voltage increases with the speed of the arc at the moment of extinction and that the speed of the arc is proportional to the intensity of the magnetic field and is in inverse ratio to the density of the gas surrounding the arc. Another fact brought out in the researches is that in each particular case a certain field intensity H° is the most advantageous, as with such a field the arc works more quietly and with better efficiency than with any other value of the field.

From this it follows that the most advantageous intensity H° of the magnetic field stands in an inverse ratio to the wave length, and is proportional to the density of the gas, and increases with any increase of the supply current and of the effective resistance in the oscillating circuit.

In order to illustrate how closely these deductions agree with the experimental facts, the results of a series of measurements of corresponding values of the wave-length and the most suitable field H are shown in Fig. 5. The points represent the actually measured values and the full-drawn curve the theoretical values. The agreement is quite good.

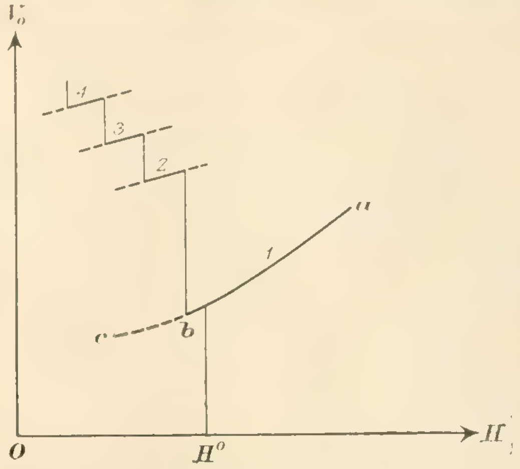

FIG. 6.—DIAGRAMMATIC REPRESENTATION OF THE SUPPLY VOLTAGE V_0 AS A FUNCTION OF THE FIELD INTENSITY H. (The figures on the Curve denote the Number of Arcs to be seen in the Side View.)

For further elucidation of the conditions determining the most advantageous field intensity we will consider Fig. 6, showing how the supply voltage V_0 depends upon the field intensity H, all other constants of the arc circuit such as supply current, wave length, and resistance being kept constant.

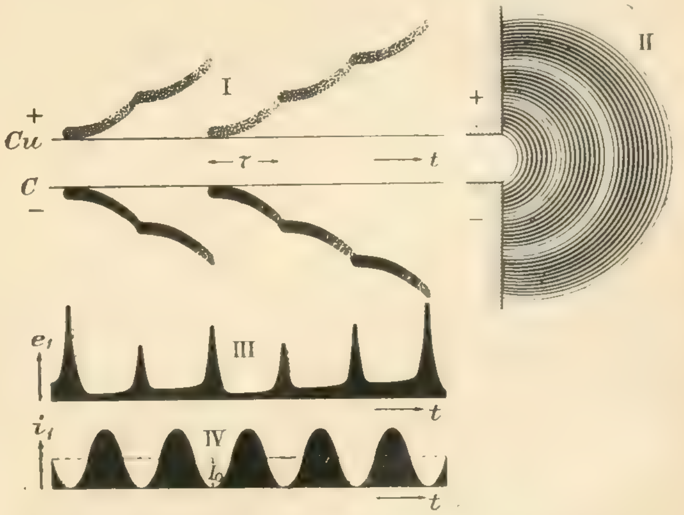

FIG. 7. DIAGRAMMATIC REPRESENTATION OF THE ARC IN TOO WEAK A FIELD.

DISCUSSION OF THE (H, V_0) CURVE.

The first part ab of the (H, V_0) curve corresponding to high field intensities has quite a regular shape, V_0 decreasing with decreasing field intensity. As the arc efficiency is inversely proportional to the value of V_0 it is most advantageous to apply as weak a field as possible. On the other hand, V_0 increases rapidly with decreasing field intensity below the point b. Hence in practice a value such as H° a little to the right of the point b must be applied.

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* These oscillograms are taken with the Gehrcke cathode light oscillograph and reproductions of some of them are to be found in the above-mentioned Papers *b*, *c* and *e*. A typical oscillogram of a normal Poulsen arc working with separate extinguishing and striking voltages is shown in Fig. 4.

The cause of this shape of the (H, V_0) curve is the following. At field intensities essentially higher than H° the magnetic field gives the arc too great a velocity. The consequence is that the temperature of the arc and of its crater is too low, the ionisation of the arc too feeble, and the supply voltage accordingly too high. As mentioned before, the weakest field possible should, therefore, be applied. But too weak a magnetic field causes quite a different aspect of the arc phenomenon. The reasons for this are to be found in two circumstances, which are consequences of or concurrent with the weak magnetic field. To begin with, the arc is not completely extinguished, or, if it is, is only extinguished during an extremely short time. And, secondly, the arc and craters travel only a very short way during a period. The combined result of this is a marked tendency for the arc to ignite again at—or, if not completely extinguished, to continue from—the point it has reached at the end of a period. If the field is much too weak, this is repeated several times until the arc has attained such a length and the arc voltage so high a value that the re-ignition takes place again between the edges, whereupon the same succession of phenomena is started over again. These conditions are shown diagrammatically in Fig. 7, where it is assumed that the arc ignites every second or third time on the edges.

Re-Ignition Voltage.

This re-ignition on the edges requires a considerable voltage, while the next extinction—and ignition—voltage will be comparatively small, and the next thereafter a little higher, as indicated in the figure. That the arc voltage really may have this appearance is clear from Fig. 8. Here the arc is struck at the edges alternately every second or third time.

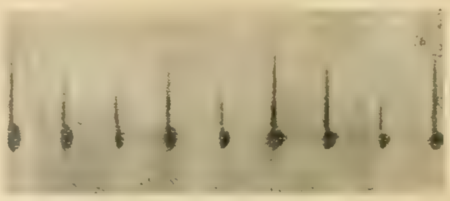

Fig. 8.—Gehrcke Oscillogram of the Arc Voltage in Too Weak a Field. Time being measured from Right to Left.

The side view in this case shows a number of arcs corresponding to the various ignition points as indicated in Fig. 7, Part II. The weaker the field is, compared with the normal field, the greater is the number of arcs. Of all these arcs only one exists at one time.

(To be concluded.)

Clydes Mill Station of the Clyde Valley Power Co.

The Beginnings of a Super Station.

The Clyde Valley Electric Power Company operates over an area of about 750 square miles in the South-West of Scotland. The extreme length of the area is 46 miles, and its average width 10 miles. It roughly follows the direction of the River Clyde from east to west, and there is a "blank" in the middle, which is represented electrically by the system of the Corporation of Glasgow. Another smaller blank is accounted for by Paisley. All this is indicated in the accompanying map (Fig. 1).

The company possesses three generating stations, one of which is at Yoker lower down the Clyde than the Clydes Mill Station, and the other at Motherwell, some distance higher up. The latter station was originally a cooling tower station, but recently a pumping plant has been added to allow a certain amount of circulating water to be drawn from the river some distance away. Owing to this drawback and the way in which the load of the company's system has developed it is not expected that this station will be further extended.

Interconnection and Transmission.

The transmission and distributing network of the company is operated on the three-phase system at 11 000 V, with a frequency of 25 and it is interesting to note that 11,000 V is also the generating pressure, so that transforming is reduced to a minimum. One exception to this arrangement is the 33 000 V interconnector, which has recently been laid between the Yoker and Clydes Mill stations. This interconnector is connected to the system generally through transformers at each end, which are fitted with boosting equipment. The interconnector is designed for transmitting 15 000 kVA both ways. To obtain the maximum transmission in kilowatts at the low average power factors (0·75), which have to be dealt with on the system, the provision of boosting equipment has been necessary. With the transmission of 15 000 kVA at the above power factor the cable will be subjected to a pressure of 36 000 V. The transformers and accessory gear are being supplied by the British Electric Transformer Company, and the cables are the work of Messrs. Pirelli. In future, arrangements may possibly be concluded for running this interconnector into the Dalmarnock station of the Glasgow Corporation, which it passes within about half a mile, thus forming one link in a very necessary scheme for co-ordinating electricity supply in the Glasgow area. Meantime, this interconnector is operating at 11 000 V until such time as the transforming equipment is available.

The cables employed are double taped, armoured, and laid direct in the ground. Interlinking is adopted to the fullest possible extent, and the whole system is protected by the well-known Merz-Price system. The length of the cable now operated by the company amounts to 240 miles, while, in addition, there are 60 miles of overhead lines. These latter are mostly used on the outskirts of the area and it is interesting to notice that the general tendency is to extend the underground rather than the overhead system.

Substations.

The substations of the company number 210 and are, in almost every case, on the consumers' premises. The 11 000 V lines are laid direct into the substations, and arrangements are made whereby the consumer can cut off the high-tension side of the transformers in case of need. On the low-tension side four-wire distribution at 425 V between phases is used for power supply. This gives 250 V on the two-wire lighting circuit.

Generating Arrangements.

Turning to the generating side of the system the station at Yoker contains one 18 750 kW Metropolitan-Vickers turbo-alternator, two 6 000 kVA turbo-alternators, and two 3 000 kVA alternators also of Metropolitan-Vickers manufacture. The Motherwell station contains three 6 000 kVA and one 3 000 kVA turbo-alternators, all made by Messrs. Metropolitan-Vickers. The 3 000 kVA set uses the cooling towers mentioned above.

The Clydes Mill generating station, which we describe more particularly below, contains one 18 750 kW set and two 6 000 kVA sets, all of the Metropolitan-Vickers type and make. This station was designed and built in 1916 to deal with the enormously increasing load of the company, an increase which was brought about by war conditions.

An external view of the station is given in Fig. 2. This indicates the general arrangement of the outside equipment on the river front. It shows the dam, which helps to maintain the supply of circulating water. This is fitted with the usual protecting screeens. These are particularly necessary at Clydes Mill, as the quantities of leaves which come down the river during the autumn is particularly large. Jet blowing arrangements are provided for clearing the bars of obstruction.

Coal Storage and Handling.

The coal storage ground and the sidings whereby coal is supplied from the Caledonian Railway system are on the other side of the station from the river, as are obviously the chimneys, a small portion of the top of one of which only is seen in the photograph. The coal is drawn over from the company's siding by means of either a steam locomotive or two electric locomotives, which were built by the Glasgow tramways department to the company's design. The company's siding is about 1½ miles long, and at the far end the coal trucks are tipped by a hydraulic arm into a sifter or crusher, with a capacity of 40 tons per hour. The coal is then either transferred direct to the boiler house, or, by means of a grab crane, is deposited on the storage ground. The present arrangements for handling coal to and from the bing are of a temporary nature, and provision has already been made for erecting a large gantry crane having a span of 150 ft. Similarly, the present arrangement for ash handling is temporary and a modern suction ash removal plant is in course of installation and will be in service shortly. It is interesting to note that arrangements are in progress for taking the whole supply of fuel required for the station from a neighbouring colliery. If this comes about a rope railway will be built to ensure easy handling. The bunkers over the boilers into which the running coal is fed have a capacity of 240 tons, or about sufficient to meet the full-load requirements of the boiler house for one day. The steam raising plant installed consists of 10 B. & W. water-tube boilers, each with a capacity of 33 000 lb. of steam per hour, at a pressure of 200 lb. They have three drums and are fitted with chain grate stokers. Six of them work on induced draught and four on balanced draught. They are all fitted with integral superheaters, and each boiler is equipped with its own fan. They are amply provided with CO_2 recorders of the W. R. Patents, Ltd., type, and steam flow meters manufactured by GEORGE KENT, LTD.

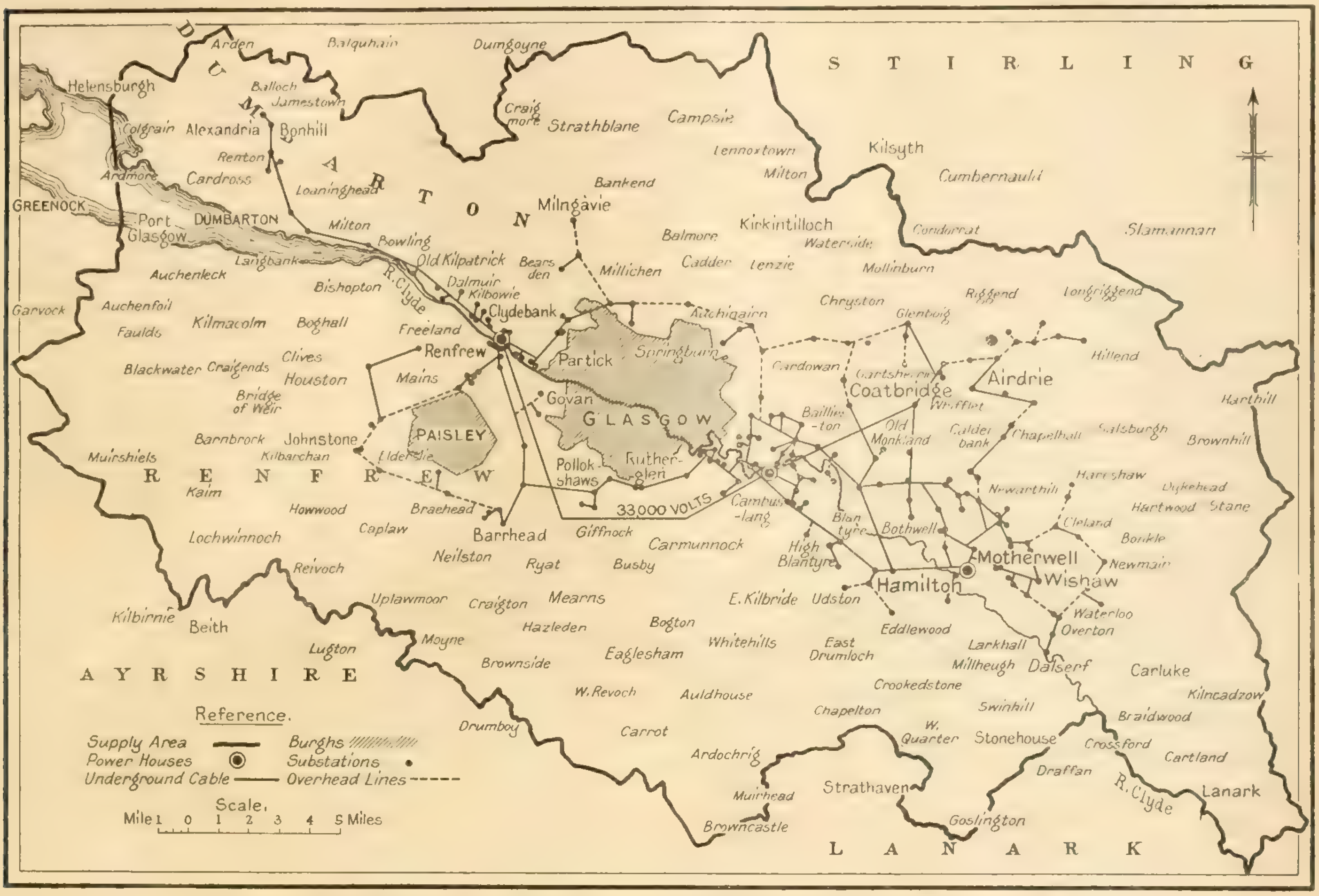

FIG. 1.—MAP SHOWING THE CLYDE VALLEY ELECTRIC POWER CO.'S AREA OF SUPPLY.

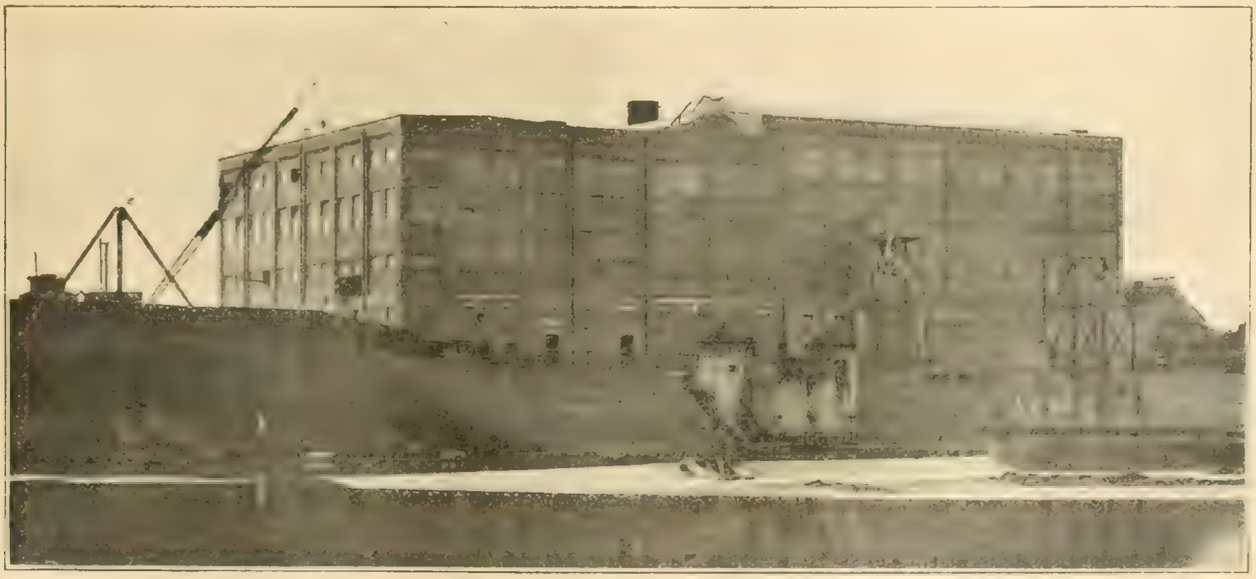

FIG. 2.—VIEW OF CLYDES MILL POWER STATION, SHOWING SWITCHGEAR AND TURBINE HOUSES WITH DAM AND RIVER SCREENING ARRANGEMENT

The Generating Plant in Detail.

As mentioned above, the generating plant installed in this station consists of one 18 750 kW set and two 6 000 kVA sets, all of which are of the Metropolitan-Vickers type. As is well known, these machines work on the Rateau impulse principle and, in this case, operate at a steam pressure of 190 lb. per square inch, though this pressure can be raised to 250 lb., with a total steam temperature of 650°F. The speed of the set is 1 500 revs. per min. which allows an ample factor of safety. The cylinder containing the first three stages is constructed of steel and the remainder of cast-iron. The turbine is divided on the horizontal centre line so that the interior is readily accessible for inspection when the cover is lifted. The exhaust end has been specially constructed to minimise losses due to the eddying of the steam. Directing vanes are cast in the outlet to give a stream line flow to the steam at the exhaust. The area of the exhaust is 96 in. square, and is large enough to take the full load steam quantity at a pressure of 1 Hg. absolute. The turbine is fitted with a surface condenser supplied by Messrs. G. & J. Weir, Ltd., which is designed to give a 29 in. vacuum at the turbine exhaust flange with the barometer at 30 in. The air pump draws the condensate from the condenser and discharges it into a receiver from which it is delivered by means of a force pump coupled to an air pump through the feed water house to a Lea recorder and thence to the feed tank. By-pass valves and pipes are provided so that, if necessary, the feed water can be discharged direct to the feed tank without passing through the heaters. This arrangement, it is claimed, gives a saving in heat over the usual methods amounting to 4 per cent. The condenser is bolted direct to the turbine exhaust and the whole is supported on two monoliths of comparatively simple construction.

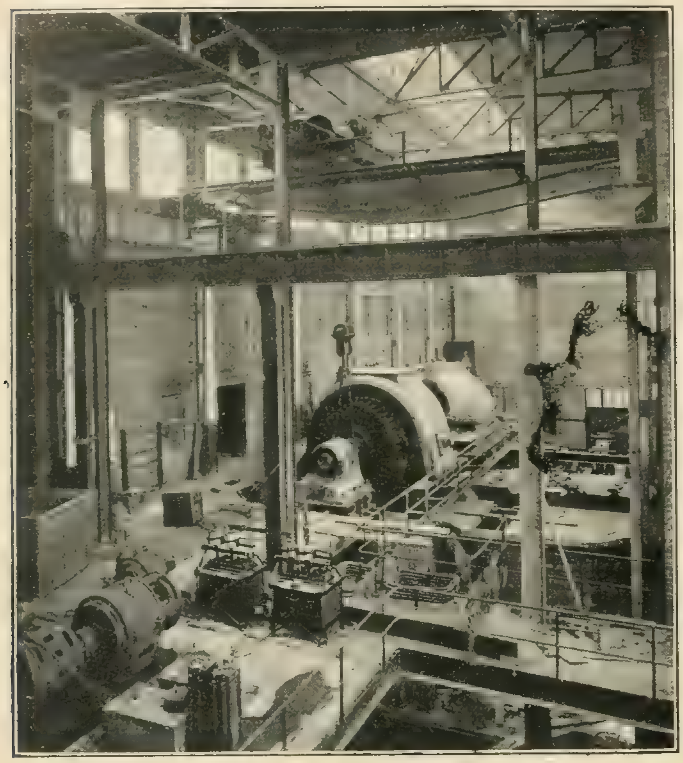
Fig. 3.—View of the 18 750-kW 0·8-P.F. 1 500-rev. Metropolitan-Vickers Turbo-Alternator in course of erection.

Alternator Design.

The alternator is designed for a maximum continuous rating of 18 750 kW with an 80 per cent. power factor. As the economical rating of the turbine is 15 000 kW there is, therefore, ample margin in the alternator to deal with any overloads. The general design of this machine is similar to that installed at the Dalmarnock station of the Glasgow Corporation, of which a description appeared in The Electrician of September 10, 1920. It will be remembered that a noteworthy feature is that it is of the two-pole type, and that for this reason the stator is of large cross-section and very heavy. The complete stator including the winding covers weighs approximately 100 tons, and for this reason it was necessary not only to assemble the punchings but to wind the stator on site. The rotor which weighs 40 tons was completed and tested at the factory. The alternator is totally enclosed and ventilation is provided by means of fans mounted on the rotor.

The air for ventilation purposes is drawn in through Davidson air filters, the yoke being provided with an outlet chimney at the top and bottom, while sufficient section of ventilating passage is given for the foul air volume to be discharged either way.

Armature Winding.

The armature winding consists of two conductors per slot, each conductor being sufficiently insulated with mica and capable of withstanding the working voltage of 11 000 V, so preventing any possibility of a breakdown between two conductors in the same slot. The conductor nearest the slot opening is divided into several parallel strips to reduce the eddy currents, the strips being transposed in the centre of the core by a method patented by the Metropolitan-Vickers Electrical Company. The end connections consist of solid copper bars having a cross-section of approximately 1 in. square. Such connectors offer a very large resistance against the bending forces which occur in the case of an accidental short circuit. To prevent movement of the straight parts of the coil which are outside the iron they are blocked together into a solid ring by means of substantial segments of strong insulating material which are provided with an opening for each of the conductors. This prevents any radial or lateral movement of the conductors and also prevents the mica cracking where the conductors leave the core. The generators are provided with an internal reactance of 10 per cent., and an external reactance of 5 per cent., made up in three reactance coils which are connected in series with the stator winding. The set is provided with an exciter which is of the usual overhung type and is provided with a single face radial commutator so arranged that its field can be satisfactorily excited from a battery so ensuring stability of voltage in case of severe forces on the turbine. To permit of the station auxiliary plant being run independently of the main turbo units a 500 kW Fraser-Chalmers-General-Electric geared turbo-alternator is also being installed. This set has turbine and generator speeds of 4 300 and 750 revs. respectively, and a guaranteed steam consumption of 13·6 lbs. per kilowatt-hour. The two 5 000kW sets are of similar construction. Views in the turbine room are given in Figs. 3 and 4.

Interesting Switchgear.

Perhaps the most interesting feature about this station is the switchgear. As mentioned above, when completed, Clyde Mills will be one of the largest stations in the country, the proposed final capacity being about 200 000 kW. The switchgear now being built will control a quarter section of the final scheme and includes that required for two 15 000 kW and two 5 000 kW turbo generators,

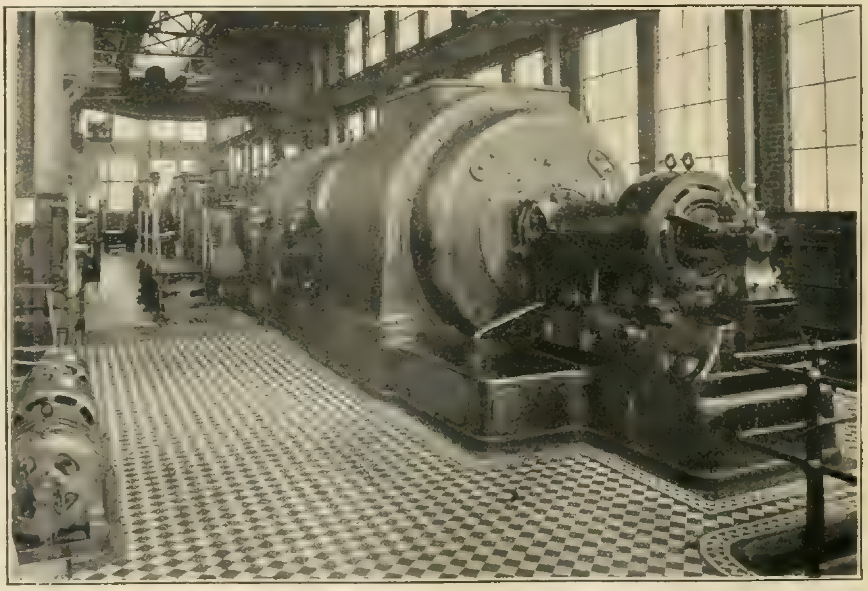
Fig. 4.—View of the Two 5 000-kW 0·8-P.F. 1 500-rev. Metropolitan-Vickers Turbo-Alternators in the Small Turbine House.

as well as for eight feeders each with a capacity of 5 000 kW. The additional sections which will be necessary in the future will be coupled to this section through suitable reactance coils by an auto-static oil switch.

The main switchgear occupies three floors of an annexe to the main mation, the control board being mounted on a gallery overlooking the engine room. The switch cubicles were built by the Clyde Valley Company themselves from designs supplied by the METROPOLITAN-VICKERS ELECTRICAL COMPANY. They are of moulded stone and iron framework construction. The top floor of the annexe carries the main and "hospital" busbars and the selector and isolating switches. The main bars are arranged in the form of a ring for the section only. This ring can be coupled to the hospital bars by a non-automatic oil switch if required. The "hospital" bars extend the length of the annexe and each circuit can be connected to these bars by special selector switches. All isolated switches are provided with locking catches to prevent them opening from any magnetic effect caused by excessive overload conditions.

SPECIAL OIL SWITCHES.

The middle floor is divided into two parts by means of a gallery built between the cubicles and the outside walls of the annexe. The upper portion of the structure carries the oil switches rated at 500 000 kVA rupturing capacity, which are of a type new in this country as will be seen by reference to the accompanying illustration, Fig. 5. It will be noted that the oil tanks are circular in shape, and are provided with a hemispherical bottom. These tanks are fluid pressed from thick steel plate, and are without seam. The makers contend that this method of construction combined with the shape adopted gives a type of tank which is very suitable for withstanding the high internal pressures caused when heavy overloads are broken on the switch. These tanks are carefully earthed, and are so arranged that they can be lowered without disturbing any of the mechanism or connections. The moving contacts are of the wound brush type with butt arcing tips, and the fixed contacts consist of faced copper blocks which are provided with renewable arc tips. The construction of the switch is such that all forces assist in increasing the speed of the break. These switches are solenoid operated, and are controlled by a push-button controller on the panel working in conjunction with a contactor in the cubicle. The breaking of large operating currents and the inductive discharge effect on the main solenoid of the operating board is thus provided. The lower portion of the middle floor carries the instruments, series transformers and the Merz-Price protective transformers for the generators and feeders. All these transformers are of the bar primary type with compound filled sectional windings.

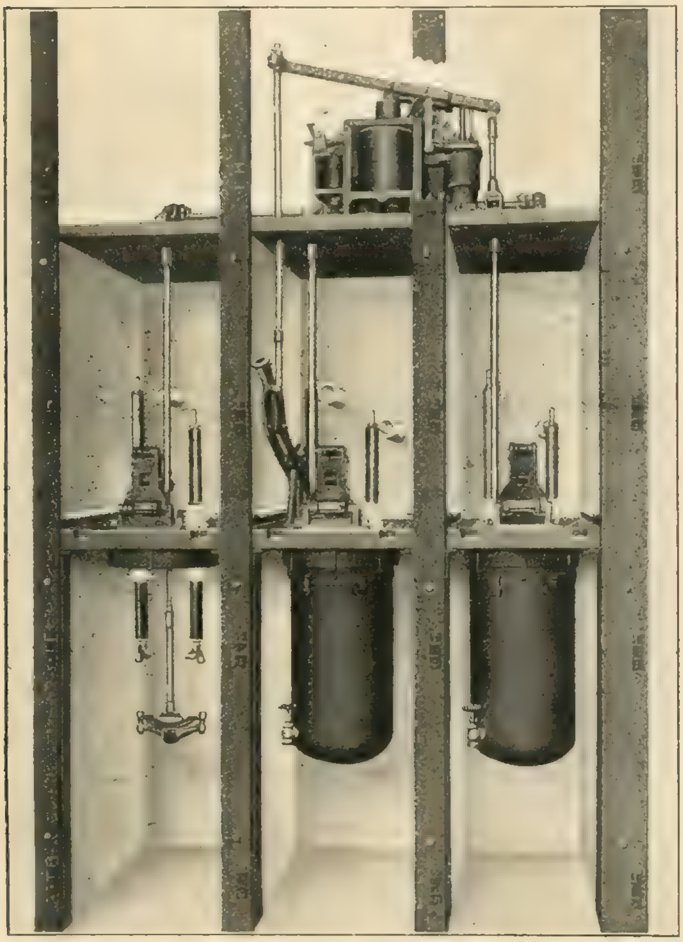

FIG. 5.—THE 500 000-KVA OIL SWITCH USED AT CLYDES MILL.

The bottom floor of the switchgear annexe carries the generator units, coils, instruments, shunt transformers, and the cable boxes for the feeder and generator cables. The shunt transformers are of the Merz-Price type, and three single-phase transformers are used, connected in star to form a three-phase unit. In the case of the busbar, shunt transformers are so arranged that oil switches can be fitted to them at a later date. As these circuits are connected directly to the 'bus-bars in the ordinary course of events this would necessitate the oil switches having the same short circuiting breaking capacity as the main switches in order to operate satisfactorily in the case of a shunt transformer fault. In order to avoid making these arrangements at the present time, suitable Koppat resistance rods have been inserted in circuit and this, whilst having practically no effect on circuit at normal load, reduces the current to a low enough value for the expulsion fuses to work satisfactorily under fault conditions.

Provision is also made on this lower floor for the installation of reactance coils in the coupler circuit between this section and the proposed second section. All these reactance coils are single-phase coils of the oil-immersed type, and are inserted for the purpose of reducing the short circuit energy in the event of a fault. The control board is of the vertical type and is built of black enamel slate work, carried on a wrought-iron framework. The two smaller sets are at present controlled by a temporary board. The control panels are provided with a system of dummy bus bars which shows the position of the sets of isolating switches, and the bars to which the circuits are connected, while a very complete system of lamp signalling allows the position of each switch to be recorded. The Merz-Price system of protection has been adopted throughout, and overload relays and constant time limit type have been provided on the feeder circuits.

We have to thank the Clyde Valley Electric Power Company, especially their general manager, Mr. E. T. Goslin, for permission to describe this interesting station, and for the loan of the photographs illustrating it, with the exception of Fig. 5, which has been lent by the Metropolitan-Vickers Electrical Company. Much of the information given on the generators and switchgear was also obtained from the same company.

The consulting engineers to the Clyde Valley Electrical Power Company are Messrs. Strain & Robertson, of Glasgow, who have been responsible for the lay-out and design of the Company's system.

Hydro-Electric Development in New Zealand.

In a recent address to a meeting of representatives of Christchurch local bodies the MINISTER OF PUBLIC WORKS assured his hearers that the Government considered the development of hydro-electric power essential not only for the towns but for the country districts and for the alleviation of the conditions of people in the back-blocks. Referring to the Lake Coleridge power scheme the Minister said that the results showed that only a quarter of the power that could be used was being turned out. Though the capacity of the plant was 8 000 H.P., at present 1 500 H.P. more than this amount was being supplied and the plant was being run near the danger point. Plant to provide another 4 000 H.P. would be ready for winter use, and in 1922 provision would be made for another 4 000 H.P., which would bring the output of the Lake Coleridge power station up to 15 000 H.P.

With regard to distribution the Minister stated that 1 000 H.P. would be distributed on the Timaru line to Ashburton-Orari, and 500 H.P. to Banks Peninsula, Ellesmere and other outlying districts. All the money set aside for electrical extensions (£750 000) would be spent; the plans and specifications of the power house had been approved, but certain surveys remained to be made. A new 10 ft. tunnel and a pipe line would, when completed, result in a capacity of 36 000 H.P. It would be necessary also to double the capacity of the transmission lines to Christchurch and make extensions to South and North Canterbury. It was necessary that the money available should be spent to the best advantage, and in connection with other schemes, *e.g.*, Arapuni, Waikaramoana and Mangahae in the North Island, and Marlborough, Nelson, Westland and Otago, to be connected ultimately with Monowai (Southland) in the South Island. High prices and insufficiency of supplies and also of labour had delayed progress.

The English Electrical Industry.[*]

An Austrian Engineer's Criticisms.

By Dr. E. ROSENBERG.

In the development of the electrical industry in England the following points were of decisive importance :—

1. Free trade, whereby the English industry on the one hand remained unprotected from foreign competition, while, on the other hand, it was not dependent on English suppliers alone for raw material.
2. The strength of the trade unions, which everywhere hampered free development.
3. The large number of manufacturers, mostly small or of moderate size only, carrying on unlimited competition with one another, and with too small capital for mass production or important technical equipment.
4. Owing to the severe competition between firms, the position of the buyer, and particularly that of the buyer's technical expert, became all powerful.

The Shortcomings of the English Electrical Engineer.

The English engineer in general showed himself less suited for or interested in theoretical investigations than his Continental colleague. This, perhaps, was the reason why so many German, Austrian, Swiss, and Scandinavian designers were employed in England before the war. It would be wrong, however, to generalise on this point, because there are excellent theoretical English engineers. For example, the voluminous publications in recent years in Germany on additional losses in armature windings are principally paraphrases of A. B. Field's short Paper published in the A.I.E.E. " Transactions " in 1905.

The Effects of Free Trade.

The English electrical industry had to grow up under Free Trade. While in other countries it was protected to some extent from foreign competition by tariffs, and could grow strong at home before entering into external competition in England it had to face American, German and Swiss competition. A few Government contracts specified English goods, but the railways gave no preference. Of railway electrifications round London, one of the chief contracts went to Germany and another to Switzerland. Owing to the large differences in price, municipalities also purchased their machines abroad. The same was true of the Colonies, although several exacted tariffs on electrical imports. Since, however, electrical goods were manufactured only in Canada and the preferential rates for English goods were small, England had actively to compete with America and the Continent for the Indian, Australian and South African markets, in spite of the Colonies preferring to buy from the Mother Country, and their consulting engineers being resident in Britain. Moreover, since tariff-protected countries pursued the policy of fixing lower prices for the export than the home market, the English salesman lay on no bed of roses.

The Benefits to the English Buyer.

In buying, however, the English firms profited by these conditions. They could buy steel, &c., from Germany and Belgium much cheaper than in England, and even cheaper than German firms in Germany. English steel works were therefore driven from the market, with the result that before the war large castings for turbo-rotors or for the flywheels of Ilgner sets for peripheral speeds up to 150 m./sec. were seldom made in England. The war has altered this, and now English steel makers even supply such steel abroad.

English machine manufacturers have often tried to get tariffs imposed, but have failed owing to the opposition of textile, shipbuilding and other industries which mainly live by export.

The Effect of the Patents Act.

About 1907 a new Patents Act came into force. This was intended to protect the English industry by allowing the patent on any article which was mostly manufactured abroad to be annulled. Two important actions showed, however, that the interpretation of the law by the Patent Office and the inferior courts was not supported by the Supreme Court and counsel for the owners of such patents could boast that they had made a dead letter of the law. The Act had really no effect on British industry.

Trades Unions as an Obstacle.

Not only had the British manufacturer to compete with foreign manufacturers, but he was still more hampered by the policy of the trade unions. These exerted a close control over all factory methods, and exercised in the most short-sighted manner the recognised principle that no innovation must be introduced to the disadvantage of the organised worker. When once a skilled workman was allotted to a machine the work on that machine could never be given to an unskilled workman, and when once a workman operated *one* machine two machines must not be operated by one man in future. This necessarily led to a waste of energy, and often prevented the introduction of new labour-saving machines, if the manufacturers had gained experience that nothing could be saved by introducing such machines. In general the unions reduced output.

The War and Output.

During the war, national patriotism—assisted by reverses at the front—led the unions to forego their privileges and customs, of course, with the stipulation that pre-war conditions would be later restored—a promise that could be as little fulfilled as many of the other promises given during the war. It was found that an unskilled woman could with automatic machines replace three skilled turners. The unions have much influence on all municipal councils, and there is scarcely a municipal contract awarded without a list of trade union minimum rates which must be adhered to.

Cut-throat Competition.

The severe home competition hindered the development of British firms. At the beginning of the twentieth century there existed practically only small firms when a large branch of an American firm with possibilities for mass production far greater than all previous undertakings was established. Competition between the native firms, the English branches of American and German firms, and foreign importers reached a degree almost incredible to anyone acquainted with present-day conditions. An enquiry for a small installation or a medium-sized motor would be answered by sixty firms, all of whom would go to much expense to obtain the order, which was finally given at a price below works costs. Few firms were able to pay dividends. This went on for years; several firms needed yearly increases of capital, while shares were written off again and again. This was particularly the case with firms which built large steam-turbine installations. Profits were made usually only by firms in which the electrical department was a small part of the whole concern, so that the losses on the electrical side were insufficient to swallow up the total profits.

This policy put the English firms at a great disadvantage in developing new lines compared with American and German firms, who, with ample profits and prudent policy, laid by great reserves.

England as the Pioneer.

In certain branches England was the pioneer. The steam turbine was invented by Parsons, but all countries have assisted in its development, and in the victorious course which the steam turbine had run in the last twenty years English designers were for a long time behind their foreign competitors.

In size of units the German firms with their 50 000 kW turbines are still much ahead of the English. Electricity supply in towns and large industrial districts in England is well developed, and in many cases the tariff policies have been such as to encourage large factories to buy from public supply authorities and close down their own stations.

High Frequency Rotary Converters.

In the general use of high frequency rotary converters England has also been ahead of the Continent. When the large substations for the London underground railways were built efficient American 25-cycle converters were available. At that time, however, designers did not feel confident about large two-pole generators running at 1 500 revs. per min., and since four-pole 25-cycle generators would have needed expensive and uneconomical steam turbines, the compromise of 1 000 revs. per min. with 33⅓ cycles was chosen for these stations. The 25-cycle converters could be adapted with comparatively small trouble. From 33⅓ to 40 cycles is only a small step, and it thus became possible in the great electricity area around Newcastle-on-Tyne, which had been developed by Merz & McLellan, to introduce 40-cycle converters. The successful results formed the bridge to the common 50-cycle converter, which before the war had, after a hard fight, established itself everywhere in England. The motor-converter, which had proved technically sound, formed merely an episode before the general adoption of the 50-cycle rotary converter.

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[*] This article gives the substance of a lecture delivered by Dr. E. Rosenberg, late chief electrical engineer to the British Westinghouse Electric and Mfg. Company, Ltd., Trafford Park, before the "Elektrotechnischer Verein," in Vienna, on January 12, 1921. It was published in the " Elektrotechnik und Machinenbau," Vol. XXXIX., p. 233.

British Tramway and Railway Progress.

Electric tramways were developed earlier in the provinces than in London. The electrification of railways long since reached an advanced stage by the electrification of the London underground railways on the 600-V, continuous-current system with third rail. Only the Brighton line adopted the single-phase system. Later in Lancashire 1 200 volts continuous current with a third rail was used, but experiments with 3 000 V did not lead to practical developments. An important electrification was carried out at 1 500 V continuous current with overhead conductors on the North-East coast and on the Melbourne suburban lines by Merz & McLellan, and it is probable that this system will be used by these engineers on several colonial railways.

For the electrification of long distance lines cheap coal made it impossible for the saving in locomotive coal to provide dividends for the large capital needed for electrification. The great increase in the cost of coal, even in England, which is relatively much higher than the increase in the cost of electrical machines and stations, will perhaps reverse the situation.

Some interesting specialities of English firms or engineers, which, however, have not conquered a very wide field, are the radial commutator for continuous-current turbo-generators, the Hunt cascade motor, and the Kapp phase advancer.

The Foundation of the B.E.A.M.A.

The policy of unlimited competition led a few years before the war to the foundation of the British Electrical and Allied Manufacturers' Association (B.E.A.M.A.). At the outbreak of war, the B.E.A.M.A. was well on the way to standardising the legal and financial clauses in contracts, while many technical anomalies were thereby done away with, and this association had soon such beneficial results that the payment of a dividend in 1914 by English electro-technical undertakings was no longer an unheard-of event.

The War an Advantage.

The war reversed the position and enormously strengthened manufacturing firms. As a result of the war several firms amalgamated or were swallowed up by powerful concerns. At the outset of the war German undertakings were sequestrated and continued as English concerns. The nationalist wave, however, also suppressed American participation in English concerns, and the largest electrical-manufacturing firm in England, the British Westinghouse Company, after combining with the Metropolitan Carriage and Wagon Company, was swallowed up by the armaments firm of Vickers, and converted into the Metropolitan-Vickers Electrical Company. Siemens' English electrical undertaking amalgamated with Dick Kerr & Company, the Phœnix Company and a carriage works to form the English Electric Company.

Conservatism and Standardisation.

Conservatism, which is regarded as the most prominent characteristic of the Englishman, certainly cannot be considered the reason for the lack of development in electrical engineering. There are, of course, electrical concerns which show a conservative spirit unknown to us. An interesting example is electric train lighting, which is still the same as that introduced 25 years ago. Otherwise the English electrical industry has suffered less from conservatism than from too great individuality. At the outbreak of war the electrical expert thought it peculiar when he read in the English newspapers that the Englishman had lost the Colonial and foreign market against German competition, because the German catered in every way to meet tastes of his customers while the Englishman rigidly refused to depart from his standard manufactures. I cannot say how far this is true of other industries, but the English electrical industry had certainly not deserved this reproof. Before the war, on the contrary, it had not many standard articles; while in America and Germany it was early recognised that not only manufacturers but also customers were best served by standard production. This was usually out of the question in England, owing to the pet fancies of the consulting engineers, who refused to have standard apparatus. This might be good enough perhaps for other people—for them something special must be built in accordance with their own ideas.

The Shortcomings of the Consultant.

A special chapter could be devoted to the English consultant. It is understood that the civil engineer works out in detail the plans of a construction, and requires the contractor to fill in all particulars in the specification. The English mechanical and electrical consulting engineer does the same. The manufacturer must dance to his tune. Now everyone will agree that an experienced consultant is justified in demanding improvements. Several English electrical engineers have in this way improved both English and foreign goods and a reasonable firm will accede to their demands. The demand for the short-circuit test of generators, transformers and switches may well be unpleasant for the manufacturer, but, when it can be fulfilled, leads to a better construction, and repays trouble and expense. When, however, the customer in *every* case demands something special he injures both the manufacturer and himself.

Pushing Demands Too Far

Thus the English consulting engineers before the war pushed their demands in many things too far, but were able to carry them through until the manufacturers united. Whilst with us an ordinary order can be settled by a simple confirmatory letter, an enquiry or an order from an English consultant is always accompanied by a specially printed specification—a kind of novel in two volumes: the legal and the technical volume. Before the war the legal paragraphs stated that every occurrence between heaven and earth which might have harmful effect on delivery or on the completed installation only affected the contractor, whilst the buyer must always be free from blame or loss. The technical part prescribed the output, overloads, efficiency and heating of each part of the machine (here the consultant adopted only his own, never the commonly accepted standards), specified constructional details such as current densities in the conductors, collecting surfaces on commutators and slip-rings, flux-densities, thickness of insulation, all the details of a switchboard; but at the same time inserted the condition that despite all that had been prescribed or had not been prescribed by the consulting engineer, the contractor must guarantee the proper working of the complete installation, and must also supply such parts as were necessary, though not provided for by the consultant.

Out of Date Data.

The constructional data in such specifications were often out-of-date. Such low loadings would be prescribed that a machine built to specification could not be competitive. In some cases these conditions were not as bad as they seemed, at least not for all competitors. In municipal undertakings the influence of the Labour members made it very difficult to accept any tender but the lowest, unless the consulting engineer could prove that the lowest tender was not in accordance with the specification. Consequently either constructional details were intentionally prescribed which certain firms would not agree to, or certain firms not approved of by the consultant would be informed that their tender did not comply with the specification, whilst deviations by other firms were not reported to the Council, &c.

When the Specification Misfires.

In many cases this is the only means that the municipal engineer has of excluding firms which he does not trust, or with which he has had unfortunate experiences, because the members of the Council take up the standpoint "When the engineer specifies what machine he wants and how it shall be built every firm complying with the specification and willing to undertake the guarantees must be considered, so that the cheapest is then the best." In many cases the skill of the author of the specification does not lead to the desired end. The manufacturer who knows that he, rightly or wrongly, is not in favour with the consultant accepts all the specified conditions and tenders at the lowest price, so that he gets the order. He must then either build a machine similar to that of another maker or one of very liberal dimensions. Since every firm sooner or later came into this position, it often happened that every machine represented a special construction—"a freak." Obviously the maker gained nothing thereby; standardisation became impossible, and the customer obtained a dearer and poorer machine.

Heating and Overload Conditions.

As regards heating, on the Continent it is generally only necessary for the machines to comply with the V.D.E. rules. Although for many years there have been English and International standards these have been ignored by every consultant, every one of whom has his own standards—the one permits a temperature rise of 40°C., the other 39°C. (70°F.); the one demands a temperature rise of the commutator of only 35°C., the other allows 45°C. For the same tropical climate, one consulting engineer allows 40°C., the other 25°C. rise. The one determines temperature rise by thermometer, the other by resistance. A main clause in the guarantees was the overload capacity—mostly 25 per cent. for several hours was demanded; in many cases, however, 50 per cent. for many hours and 200 and even 300 per cent. overload for several minutes was specified. Thus it often happened that for a specified 3 000 kW turbo-generator, plant having a normal capacity of 5 000 kW had to be installed. The objects for such guarantees were twofold: Often the engineers wanted a larger installation than that granted by the public authority; on the other hand, consulting engineers found that they actually got a 5 000 kW installation cheaper by designating it as 3 000 kW, because competitors often based their price not on actual costs, but according to the prices of other firms.

A Striking Diversity.

It will scarcely be believed that less than 10 years ago in England there were not perhaps two identical steam turbines in different stations in the kingdom. For example, two three-phase 25-cycle stations in London and in the Clyde Valley installed at the same time 5 000 kW turbo-generators built by the same firm. For Clyde Valley 1 500 revs. per min. sets were chosen; for London, however, 750 revs. per min. was adopted. As both stations then installed larger units, and London also adopted 1 500 revs. per min., a different rotor construction had to be used for London. No part of the installations—neither turbines, generators, condensers nor pumps—were the same. The engineer for one of those installations wanted also special bearings and slip-rings for a 5 H.P. auxiliary motor.

Severe Guarantee Conditions.

The guarantee conditions were usually very severe, and efficiency and temperature had to be guaranteed under heavy penalties. Machines of any importance and often quite small motors were only accepted after strict tests. The leading consulting engineers have well-trained technical assistants who have usually worked in works' test houses and are thus well versed in all points concerning testing and the organisation of the manufacturing firms. Despite the oppressiveness of the penalty clauses against efficiency and delivery, the practice of the English Courts led manufacturers to accept them, limiting, of course, the penalties to reasonable amounts. This arose from the fact that the amount of the penalty is determined thereby beforehand; otherwise, if the customer complains of non-fulfilment of contract and claims compensation for the whole loss suffered by him, it can be imagined what consequence this could lead to when a turbine installation consumes 0·5 kg. of steam per unit above the guaranteed figure. The well-known case of the Chelsea power station is mentioned. In acceptance tests for public authorities an article would be rejected or only accepted under conditions even when the deviation from the guarantee was of no importance whatsoever to the customer. Thus for a crane motor with intermittent rating, which mostly worked with resistance in series, the price had to be reduced on account of the efficiency being somewhat low, because the finance department ruled that any deviations from specification must be penalised by fines. Three-phase generators had to be rebuilt or rewound because the pressure drop slightly exceeded the guaranteed figure. Cases occurred where a part of the machine was a few degrees, or even only one degree worse than was guaranteed, and when the maker fitted a fan the consultant refused acceptance because the fan was not specified.

Being Too Clever.

It occasionally happened that a consulting engineer fixed the penalty clauses to his own hurt. The head of the electricity station in a Lancashire industrial town had specified severe penalties for every one-tenth pound excess steam consumption and laid down that the contract should be null and void if the steam consumption exceeded the guarantee by 1 lb. per kilowatt-hour. Owing to severe competition the contract was awarded at such a price that quite apart from penalties it could only be carried out at a loss. At the preliminary trials, which the engineer supervised with Argus' eyes, the steam consumption was too high. The manufacturer's engineers consulted together to consider what changes in the condenser, pumps, &c., could be made to reduce the consumption to the guaranteed figure; but soon all technical discussions were dropped when the contract conditions were closely examined. Without the least alteration, it was triumphantly shown at the official acceptance tests that the steam consumption exceeded the guarantees by more than 1 lb., therefore making the contract null and void. The manufacturer declared himself ready to remove the installation at once and caused grave embarrassment to the municipal engineer, who needed the set badly. As a result, the town signed a new contract and bought the installation as it stood at a new price, which covered the costs of the manufacturer.

Both before and during the war, the B.E.A.M.A. changed fundamentally both the legal and technical part of specifications.

English industry has been compelled to fight its competitors in the hard school of free trade. The war and the cutting-out of German competition, &c., have enormously strengthened English industry. The war also brought both technical and industrial progress in branches where England was backward, as in aviation. It has caught up its competitors in remarkably short time, and in cases overtaken them, so that the race breaking out again between English and German electro-technical industries will pass through many interesting phases.

"Conduit Mania."

A Plea for a Return to Wood Casing.

By "ELECTROCYNIC."

Wood casing seems to have been almost entirely eliminated from the stock-in-trade of the present-day wireman. I am sure that, on sentimental grounds alone, a great many electrical men, especially those whose business experience goes back 20 years or so, must regret the passing of their twin-grooved and, I fear, unjustly calumniated friend. Nowadays, steel conduit is considered the only fit repository for the precious conductors of electric current, and the practice of wiring, which aforetime was the preserve of the meticulous and gentle-mannered carpenter, is to-day the monopoly of raucous and grimy beings who know not the charm of carefully mitred casing nor the fine solemnity occasioned by the act of screwing chastely moulded capping over wires which, while temporarily dead, await a juice-induced revival.

My feeling in this matter is akin to that of the mid-Victorian sailor, who bemoaned the obsolescence of England's "wooden walls." The development of the steel ship was, however, a move in the direction of efficiency, whereas the sad affair with which I am here concerned is, in my view, a retrograde step. It does violence alike to sentiment and expediency.

The Illogicality of Conduit.

I had better, perhaps, confine myself to the practical aspect of the matter. I am probably alone (and almost certainly wrong) in my opinions, but they are justified by my own observation and experience. Of course, conduit must be used in a great many places where damp and other disintegrating influences are to be expected, or where the wiring has to be buried beneath the plaster. These excuses will apply in the majority of industrial and business premises, and I have no intention of tilting at the use of conduit under such conditions.

But I *do* consider that conduit is a *pis aller* which should only be resorted to under the compulsion of stern necessity. To use it in ordinary private houses is to forego the many definite and admitted advantages of wood casing in order to provide a quite superfluous safeguard against unlikely rodents, unlikelier floods, and the incredibly foolish persons who hammer long nails into floor boards and ceilings.

What are the advantages of casing? First of all, it keeps the conductors apart, and this I consider a very important function. Within my own experience it has more than once occurred that, due to some imperfection in apparently well-preserved insulation, sparking has taken place between contiguous conductors. In one case this happened under a P.D. of 110 V. These particular wires were not enclosed at all, but had been festooned temporarily across a wall. The insulation was apparently quite intact, and there was no perceptible moisture about. The two conductors were, however, pressed tightly together at the point where sparking occurred.

The C.M.A. Not Guilty.

Presumably the quality of the cables was not beyond suspicion, but my only definite information on this point is that they were not manufactured by a member of the C.M.A. The danger of inter-polar leakage is, of course, absolutely ruled out where wood casing is used, and the separation of wires of opposite polarity is scrupulously and consistently maintained.

Wood casing is also easier and less expensive to install than conduit. Moreover, it can be run on the surface of walls without producing any noticeable disfigurement. Should it be desired at any time to get at the wires, this can be done with only a tithe of the difficulty entailed by the most generously "junctioned-boxed" system of conduits.

On the debit side, it is objected that a wood casing does not offer a sufficient degree of mechanical protection to the wires. That is, no doubt, true in workshops and factories; but I submit that the point is entirely unimportant in private houses. And it can, at any rate, be claimed by the advocate of casing that, while it may not protect, it does not, on the other hand, *inflict* any damage on the wires, which in conduit installations have often been hopelessly strained and abraded before they have even had the opportunity of demonstrating their current-carrying efficiency.

An Abrasive Effect.

Conduit is frequently necessary, but it is, in my humble opinion, a necessary evil. Even where the best screwed tubing is used, and every care is taken to avoid damaging the wires, it is impossible to believe that the cables do not suffer during the process of installation. It is, I believe, the practice of the modern wireman to find out whether the tubing has any internal obstructions by the simple method of inserting a stick of the same diameter. The fact that this should be considered necessary is hardly a point in favour of conduit, and there is always the possibility that this preliminary rite may be omitted. In any case, this method of locating actual projections would not indicate the presence of slight roughnesses which, although imperceptible to eye and stick, might, nevertheless, have an abrasive effect on the cables.

It is, of course, common knowledge that a great deal of inferior conduit is used even on fairly expensive jobs, and that it is often installed in an unscrupulously careless fashion. In such cases the wires begin their career of usefulness in a far worse state than one would expect to find them after 10 years' service in the harmless grooves of wood casing.

The Dangers of Propinquity.

Furthermore, it seems evident that the close and constant propinquity of wires of opposite polarity in a conduit must encourage insulation failures, even under quite moderate differences of potential. As already mentioned, I have myself met with several instances in which arcing between conductors has occurred under such conditions. It is, perhaps, true that the conduit would prevent a fire from spreading, and, as a just critic, I must record this as a point in its favour.

On an important job, separate conduits could, of course, be run for the red and black wires; but in a small house such a course would be prohibitively expensive and exceedingly cumbersome.

On the general question of expense, I suppose that a decent conduit installation must always be more costly than a casing job. In the early days of conduit the difference may have been less, owing to the somewhat sketchy methods then employed in the treatment of terminal points. Nowadays, the cost of conduit boxes at switch and lamp points is a serious item. They are not strictly necessary in slip-joint work, or perhaps it would be better to say that they are not generally used in this connection. In screwed conduit installations conduit boxes are essential.

An Extravagant Superfluity.

Even the least expensive kind of wiring is much too costly for most people, and it is, I think, a great pity that the necessary and fundamental cost should be augmented by the modern insistence on such an extravagant superfluity as conduit.

In the non-basement houses of to-day there is not likely to be enough moisture to harm the wiring. If the house is damp to begin with, it will very soon dry out. Such houses, too, are unlikely to be overrun with rats or mice. As to the possibility that nails may be driven into the wires, I think this is actually less likely to occur with casing than with tubing. As a rule, the only place where casing is concealed is under the floor boards, and that householders should drive through the floor nails long enough to reach the wires seems to me to be one of the supreme improbabilities of life. I suppose we may take it that nobody out of a lunatic asylum would drive nails into surface casing. In any case, the risk is so slight as to be practically negligible.

Conduit and the Nail Hazard.

Conduit, however, is frequently buried in walls where even the most sensible householder might be excused for driving nails; and I imagine that some of the thin, open-seam tubing in use would offer a very ineffectual resistance to the penetrating power of a well struck nail. At the least, the tube would be dented and the wires damaged, if not actually severed or short-circuited.

I feel that there are serious lacunæ in my contra-conduit argument, but it will serve its immediate purpose, which is to convince me—*moi qui vous parle*—that casing is really better than conduit in the wiring of ordinary houses. Having given orders for the use of casing in an installation in which I am intimately concerned, I am grateful for the dialectical gift which has enabled me to prove to my complete satisfaction that casing is not only cheaper than conduit (which is why I chose it), but that it also possesses the mechanical and electrical superiorities which alone afford a respectable excuse for flaunting convention.

The Electrical Equipment of Whiteley Park and Village.

It will be remembered that the bequests of the late Mr. William Whiteley, the pioneer of the great London retail stores, included a sum of £1 000 000 for providing homes for aged persons. After the extensive legal preliminaries and a prolonged search for a suitable site an area of about 225 acres was selected between Walton-on-Thames and Weybridge on a ridge known as Burhill. The estate is heavily wooded and every care has been taken to preserve the rural amenities for the benefit of the inhabitants. Sir John Oakley has acted as the Trustees' consulting surveyor, and after competition Mr. Frank Atkinson, F.R.I.B.A., was chosen as architect for the layout. Mr. Hiram Morecroft was responsible for the roads and sewers, while the cottages were designed by Sir Aston Webb, Sir Ernest George, Sir Reginald Blomfield, Mr. Ernest Newton, Mr. Mervyn Macartney and Mr. Walter Cave.

There are 240 cottages for single persons and 48 for married couples or sisters. These are arranged in eight sections round the sides of an octagon, each section being provided with a staff cottage. The staff cottage is in telephone communication with the administrative headquarters and each cottage can communicate with its own staff cottage by a bell. The whole scheme is now approaching completion and was visited by T.M. the King and Queen on Saturday last. Needless to say, the estate, the houses and other buildings are electrically lighted, the whole of the work under this heading having been supervised by Mr. H. D. Wilkinson, the Trustees' consulting engineer.

Distribution.

Electricity supply at 480 volts on the 3-wire D.C. system is taken in bulk from the Urban Electric Supply Company, Ltd., Weybridge, the supply mains coming into a main switchboard in the substation on the estate. From this board two feeders are laid to the load centres, located at the north and south of the octagon. These are interconnected with two section pillars located east and west of the octagon, the whole in effect constituting a sectionalised ring main by which any section, in the event of temporary failure, can be immediately isolated and the supply continued without interruption to the rest of the system. Messrs. Malcolm Allen & Company were the contractors for the main switchboard which is of Cecil Hodges' make.

From the section pillars distributing mains are laid to underground link and network boxes situated at convenient points for taking off supply to the blocks of cottages and houses on the estate.

Road Lighting.

The road lighting is throughout on an entirely separate circuit which is also controlled from the section pillars. There are two switch wires and one live wire on this circuit, the former being for either half night or all night lighting, and being controlled by Venner automatic double-time switches. The switches are set to put all the road lights on at dusk and switch off most of the lights at 10 or 11 p.m., leaving a few on all night as pilots. At dawn the latter are automatically switched off. The time switches have, we understand, stood up to this work well and have given no trouble. Connecting links are provided at each lamp-post by which any lamp can be changed over from the all night to the pilot circuit, or *vice versa*, as may be required.

Feeders and Distribution.

The feeders and distributing mains are triple-concentric paper-insulated and lead-covered, some armoured and laid direct and some unarmoured and drawn into fibre conduits of the Key Engineering Company's make. The general rule has been followed that where a cable could be laid continuously without crossing a road it is armoured and laid direct, but cables which cross the roads are unarmoured and drawn in. At road crossings the conduits have been laid in concrete forming an arch or bridge to take any strains from road rollers or traffic on the surface. This arrangement ensures that any withdrawal of cable for repair can be easily made without disturbance of the roadways.

The feeder, interconnecting and distributing cables are of the B.I. & Helsby Company's make. The house services and road lighting cables are of the C.T.S. single-core type and are laid in G.I. screwed tubes.

Cottage Installations.

Each of the eight sections of cottages in the octagon contain about 30 dwellings, some single and others in blocks of two to six. Each half-section can be fed either way, so that continuity can be maintained if any cottage or block has to be temporarily isolated. House switches and fuses are located at points where the services are taken into interiors and D.P. links in ironclad boxes in interiors of adjoining blocks. The service cables are of core armoured type laid direct and C.T.S. wires drawn into G.I. screwed tubes.

Where a number of dwellings are in one block the service cables are run throughout in screwed conduit with tee boxes for taking out supply to each dwelling through separate fuses. Messrs. Pinching & Walton were the contractors for the service cables and Messrs. H. J. Cash & Co. for the road-lighting cables and boxes. All interior wiring is in V.I.R. drawn into screwed conduit chased in walls with draw boxes in the runs and conduit boxes at switches and fittings. All conduit is substabtially connected to earth. Messrs. Pinching & Walton were the contractors for the interior wiring of the buildings and Messrs. William Whiteley, Ltd., supplied and fixed the fittings and lamps.

The Large Hall.

The large hall, with stage lighting, is wired in two circuits off the three-wire system; other buildings are wired two-wire. The wiring of the church was carried out by Messrs. Drake & Gorham. The only motors are one for blowing the church organ and one for a cinema motor-generator. The organ-blower requires a reciprocating movement on the bellows principle, and the drive is by enclosed worm gear and crank. The automatic device for limiting the running of the motor blower to such times as the air in the receiver is down to one-third its full capacity works exceedingly well and is worth attention. This was jointly devised by the consulting engineer, Mr. H. D. Wilkinson, and the resident engineer, Mr. J. Hetherington, and has proved a great success. The motor is only run when it is absolutely required, and noise is reduced to a minimum. The space available for this blower and controller was extremely limited, and a good deal of attention had to be given to the dimensions to fit everything in.

The installation is, of course, capable of extension as further buildings are erected, and motors for other purposes, such as circular saw, lathe, &c., are contemplated. The interior wiring of the large hall, involving stage lighting, was carried out to the consulting engineer's plans by Messrs. Duncan Watson & Company.

The Telephone System.

The telephone system consists of a central exchange 20-line magneto switchboard at the administration offices, Fox Oak, from which the agent and manager, Mr. H. E. Cooke, can communicate with the staff at various points on the estate, or can, on request, permit any pair of stations to be put through to speak to each other. The exchange board and magneto call telephone instruments were supplied by the Western Electric Company and were fixed and wired by Messrs. Duncan Watson & Company. The telephone cables are multicore (2 to 12 pairs) solid dry paper insulated, lead covered and wire armoured, laid underground with junction and tee boxes run in with compound. The cables are terminated in interiors by pot-heads and terminal strips. The underground cables and boxes were supplied and laid by the B. I. & Helsby Company. A pair of No. 18 S.W.G. wires is run to every telephone point on account of the long distances.

A system of electric bells is installed with two-call pushes in each dwelling (one by bed and one by bath) by which the nurse in any one of the eight sections can be called. At the nurses' houses annunciator boards are fixed. This installation was carried out by Messrs. H. J. Cash & Company.

Electric Heaters.

A few electric heaters have been used, but no electric cooking. The communal kitchen is entirely fitted with gas boilers and stoves. This is due to the fact that the policy to be followed for cooking, whether individual or collective, has taken some time to develop. If it had been possible to decide on the collective method at the start it might have been possible—even during the adverse conditions of the war period—to have entertained electric cooking, but the apparatus at that time was very limited and not so well advanced as it is now.

Our thanks are due to Mr. H. D. Wilkinson for giving us an opportunity of describing this interesting installation.

A Physical Phenomenon and Its Application to Telegraphy, Telephony, &c.[*]

By A. JOHNSEN and K. RAHBEK.

The lecturers discovered in 1917 that strong adhesive forces were developed in some cases where an electric potential difference was applied to a solid body consisting of certain badly-conducting materials, *i.e.*, various minerals, and a conducting body, such as a metal disc, resting on the former body. This adhesion was found to be proportional to the true area of contact between the bodies, so that ground and polished surfaces fitting accurately together afford the best results.

It was found that the adhesion was due to an extraordinarily strong electrostatic attraction between the two surfaces in contact. The solid materials in question conduct electrolytically and show a very high contact-resistance with regard to an adjacent conductor, if no conducting liquid, cement, &c., be interposed between the two surfaces. The contact resistance can greatly exceed the interior resistance in the material used. If a potential difference be applied to the metal disc and a metal electrode cemented to the semi-conductor (as the material may be called) a weak current will flow through this semi-conductor and across the contact surface to the metal disc. This causes a finite potential difference between the surfaces in contact, due to the very high contact-resistance. The result is an unusually strong static attraction, which may easily be understood if it is borne in mind that the attraction between the plates of an "air condenser" for a given potential difference between the plates is proportional to the inverse square of the distance between the plates. The distance between the attracting surfaces being, theoretically, in this case zero, an infinitely large attraction should be expected. In practice, a limited attraction is manifested, the limitation being probably due both to electrolytic phenomena and to ionisation; nevertheless, an exceedingly strong attraction can be obtained at moderate potentials. It has been found that an electrostatic attraction of several pounds can be obtained between a thick lithographic stone, fitted with an electrode at the back, and a metal disc, 2 in. in diameter, resting thereon, when a potential of 440 V is applied. The current is of the value of a few micro-amperes. The disc will lift the stone in an exactly similar manner to that in which an electromagnet can be lifted with its armature, and the stone will drop if the current be interrupted. Similar qualities are exhibited by flint, agate, some species of slate and many other minerals and salts, as well as many organic substances, for instance, animal membranes, skin, gelatine, bone, &c. On the other hand, the experiment cannot be carried out with true insulators, such as glass, mica, hard rubber, &c., as the necessary current cannot flow.

The attraction naturally causes a considerable friction between the two surfaces. This is utilised for technical purposes by using the semi-conductor in the form of a cylinder, which is held in rotation, and on which a metal band slides. As soon as a suitable potential is applied to the apparatus the band will adhere firmly to the cylinder, and can be made to operate various devices, the whole forming an effective electrostatic relay. In connection with telegraph apparatus, it is essentially useful as a radio recorder, the current from ordinary small valves being sufficient for its operation at a speed up to several hundred words per minute, if a sufficiently high potential (100 to 200 V) be used for the valves. If the metal band be connected to a diaphragm or similar sound-reproducer, and telephone currents be applied, a very loud-speaking telephone is obtained. This and other applications, among which is a low-tension pocket electroscope, will be demonstrated at the lecture.

It is obvious that the phenomenon forms a wide basis for scientific investigation, and that it will probably in the future be used for the construction of electrical apparatus for various purposes, especially in cases where a small current consumption is essential.

The latest production of the British Electrical Development Association, which is entitled "Electricity on the Farm," gives an impressive list of operations in connection with farming which can be facilitated by the use of electricity, and supplies the farmer with a good deal of useful data which will help him to decide whether to employ them electric drive will not be the best way of curing a good many of his present afflictions. It is needless to add that as is usual with B.E.D.A. publications the pamphlet is excellently got up and illustrated and will, we feel sure, play its part in bringing about the desired electrification of rural areas.

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[*] Abstract of a Lecture delivered before the Institution of Electrical Engineers.

The Ediswan Circuit Breaker.

The Edison Swan Electric Company have recently designed a type of circuit breaker in which greater attention than is usual has been paid to the size and disposition of the current carrying parts. These indeed should be given first place and the operating mechanism should be built up round them rather than *vice versa.*

A circuit breaker which has evidently been designed with these points in view is the Ediswan "W" type, an illustration of which is shown herewith (Fig. 1). To the operator the most attractive feature is the very easy closing action. To close a 4 000 A breaker of this type, we understand that a maximum pull of only 55 lbs. is required at the point of the greatest resistance to closing.

It will be seen from the illustration that the mechanism is extremely simple and that all parts are readily accessible. There are, however, points in the design which can only be appreciated by a close examination of the actual article. The wide quick break, the wiping action of each lamination of the main brush ensuring self-cleaning of the contacts and the adequate protection of the main brush by means of three sets of auxiliary sparking pieces, all call for special attention. The sparking pieces, two of which are of metal and the other of carbon, are all readily renewable.

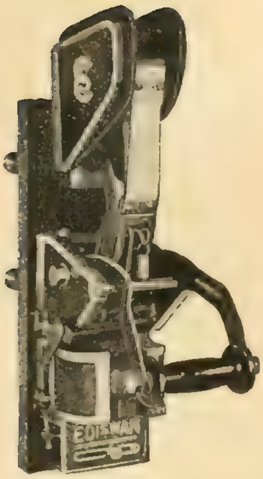
Fig. 1.—Ediswan Type "W" Circuit Breaker.

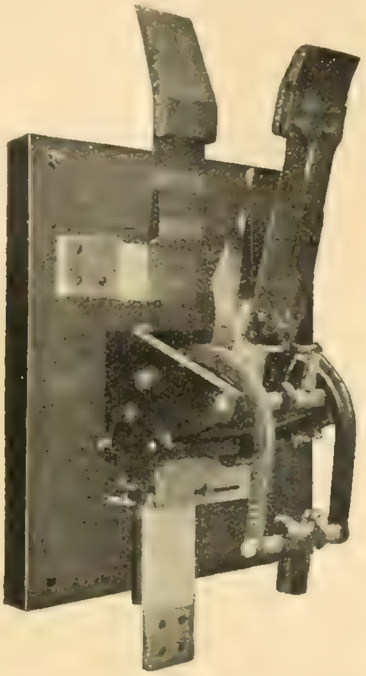
Fig. 2.—Ediswan Breaker for D.C. Circuits up to 2 000 V.

Novel Reverse Current Attachment.

The reverse current attachment which is fitted is novel in design, but the principle on which it operates is based on a purely polarity effect. It differs from the differential type in that the field of the polarising, or potential, coil is at right angles to the field, due to the main current, and there is, therefore, no swamping effect when large series currents are passing. The absence of swamping effect means that the attachment can be relied upon to operate even with a large drop of potential across the bus bars. In setting, a slight bias of the polarised armature is given towards the "holding-in" side of the dead centre, so that large forward currents tend to hold in the armature even if the potential circuit is interrupted, and rises of pressure also act the same way.

A very important feature of this type of reverse attachment is that the operating force increases as the reverse current increases. The curve given (in Fig. 3) shows the performance of a standard reverse attachment of this type. A somewhat curious feature, it will be noted, is that the amount of operating reverse current tends to fall as the pressure falls, down to a certain point.

Some Defects and How They Are Overcome.

Experiment has proved, we understand from the Edison & Swan Company, that the type of breaker with a short break combined with a strong magnetic blow-out is subject to two defects. In the first place in the case of heavy short-circuits, the circuit does not clear until after a series of rapid re-makes, which have a destructive effect upon the contacts. This phenomenon occurs when the power behind the short-circuit is considerable, as must always be the case with large turbo-generators having only a small armature reaction on the field. Further, the abrupt opening of a circuit carrying a very heavy current results in a considerable rise of pressures due to the inductance of the circuit. Comparative tests have demonstrated that the breaker having a short break in a strong field is the worst offender in this respect. It has been found that opening a heavy direct current with the contacts immersed in oil results in a much smaller pressure rise than is invariably the case when opening the circuit in a strong blow-out field.

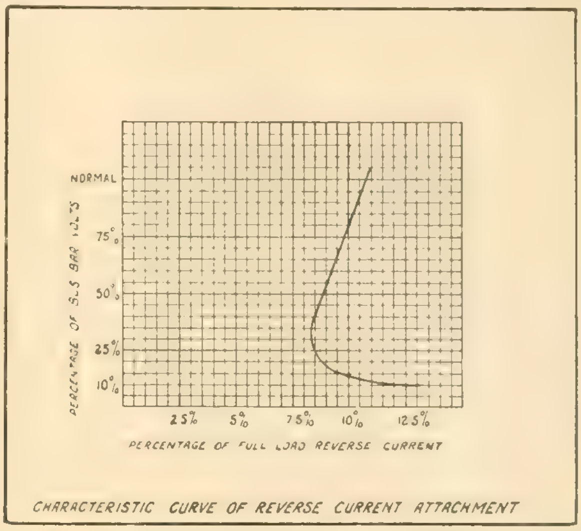

Fig. 3.—Characteristic Curve of Reverse Current Attachment for 2 000-A Breaker.

The Ediswan breaker has therefore been designed with a comparatively weak blow-out field combined with a wide break. A series of tests, similar to those described above, have been carried out on this type of breaker, and they show that while the circuit was opened effectively and certainly under the most severe overloads, the oscillograph recorded quite a moderate rise of pressure.

For high voltages a magnetic blow-out is, of course, inadmissable owing to the destructive effect of the high pressures induced in the windings of the machines on breaking the circuit. To meet these conditions the breakers are provided with a wide open break, approximating to the horn-break. In doing this, some little mechanical difficulties were encountered owing to the high velocity of the carbons at the end of the long moving arm, but these have been successfully overcome. Fig. 2 shows such a breaker designed for large currents at high D.C. voltages up to 2 000 V.

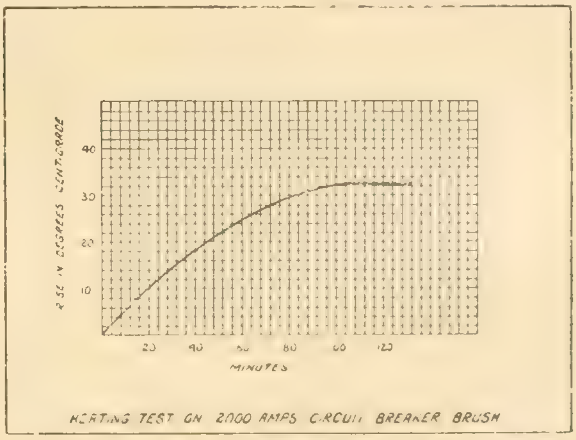

Fig. 4. Heating Test on 2 000-A Circuit Breaker Brush.

The Rating Question.

The rating of circuit breakers is an extremely important point and should be based on the results of actual tests. Before the "W" type Ediswan breakers were put into use some nine years ago, tests were made by the National Physical Laboratory to determine the correct pressure required to give the maximum conductivity and also the current carrying capacity of the brushes. The curve (Fig. 4) shows the results of the tests then made on a standard

2 000-A brush with a continuous load of 2 000-A. The load was kept on for 130 minutes, the final temperature being reached after 105 minutes, and the rise of temperature measured was 32·5° C. Tests were also made at a large station on a 1 000-A breaker to determine its breaking capacity. It was shorted six times in quick succession on 550 V through an inductive load of ½ Ω resistance with six 500-kW machines behind it. Afterwards the breaker was left in service on a tramway feeder for two weeks during which it operated 45 times on faults, when it was taken down practically undamaged. The results obtained in these tests have since been fully realised in the thousands of breakers of this type now in service.

Correspondence.

THE JOHNSEN-RAHBEK ELECTROSTATIC LOUD-SPEAKING TELEPHONE AND RELAY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: While listening to the brilliant lecture on this subject yesterday at the Institution of Electrical Engineers, and while witnessing the very remarkable and beautiful demonstration with the authors' talking violin, I experienced some dim feeling that I had, in the distant past, read of similar apparatus working on the same principle. I remembered Edison's loud-speaking telephone, with its rotating cylinder of moistened chalk, but I also recollected that in that instrument the passage of the electric current had the effect of reducing the friction between the cylinder and the metallic slider rubbing thereon owing to electrolytic decomposition.

This morning, from the perusal of a collection of technical press cuttings nearly 40 years old, I have confirmed my vague impression that Messrs. Johnsen & Rahbek's method, in which electrostatic attraction is employed to increase the friction between sliding surfaces, one of which is of metal and the other of imperfectly conducting material, is not entirely new, as I find that in the late seventies a speaking telephone receiver based on this principle was invented, patented and constructed by Mr. Elisha Gray, the well-known electrician, of Chicago. I have a complete printed account of this instrument, taken, I fancy, from a long extinct journal of those days called "Design and Work," and find that the instrument is also mentioned in a lecture on Telephony given by my old friend Mr. Conrad Cooke before the Royal Society of Arts on May 23, 1879. For his badly conducting substance, Mr. Elisha Gray used animal tissue, such as bacon rind, pork skin, kid-glove skin and even the living human hand. A portion of one of these was lightly pressed against a rotating disc of polished metal, and produced sounds and speech from a resonating box owing to the amount of the friction varying with the electrical potential applied through a step-up transformer from a microphone, the effect being due, according to Mr. Gray's own explanation, to electrostatic attraction and repulsion between the sliding surfaces.

Verily "there is nothing new under the sun"; but this revival is an improved and modified form of what would seem to be an old idea appears likely to have several useful present-day applications, while Messrs. Johnsen & Rahbek's experimental demonstration of the surprisingly considerable amounts of force that can in this way be controlled was certainly most convincing.—I am, &c.,

London, May 27. A. A. Campbell Swinton.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The report of the lecture given at the Institution of Electrical Engineers last Thursday contains an account of some electrical devices depending upon the discovery that when an electric current is maintained across the contact-surface of a badly-conducting material and a metal, adhesion occurs. The lecturers, Mr Alfred Johnsen and Mr. Knud Rahbek, are stated to have noticed the adhesion in 1917. In a Paper on "Contact with Dielectrics," read before the Physical Society of London in June, 1905, however, is described this same phenomenon, under the name of "retentive force." The "retentive force" was directly measured by a balance, and the variations of "retentive force," with changes of potential between 0 and 750 V, were observed and tabulated. These and related experiments and tests on dielectrics are recorded in the "Philosophical Magazine" for October, 1894, August, 1896, May, 1897, July, 1897, and October, 1905.—I am, &c.,

London, May 27. Rollo Appleyard.

"THE ORGANISATION OF THE SALARIED CLASSES."

TO THE EDITOR OF THE ELECTRICIAN.

Sir: The article on the above subject in your issue dated May 20th, at once states a very definite need, while, at the same time, raises innumerable obstacles which on the surface seem almost impossible to overcome.

The organisation of the salaried classes, or "brain workers" is imperative. The primary difficulty, however, appears to be the apparent impossibility of maintaining the power which a large organisation carries, without falling into what is the greatest error of very large combinations of workers in different grades, *i.e.*, the tendency for the classification of workers to become too general and thereby lessening the vitality and initiative of the individual.

Another difficulty appears to be that many organisations which are working for the improvement of certain classes of workers, and who are not registered as a Trade Union, would be prevented from joining the suggested Federation of Organisations.

The obvious advantages to be gained, however, from such a federation seem to far outweigh the disadvantages and difficulties which present themselves, and with the loyal co-operation of all groups of brain workers it should be possible to arrive at a clearly-defined policy. But any attempt to become political except in so far as the direct interests of the brain workers are concerned, would defeat the end for which the federation had been formed.

It would be essential that any federation that may be formed should include women on an equal basis with men. On questions of conditions of employment, &c., the point of view of the woman salary-earner must be identical with that of her male co-worker.—I am, &c.,

London, May 31. C. Haslett,
Gen. Sec. Women's Engineering Soc.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your leading article on "The Organisation of the Salaried Classes" in a recent issue of The Electrician, you called attention to the need for organisation by the numerous and diverse class of managerial, administrative and technical staffs of industrial concerns. There will doubtless be general agreement with your view that the chief merit of such an organisation lies in its competency to present an authoritative expression of the collective view of its members on matters concerning their own interest and that of their business. Its value is becoming increasingly apparent to those who are unable to reconcile their opinions with the vigorous methods of a combative trade-unionism; moreover, it is realised by many employers that there is an immense advantage in the opportunity of discussing relevant matters with accredited representatives of their technical and supervisory staffs. This is particularly the case where they find the employés' case argued with consideration for the efficient performance of their duties, and with a desire to avoid any action respecting individuals which would be subversive of normal business discipline.

It is indicated in your article that such organisations should be but little concerned with emoluments, since individuals of proved ability and enterprise will find their proper financial level by the normal process of events. This may be so when the matter is in the hands of a wise and successful industrial employer, whose material success is so largely dependent on the activities of his staff. The proposition, however, is not universally applicable. Were it so, the movement towards the fixing of minimum salaries according to a graded scheme would lose much of its point ; in such a scale minima tend to be regarded as maxima, and where assistance has to be given to the weak, it is provided at the expense of the strong. This, coupled with the elimination of the incompetent, is doubtless as it should be ; it is at any rate evidence that a great number of the participators in such a movement are concerned with equity rather than with personal advantage.

A specially difficult position arises, however when, as in the case of universities and technological institutions, efficiency has to be maintained on a limited income, derived in a large measure from private benefactions, state subsidies and municipal grants. The financial position of members of such staffs leaves much to be desired when compared with that of persons with like qualifications in the commercial world and Government service, and the provision of even modest salaries, together with some arrangement to avoid an impoverished old age, becomes a very real problem with which the Association of University Teachers is confronted.

It is to be hoped, Sir, that the near future will see members of university staffs provided with salaries on a scale commensurate with those now being applied to their colleagues in elementary and secondary schools, and with superannuation benefits equivalent to those enjoyed by every other recognised branch of the teaching profession. Otherwise, it is to be feared that the universities will be starved into a moribund condition, to the incalculable detriment of the industrial position of our country.—I am, &c.,

London, May 31. A. A. Eldridge,
Hon. Secretary, Association of University
Teachers, Imperial College Branch.

Institution of Electrical Engineers.

Annual General Meeting and Royal Charter.

The Annual General Meeting of the Institution of Electrical Engineers was held on Tuesday, May 31st, at the Institution building, the **President** (Mr. Llewelyn B. Atkinson) in the chair.

The **President** read the report of the Council for the past year and announced the following awards of premiums for papers read during the session.

Institution Premium of £25 to Mr. E. A. Watson, for his Paper on "Magnetos for Ignition Purposes in Internal Combustion Engines." *Ayrton Premium of £10 to* Sir P. Dawson, for his Paper on "Electric Railway Contact Systems." *Fahie Premium of £10* to Sir W. Noble, for his Paper on "The Long-Distance Telephone System of the United Kingdom." *John Hopkinson Premium of £10* to Mr. G. A. Juhlin, for his Paper on "Temperature Limits of Large Alternators." *Kelvin Premium of £10* to Prof. E. Wilson, for Three Lectures on "Magnetic Susceptibility of Low Order." *Paris Premium of £10* to Mr. K. Baumann, for his Paper on "Some Recent Developments in Steam Turbines." *Webber Premium of £10* to Mr. J. Paley Yorke, for his Paper on "Some Recent Developments of High Current Arcs, with Special Reference to Searchlights." *Extra Premium of £10* to Mr. Sydney Evershed, for his Paper on "Permanent Magnets in Theory and Practice." *Extra Premium of £10* jointly to Mr. W. B. Woodhouse and Mr. R. O. Kapp, for their Papers on "Distribution of Electricity." *Extra Premium of £5* to Mr. A. E. McColl, for his Paper on "Automatic Protective Devices for A.C. Systems." *Extra Premium of £5* each for Papers published in the "Journal," without being read at meetings, were awarded to Mr. G. E. Bairsto, for "The Effect of Shunted Resistance or Plug Leakage on the Spark Performance of an Electrical Ignition System" ; to Mr. M. B. Field, for "Multiple Unit Shunts for the Measurement of Very Heavy Currents," and to Mr. A. McKinstry, B.A., M.Sc., for "Notes on the Electrical Calculations of Long-distance High-Voltage Transmission Lines."

The **Wireless Section Premiums** were as follows : *Duddell Premium of £20* to Mr. B. S. Gossling, for his Paper on "The Development of Thermionic Valves for Naval Uses," and *A Wireless Premium of £10* to Capt. R. C. Trench, for his Paper on "The Range of Wireless Stations."

In commenting upon the report, which will be found in abstract below, Mr. **Atkinson** said the Council were pleased to state that there was evidence of the value attached to the Institution's work by other societies and bodies. The Council also wished to thank members for devoting their time and expert knowledge to the duties of the various committees. The resolution for the adoption of the report was seconded by Mr. G. L. **Addenbrooke** and was carried unanimously.

Sir **James Devonshire**, hon. treasurer, moved the adoption of the accounts, which was seconded by Mr. A. H. **Allen**, and also carried unanimously, after it had been pointed out that the Institution would suffer a loss of revenue on re-entry into their building.

Votes of thanks were accorded to the Institution of Civil Engineers for the facilities they have given for meetings during the past few years and for placing their library at the Institution's disposal ; to the Honorary Secretaries of the Territorial Centres, the Local Honorary Secretaries and Treasurers of sections abroad, the Honorary Treasurer of the Institution and the Honorary Solicitors. After the Auditors had been reappointed the meeting was adjourned.

ANNUAL REPORT.

Since April 1st, 1920, the membership of the Institution has increased from 8 146 to 9 449. This figure, which includes over 1 900 students, is the largest increase in any one year, and is to be attributed to the activities of the Territorial centres and sub-centres and to the fact that nearly 200 Post Office electrical engineers joined the Institution during the session.

Deaths.

Forty-five members died during the year, including one honorary member, Prof. A. Righi, and Prof. John Perry, Mr. Wilson Hartnell, the Rt. Hon. Lord Moulton, Dr. A. Muirhead and Mr. T. E. Gatehouse.

Honours were conferred on 19 members, including knighthoods to Sir J. C. Beatty, Sir Philip Dawson, Sir James Henderson and Sir William Noble.

War Memorial.

The question of erecting a suitable war memorial will be taken up as soon as it is possible to select an appropriate position in the building. The task of collecting data for the biographical notices to appear in the war memorial book has been in progress, and the Council desire to express their warm thanks to the many engineering firms, institutes, colleges and schools which have so readily supplied particulars of the careers of fallen members.

War Thanksgivings.

The benefaction of £2 000 5 per cent. War Loan referred to in the last annual report has now been constituted as a trust fund with Sir James Devonshire, Mr. Roger T. Smith and Sir John Snell as trustees. A grant of £100 for educational purposes has been made under the provisions of the trust deed to Mr. F. B. de Steiger, of Finsbury Technical College, an ex-member of the Australian Imperial Force. The Council have undertaken to award a sum of £25 in prizes to young professional men in commemoration of the Royal Indian Engineering College, Cooper's Hill, and of its members who fell during the war. The prize will take the form of a bronze medal, a parchment certificate, and a money prize. Those eligible will be students, associate members and members of the Institution of less than 30 years of age, and the award will be made for the best paper on a professional subject submitted during the period dating from the last award. The prize may be awarded in addition to any other to which the paper will entitle the recipient.

Library and Museum.

The Council express their thanks to the Council of the Institution of Civil Engineers for placing the library and reading rooms of the Institution at the disposal of members for the long period during which the Institution library has been inaccessible. The Council proposes as an experiment, when the library again becomes available, which it is hoped will be by the end of the summer, to keep it open during the evenings. If it is found that the use made of it justifies the expense the arrangement will be continued. During the year 163 books and pamphlets have been presented to the reference library by members and others. During the year 818 books from the circulating library were issued to 408 borrowers, the corresponding numbers in the previous year being 667 and 300 respectively. An amount of interesting apparatus has been added to the museum during the past year, and the work of classification will be resumed at the earliest possible moment after the Institution is reinstated in its building.

Electrical Appointments Board.

The work of the Electrical Appointments Board has been very much restricted owing to the limited number of vacancies reported to the Board. The Council hope firms with vacancies will report these to the Secretary of the Electrical Appointments Board at the Institution offices.

Institution Journal.

The number of pages in the 1920 volume was 944, compared with 682 in 1919. In addition the Institution published in 1920 a supplement to the 1919 volume consisting of 336 pages and including papers which on account of shortage and high price of paper had remained unpublished during the two previous sessions. The net cost of printing and publishing the **Journal** in 1920 was £6 739 as compared with £3 396 in 1919. The Council feel that this unavoidably high expenditure is fully justified by the necessity of maintaining the character of the Journal as a complete record of the proceedings of the Institution and of the papers which it accepts for publication. The Council have decided to publish in future in the Journal a classified index of British manufacturers engaged in the electrical and allied industries. The Council consider that in view of the wide circulation of the Journal such an index will be of considerable value. The sizes of both the Physics and Electrical Engineering volumes of Science Abstracts were increased during 1920, and the deficit on that publication has been reduced from £754 to £261. This reduction is partly due to the increase in the rates of subscription and partly to the expansion of the sales.

Wiring Rules.

The Main Wiring Rules Committee and its six sub-committees have been actively at work during the session, and the editing sub-committee has nearly completed the first draft of the new rules. It is intended after the draft has been considered and approved to forward it to the Fire Offices and to hold a conference with their representatives. The draft will also be discussed in London and at the Territorial Centres before the Rules are published. The British Engineering Standards Association has been asked to draw up standard specifications for wiring accessories which, while not being made definitely compulsory, will embody the requirements of the rules and enable users and contractors to comply with them without question.

Ship Electrical Equipment Regulations.

The Ship Electrical Equipment Regulations have with certain omissions been adopted by Lloyd's Registry of Shipping and are now in force for all ships built under their survey throughout the world. A sub-committee has on two occasions met representatives of the Electrical Trades Union to discuss the question of urging the Board of Trade to hold examinations and grant certificates to sea-going electricians.

Power Lines Committee.

The Regulations Sub-committee of the above Committee, which was appointed to prepare a digest of the Board of Trade Regulations and similar matters concerning overhead lines, has now been charged with the work of suggesting amendments for the various Board of Trade regulations for securing the safety of the public and for ensuring a proper and sufficient supply of electrical enginery. It is expected that a report will be presented before the commencement of the next session.

Electricity Supply Bill.

The Council has constituted a conference of representatives of the interested bodies to consider the Electricity Supply Bill, 1921. These bodies will be summoned to meet at an appropriate time.

Civil Service Officers.

In June last Mr. Roger T. Smith attended a Conference of the Presidents of Technical Institutions to discuss certain proposals which were being put forward by the Civil Service National Whitley Council urging the recruitment and training of non-technical civil servants for technical appointments in the Civil Service. As a result of the Conference, a letter, signed by the President jointly with the Presidents of the Institution of Civil Engineers and other societies, was addressed to the Prime Minister deprecating the proposal.

Salaries of Teachers.

In November, 1920, the Council addressed a letter to the Burnham Committee of the Board of Education urging that corporate membership of the Institution should be accepted as an acknowledgment of a first class honours degree, which in the case of secondary teachers makes them eligible for a higher scale of salary. This recommendation is under consideration.

British Engineering Standards Association.

The British Engineering Standards Association has undertaken the work of co-ordinating the Government department's specifications for electrical apparatus and materials in collaboration with the Permanent Government Inter-Departmental Committee set up for the purpose. Wherever possible, existing British standards will be employed, and, when the specifications so prepared are suitable, they will be issued as British standards. The recommendation of the Wiring Rules Committee that the standardisation of the dimensions of distribution boards and other accessories should be proceeded with has been adopted.

Scholarships.

The following scholarships have been awarded by the Council: *David Hughes Scholarships*, Messrs. F. H. Cooper, C. Dannatt, E. H. Lakey and R. C. Titman. *Salomons Scholarships*, Messrs. E. T. Donovan, J. Fowler, H. S. Petch and L. Turton. *Paul Scholarship*, M. A. G. Pearce.

The Electrical Research Association.

At present the membership of this Association is confined to manufacturers, but provision is made for enrolling other interested persons as Associate members, and applications will shortly be invited. The Council of the Association is constituted as follows: Messrs. C. H. Wordingham, C.B.E. (chairman), Ll. B. Atkinson, J. S. Highfield, C. C. Paterson, O.B.E., R. T. Smith, C. P. Sparks, C.B.E., and Dr. C. C. Garrard, representing the Institution. Messrs. D. N. Dunlop, A. R. Everest, A. P. M. Fleming, C.B.E., R. S. McLeod, R. K. Morcom, C.B.E., E. S. New, C. Rodgers, W. O. Smith and Mr. A. D. Williamson representing the B.E.A.M.A. Dr. W. H. Eccles, F.R.S., Mr. W. W. Lackie, C.B.E., and Sir J. E. Petavel, K.B.E., F.R.S., representing the Department of Scientific and Industrial Research.

Society of Radiographers.

This Society was completed early last October, and the first Council of the Society consists of: *Medical Members*, Dr. F. Hernaman-Johnson, M.B., Dr. Robert Knox, M.B., Dr. S. Melville, L.S.A., Dr. G. Harrison Orton, M.A., Sir Archibald Reid, K.B.E., and Prof. Sidney Russ. *Electrical Members*, Dr. W. H. Eccles, F.R.S., Messrs. J. S. Highfield, C. C. Paterson, O.B.E., A. A. C. Swinton, F.R.S., Dr. R.M. Walmsley, F.R.S.E. and Mr. C. H. Wordingham, C.B.E. *Radiographer Members*, Messrs. R. G. Blackall, F. E. Doran, A. C. Forder, H. Henry, H. Turner and G. F. Westlake. The hon. secretary is Mr. G. F. Westlake, Cancer Hospital, Fulham-road, S.W.3.

Benevolent Fund.

The Committee of Management of the Benevolent Fund of the Institution report that at December 31, 1920, the capital account of the fund stood at £5 709 9s. 6d., and the accumulated income at £2 533 1s. 9d. The donations and subscriptions to the fund in 1920 amounted to £820 13s. 9d., and in the course of the year grants were made to 11 persons amounting to a total of £340 13s. During the first three months of 1920 712 subscribers and donors gave £418 6s. 10d., while during the same period in 1921 884 subscribers and donors gave £439 17s. 3d.

Annual Accounts.

After making provision for contingencies as in the previous year, there is a margin to the good on the revenue account for 1920 of £673 7s. 1d. This amount, which has been carried to the credit of the general fund, compares with £1 495 3s. 3d. in 1919, a decrease of £821 16s. 2d. In the accounts for 1919 mortgages stood at £30 198 5s. 5d., £913 10s. 5d. being repaid during the year. The amount now stands at £29 284 15s. The total of the life compositions fund on Janaury 1, 1920, was £5 413 19s., and a further amount of £315 2s. was received in payment of life compositions during the year, making a total of £5 729 1s. Out of this sum £52 10s. has been transferred to the general fund on account of life compositions of members deceased during the year, leaving to the credit of the fund £5 676 11s.

Taking the Tothill-street property and investments at cost, and the Institution building and lease, the library furniture, &c., at the values standing in the books, after writing off depreciation, the assets amount to £109 673 0s. 1d., against liabilities of £6 976 19s. 3d., leaving a surplus of £102 696 0s. 10d., as against £97 789 10s. 10d. in 1919.

Application for Royal Charter Approved.

Immediately after the conclusion of the annual general meeting a special general meeting of the Institution was held, at which the President moved the following resolution:—

"That the Council of the Institution of Electrical Engineers be requested to apply to the Privy Council for a Royal Charter of Incorporation, and that the draft Petition and draft Charter, therefore, which have been initialled for purposes of identification by the Chairman of this meeting, be approved, subject to such alterations as the Council of the Institution may deem it necessary or expedient to make therein prior to the application to the Privy Council, and to such alterations as may be made therein by the Privy Council and approved by the Council of the Institution."

In putting the motion before the meeting, Mr. Atkinson said that at the present the Institution was a company operating under the company laws. The acquisition of a Royal Charter, which the Council now proposed to ask the Privy Council to grant, would place the Institution on an equal footing with many other institutions with which it was already equal in prestige and membership. Under the company laws the Institution was nothing more nor less than a self-appointed body and was by many people regarded as a club, with no standing other than that which might be achieved by its work. If the Institution obtained the Charter it would become a State-constituted body, representative of the electrical profession and industry and recognised by the State as the mouthpiece of the interests for which it spoke. They would therefore pass in the public eye to a better position. With regard to the clause that proposed the designation of "Chartered Electrical Engineer," there was always some little difficulty in the use of initials if other people employed them to mean something else, and could show that they had some other meaning than the primary meaning that was attached to them. No such question could arise with regard to the use of the words "Chartered Electrical Engineer." Referring to the postcard vote, he said that 63·5 per cent. of the members had sent in cards all of which were favourable to the proposal except three.

Mr. Roger T. Smith briefly seconded the resolution.

The History of the Petition.

Mr. C. H. Wordingham, speaking in support, said that during his time of office as President he had prepared a draft scheme which had been submitted to most of the Territorial Centres, and which had been considered by a special general meeting. The reason why the matter had not then been further proceeded with was that the Institution of Civil Engineers had introduced a Bill, and until that Bill was settled it was inadvisable to raise the question of a Charter for the Institution. The dropping of the Bill had cleared the way for the consideration of a Charter, though the one they were now petitioning for was different in form from that which he had ventured to adumbrate in his address. The reason for this was that they had been informed it would be better at this stage to submit a Charter which would not extend the sphere of the Institution in any way. That could be done later, and he looked forward to a considerable extension of the powers which were now sought.

Mr. F. P. Sexton, speaking as a "very ordinary member," congratulated the Council on bringing this matter forward, as a Charter would no doubt be of enormous service, not only to the Institution, but to electricity in general. He deplored the trade spirit which had arisen among some of the members, and considered that it was professional status only that should be considered.

The resolution was then put and carried unanimously.

The West Riding Inquiry.

The Electricity Commissioners concluded their inquiry into the schemes for the reorganisation of electricity supply in the Aire and Calder (West Riding) Electricity District on Friday last, the inquiry having lasted nine days.

The Conference Scheme.

After Mr. **Miller**, K.C., had stated the case for the Conference of Local Authorities, Ald. **Turner**, of Bradford, gave evidence and said that if the control were in the hands of a hybrid authority, consisting partly of local authorities and partly of private companies, difficulties would continue to arise that would hamper the work of a Joint Authority. It was therefore desirable that there should be one type of representative on it. The Conference scheme had the support of nine out of 16 boroughs in the area, thereby representing a population of 750 000 in favour and 535 000 against. The Conference and Leeds schemes proposed to form Authorities for the same area. They could not consider any solution as satisfactory which involved joint working by the Local Authorities and the Power Company.

In reply to Mr. **Wooll** (for Leeds), witness said that they considered the population basis to be the fairest and most democratic principle of representation on the Authority. They looked on it as a scheme for a new area, and anyone in the scheduled area was to have an equal right to an abundant supply of electricity. Therefore it was fair to arrange the constitution on the unit of population, rather than upon consumption. He regarded it as a system of representation consistent with electrical efficiency, having regard to the present situation. He recognised that the financial proposals and other elements of the conference scheme were *ultra vires*.

At this stage a point arose as to the purchase of the Yorkshire Power Company and the principle of compulsion, and Mr. Miller stated that the conference intention was to obtain an agreement with the Company and with all other authorities owning generating stations.

Basis of Representation.

Ald. **Turner** explained that by setting up a joint authority and by acquiring the Power Company there would be representation of the various undertakers to satisfy the requirements of the 1919 Act. While the basis put forward might not be ideal, he believed it to be a fair one, which left no one unrepresented; having studied the alternative basis of electrical consumption, he thought the population basis fairer.

Sir **John Snell** remarked that the scheme must be considered fundamentally as a financial and engineering proposal, and that the question of representation on the joint authority was a secondary consideration.

Ald. **Turner** said that, so far as he was concerned, failure to bring about an agreement with the Yorkshire Company would be fatal to the Conference scheme. It would be possible to go on without Leeds, but the scheme would not be so desirable or successful under those circumstances as if Leeds were co-operating in it. Any proposal made by Leeds would justify the calling of a special conference; but he could hold out no hope that the proposal would be calculated to meet with support if it did not come within the four corners of the resolution of the Incorporated Municipal Electrical Association. He did not think they would change the basis of representation for the unit basis. The acquisition of the Yorkshire Company was an essential part of their scheme.

Mr. **Wooll**: Then you may take it from me that those aspects of your scheme must be radically varied before there can be any question of co-operation by Leeds. It is my duty to indicate to you and the Commissioners the vital questions of principle on which we announce our determination to stand aside.

In answer to Sir Harry Haward, Ald. **Turner** said he did not see any outstanding objection to reducing the membership of the Joint Electricity Authority, except that it would make the grouping of localities rather more complicated. If representation were based on the consumption of electrical energy it might be considered a hardship by certain localities which felt that they had been neglected up to the present.

Technical Evidence.

Mr. **Thomas Roles**, city electrical engineer of Bradford, gave evidence on the engineering aspects of the Conference scheme. He put in supplementary particulars of the Conference scheme which included statistics of the present plant installed and authorised extensions, the maximum demand, output, and the prospective demand and output in five and 10 years time; also tables showing the total load connected at the end of each of the last seven years, an approximate census of the horse power in the district not supplied from public electricity undertakings and the potentialities of the district in regard to the supply for power, traction, agriculture, domestic and general uses; the present total coal consumption, average cost and average pounds per unit generated at each of the existing stations, the total tonnage estimated to be saved by the scheme, as well as a schedule of the proposed main transmission cables or lines, a general description of new generating stations, estimates of capital expenditure, &c.

In the course of his evidence Mr. Roles said central control was only useful where the generating stations remain under separate management. He was chairman of the technical committee which prepared the scheme, and he gave particulars of the steps taken to collect information, &c. In some cases the Yorkshire Company was supplying districts which were nearer to existing stations, but, if the whole of the generation and main transmission lines were under one authority, economies could be effected and duplication of cables avoided. By sufficient linking-up he thought two new capital stations would suffice for the district. As engineers they decided that as long as the electricity supply in the district was co-ordinated under one authority it did not matter, whether it was a public authority or a company authority, but the Joint Conference Committee thought it would be easier and more desirable to have an authority under public control, and also that it should be a fully operative body—owning and operating the generating stations and transmission lines. In order to get money as cheaply as possible it was considered that the rates of the local authorities should be behind the scheme, but it was felt that it was not right to put the rates behind company undertakings; the company could demand a supply from mains laid by the municipal authorities which would provide about two-thirds of the finances of the Joint Authority. By taking over the company economy could be effected, as the company's uncertaking and system could be worked into the Conference scheme. If the company remained a separate concern it might get a priority over other local authorities. The public authorities had spent £2 328 904 on generating stations at December 31, 1919, and the company £406 609; all operating stations would remain with the Authority, and the aggregate outstanding debts on March 31, 1920, was £1 226 964. By the aid of the rates the Joint Authority would be placed in an advantageous position compared with the company. The undertaking of the latter was in two electricity districts, but that would not interfere with its purchase.

In cross-examination, Mr. **Wooll** put several questions to Mr. Roles on the report of the Linking-up Committee in order to show that that report was inconsistent with the Conference scheme. The figures upon which the estimated increase in the demand between now and 1926 under the Conference scheme had been sent to him by the engineers of the existing works, who should have an idea of what the future development might be. The prospective increase of 100 per cent. in Bradford during the next five years was, he thought, a reasonable proposition, though it did not anticipate the present trade slump. As to outside districts, it was expected that places like Honley, Holmfirth and Hebden Bridge would make use of considerable quantities as soon as the transmission mains were available. The Conference scheme provided for two capital stations, one at Esholt, one at Wakefield, with provision for a third at Ferrybridge, now marked out by the Power Company. He thought the Esholt site better than the Leeds one. Keighley was, however, urging what they considered a preferable alternative to Esholt, but he had not gone into it fully. Esholt offered an advantage in that it gave facilities for utilising an enormous flow of sewage effluent for condensing water; and Wakefield was the centre of the West Yorkshire coalfield.

If they could not secure the Power Company's undertaking the scheme went, or at all events estimates of the schemes would have to be recast. So far as the engineer's committee was concerned, they would never be satisfied unless there was some co-ordinating scheme as between the bodies in agreement, whatever happened with regard to Leeds and the Yorkshire Electric Power Company. If Leeds did not come in, the amount of the proposed generating plant at Esholt and Wakefield would have to be reduced; but so far as the technical aspect of the matter was concerned it would not make much difference if Leeds stood out, though, of course, the financial results would not be so good.

Sir **Harry Haward** asked whether the presence of persons on the Board other than representatives of local authorities would be an advantage?

Mr. **Roles**: Technical experts that get on to Committees are usually more trouble than they are worth. I know cases where it has been a distinct disadvantage. Such men cannot possibly be acquainted with the details in the same way as the official engineer. In technical matters the help of the directors is not required. That should be left to the staff, the Board being composed of sound business men.

Railway Electrification.

The **Chairman** paid a tribute to Mr. Roles for the immense amount of careful work he had put into the scheme and asked whether attention had been given to the possiblity of railway electrification?

Mr. **Roles** replied that it had, and that much depended upon whether the conversion was first of all for goods or for passenger traffic. If for passenger traffic, the load would correspond very much to that of tramways, in that the peaks would rise as the ordinary industrial peaks fell, thus equalising the load.

A railway engineer had told him that the Leeds and Bradford line would probably be the earliest to be converted, in which case the Esholt Station was conveniently situated half-way between the two cities.

The **Chairman**: Supposing the Power Company did not agree to sell, and remained independent, have you and your colleagues any back-door in your mind as to how the improvement of the supplies to your constituent authorities could be bought about? We should like, as far as the Engineers' Committee is concerned, to put forward a scheme for amalgamating the districts in agreement. In our opinion some form of amalgamation should take place, and we have considered, even if the No. 2 Bill does not go through, whether there would be a possibility of forming a joint authority for generation and transmission under the Act of 1909.

Mr. **Roles** said he thought that the two capital stations at Esholt and Wakefield would be enough to meet all needs up to 1931, and if the Power Company remained independent he could see nothing for it but a third station at Ferrybridge, with serious duplication of mains.

Mr. **Percy Greaves**, mining engineer, said the coal seam under the capital station site at Wakefield had been worked and the land had quite settled down again.

Ald. W. **Turner** was recalled and spoke of prospective demand for current in the woollen trade. Approximately not more than 10 per cent.

of the spindles in Bradford were at present electrically driven. He estimated the total number of spindles in the Aire and Calder area at 2¾ millions; and said that the motive power consumed was about one horse power per 30 spindles. On that basis the total power required for combing, spinning and weaving in the area would be between 150 000 and 200 000 h.p. Much of the existing steam-raising plant wanted renewal, and in view of present costs manufacturers were seriously contemplating resorting to electricity.

Financial Evidence of Conference Scheme.

Mr. F. Ogden Whitley, City Treasurer of Bradford, gave evidence on the financial aspects of the Conference scheme. If it were not possible to come to terms with the Power Company the whole of the scheme would go by the board, and they should start along a fresh line, but he was satisfied that the scheme, without Leeds could be a paying proposition. It was not intended to scrap existing power stations; they would be used as long as they were efficient.

Sir John Snell said that the Commissioners were quite satisfied that the supporting authorities had committed themselves to the Conference scheme fully to the extent to which they could possibly go before the Joint Authority came into being.

In reply to Sir Harry Haward, witness agreed that his own advice, as a matter of business, would be that the local authorities who declined to support the scheme with their rates should not have quite such favourable terms for electricity as those who pledged their rates, although the scheme made no such provision. The conference had based the scheme on the assumption that all the localities would back the scheme with their rates.

Mr. Geo. D. Rowe also gave evidence in support of the Conference scheme. He said there was no doubt the local authorities concerned could raise the necessary money. The rates of interest proposed were quite fair, and in fact even more favourable terms might be obtained. He did not think the mere isolation of Leeds would adversley affect the raising of the money to any great extent. The inclusion of Leeds would make it easier to underwrite the issue.

With Mr. William M. Selvey's evidence on the existing and the contemplated water supply under the scheme the case for the Conference scheme closed.

Power Company's Case.

Mr. Hunter Gray, K.C., for the Yorkshire Electric Power Company, said he desired to make it clear that the Company was desirous of helping to improve the interests of the community in respect of the supply of electrical energy. The first duty of the directors was to safeguard the interests of their shareholders, and they believed that with the goodwill of the promoters of the other schemes it was possible to arrive at a much better condition of affairs than now existed. So far as the Leeds scheme was concerned, if the Company had to choose between being bought or being starved out of existence, as had been suggested, they would, of course, choose the former. In contemplating the Conference scheme there were two difficulties. The first was the determination of the price should the Commissioners come to the conclusion that the Power Company should be bought up, and the second difficulty—a more serious one—was to satisfy the Company as to the security for the payment of such moneys which in the event of purchase might be agreed upon. He proposed to hand in three alternative proposals, which he had placed in "the order of preferential importance." (1) The Power Company is willing and able to undertake the responsibilities of a Joint Electricity Authority in the proposed district; (2) the Company is prepared and has formulated its plans to go on under its present powers, and also to supply for lighting purposes those districts where there are no authorised distributors; (3) that the Company is prepared to go on under its present wide, though in some respects not wide enough, powers. He submitted that the first proposal was the best and most reasonable solution of a difficult problem.

On Thursday Mr. W. B. Woodhouse, engineer and manager of the Company, gave evidence. He said that, taking the Company's area as a whole, the average density of the population was 6·2 per acre; and the average density in the boroughs was 13·7. The load factor on units sent out to the Company's system for the year ended March, 1920, was 35 per cent., and the cost per unit sent out was 0·667d., based on the average price of coal for the period (£1. 7s. 4½d. per ton). The average price charged for energy was 1·452d. per unit. There were a large number of local authorities whose electric lighting orders had been revoked, and the fact that they did nothing with their orders hindered the Company's development. It was to overcome that difficulty that the Distribution Company was formed in 1905 to buy electricity in bulk from the Power Company. The Distribution Company had obtained a transfer of the orders of eight local authorities, and they also obtained a number of additional orders from the Board of Trade. Under their Act the Company had power to supply the railways, and could supply for traction purposes throughout the whole area. They had working agreements with 63 local authorities, and they co-operated with Bradford Corporation during the war to their mutual advantage.

Objections to Severance.

The Company felt very strongly that no advantage would be gained by dividing the Company's area on the south into two. Their area had been considered as one district, and they had laid their plans for its development as a whole. He disagreed with the line drawn from Selby to Leeds, which, he said, would cut right through the coalfield, dividing in two districts pits belonging to the same undertaking. At the proposed capital station at Ferrybridge, plant of 135 000 kW would be installed, and with the assistance of that plant and the plant at Leeds and Bradford they could supply the whole of the electricity for the area. If a joint scheme could be arranged between Leeds Corporation, the Conference authorities, and the Power Company, they would be prepared to support it. They were prepared to go on continually developing, and they had shown by their past work that they were best fitted to deal with the area.

In cross-examination witness said his principal objection was to the severance of the Company's area. The Company could carry out all the necessary duties of a joint authority, in giving a cheap and abundant supply. It seemed quite inconsistent to suggest that Joint Authorities and the Power Company should operate side by side independently. The best solution was to let the Company go on by working agreement and linking-up arrangements. The Company was improving the electricity supply in the area every year. The improvement they looked for was to be obtained by further co-ordination.

Objections to Local Authorities' Schemes.

Mr. H. F. Atter, for the West Riding Rivers Board, objected to the effect which the use of large quantities of cooling water from the Aire at Esholt and at Leeds would have in raising the temperature of the river, and creating a nuisance, especially in the summer months.

Dr. H. Wilson, Chief Inspector of the Rivers Board, spoke of the effect of sewage pollution in the river at Bradford and said that when the temperature reached 65 deg. no water should be used for cooling. If the Esholt station was properly worked there was no reason to apprehend trouble.

Mr. Arthur G. Lupton, Chairman of the Yorkshire Electric Power Company, gave evidence as to the financial position of the Company, and stated that for the first 11 years there was no dividend. Its record was, however, one of continuous growth from the start.

Mr. A. T. Thompson, General Manager of the Manvers Main Collieries, said that a more extended use was being made of electricity both on the surface and in underground workings. The South Yorkshire Coal Association thought that the schemes promoted by the municipalities were altogether too large, and would not tend to efficiency or economy. Some collieries used exhaust steam in generating electricity, and when they had not sufficient they preferred to take the excess from the Company

Mr. J. H. Cockburn, Secretary of the Association, said they had no confidence in the skill or power of the municipalities to make such a concern pay. The Association paid one-third of the rates in the districts they operated, and they had many instances of the reckless way in which public authorities proceeded.

Mr. H. F. Smithson, mining engineer and general manager of the Airedale Collieries, also advocated supply through a private company as offering a surer guarantee of cheapness and efficiency.

Mr. H. Pickard, chief engineer to the trustees of the Aire and Calder Navigation, said the site for the suggested new capital station at Ferrybridge was ideal. It would aid the development of the coalfield and also of the port of Goole. At Esholt the water supply for condensing purposes was insufficient in dry weather, and the Leeds site was too congested.

Mr. Roslyn Holiday, general manager of the Ackton Hall Collieries, and representative of the West Yorkshire Coalowners' Association, said that, in their opinion, the proposals of the company were the best, and, following the erection of a capital station at Ferrybridge, there would be coalfield developments to the east, and new pits would probably require a considerable amount of electrical energy. As business men who were out for private enterprise, the Association felt that, if a productive industrial concern had not sufficiently good prospects to warrant business men investing money in it, it was not judicious to ask the ratepayers to stake their money on it. Realising that cheap power was essential to meet strong competition, many members had put money into the power company. There was a considerable development in the use of electricity in mines. The West Yorkshire coalowners believed that, provided the policy was right, private enterprise was better than control by a public authority. If a productive concern had not the prospect of a sufficient guarantee of a return on their money he, as a business man, objected to have to pay through the rates. The tendency of development was towards a greater electrification of the collieries in the area.

Mr. J. C. McGrath (for the West Riding County Council), said that that authority would loyally co-operate to make any approved scheme successful, but the Council regretted that they were unable to support either scheme. The present economic conditions and the character of existing legislation concerning electricity formed an insuperable barrier to the success of either scheme which had been proposed. The present was not the time to encourage any venture to which was attached even the possibility of an additional burden being placed on ratepayers or taxpayers. It seemed impossible to expect the Bradford scheme to take over the undertaking of the company at such a price as would enable them to supply the district with cheaper electricity. The company had served and were serving a useful purpose in the industrial life of the West Riding. The Council believed that the Bradford Conference scheme and the Leeds scheme were *ultra vires* in their essentials, and they could not see how the essential features of either scheme could be preserved in any approved scheme without a severe straining of existing legislation. He suggested that under Sec. 6 of the 1919 Act the Commissioners might appoint an Advisory Committee to watch developments during the next few years.

Mr. A. Tylor, for the railway companies, said that in the event of the electrification of railways, which might not be far distant, it was important that the supply of electricity should be cheap and abundant. The view of the railway companies was that, all things being equal, they had no fault to find with private management of the past, and the supply likely to be obtained from private management in the future, and, whilst recognising the advantages of centralisation as a means of reducing capital costs, they also realised that centralisation would probably entail some sort of public control.

The CHAIRMAN inquired the railway load which might be expected, and Mr. Tylor said he was instructed that, assuming all the railways were electrified, the estimated load of 75 000 kW, which had been mentioned during the inquiry, appeared to be a very large figure.

Mr. J. A. GREENE, representing West Riding District Councils, with a population of 750 000 and a rateable value of £3 500 000, also supported the Power Company's suggestions, with the appointment of an advisory committee of local authorities to deal with small problems. The Association did not desire a joint electrical authority to be set up, and they were opposed to capital expenditure at present.

Counsel then addressed the Commissioners, and Mr. WOOLL stated that Leeds was determined to retain control of its own generating stations. The city also objected on principle to the acquisition by purchase of the Power Company. Otherwise he thought compromise might be possible.

The Telephone Inquiry.

The Select Committee of the House of Commons on the Telephone Service resumed its sittings on the 25th ult., when Mr. R. A. DALZELL gave evidence. He said that 12 000 000 telegrams were passed over telephone wires in a year, and 3 000 000 telegrams were sent direct to post offices by subscribers. In order to check overstaffing a limit of 1·6 telephonists per "busy working position" had been fixed for London, and a limit of 1·3 telephonists per position for the provincial districts. The day staff had a net working day of seven and a half hours. In order to keep a watch on the service given a regular system of observation was carried out at all the larger exchanges. The observations for 20 centres showed that generally the quality of the service given was much better in February last than that given in the corresponding month of 1920. Where the plant was sufficient and of efficient type, as at Edinburgh, the service was in some respects above the standard; while at Sheffield, where the equipment was not modern, the service was below the standard. The long-distance service in America was quicker than the trunk service in this country. The higher tariff and the more extended use enabled the American administration to provide circuits on a more liberal basis. If the Department was to develop it must do it now, and not wait for some time when the cost might or might not be less. If they delayed further they might get seven or eight years behind..

On Monday Mr. DALZELL was again examined by members of the Committee. He said the telephone service was working more smoothly now than it ever did before, and he did not think it would be an advantage to take the executive control from the Secretary of the Post Office. Since the war they had been working under extreme pressure, but the machine was now very efficient and working well. Having a different organisation for telephones as against the Post Office control would bring in an enormous number of difficulties and complications. If that were done they would probably get a more extensive system. At first he had not thought the organisation under the Post Office would be sound, but from experience he now thought it was a very efficient machine.

The Junior Institution of Engineers.

A dinner in celebration of the 37th anniversary of the foundation of the JUNIOR INSTITUTION OF ENGINEERS was held at the Café Monico on Thursday, May 26, the President, Lord Weir of Eastwood, being in the chair.

In giving the toast, "Progress in Engineering," Mr. C. H. WORDINGHAM, C.B.E., President-Elect, said that every true engineer loved his profession for its own sake. Engineering was essentially progressive and never halted or turned back. It demanded not only the application of theory and practical knowledge, but instinct, which the British engineer undoubtedly possessed. British engineering had been first in the field in all branches of engineering with the exception of the motor industry. Progress in engineering must depend upon research, standardisation of specifications, the well-being of employees in the various works, and the free development of engineering projects without Government interference.

Lord WEIR, in reply, said that he was faced with the difficulty of arriving at a definition of what progress in engineering really was. The engineer's value was assessed by the ability of his machines to carry out their work, and British engineers thought first of that great heritage of tradition and example which had been set up by those who had made British engineering the foundation of all engineering progress. To think of what we had done in the past was an antidote to pessimism and depression, and, in fact, given certain conditions, we could do even better in the future. To retain and increase our technical supremacy was the first thing. Dear coal and high wages placed a grave premium on men and machine-hour efficiency, and one of the greatest problems which had ever confronted British engineering was the influence of the price of coal on the raw materials of our industry. If we were handicapped and crippled initially opportunities for technical development were lost to us, for without the guidance and experience of practical application design and technique were futile. It was of little value to British engineering if it carried out the technical development for the world and allowed the manufacturing to be done elsewhere. Stability and confidence in the industrial world were therefore essential, as were imagination in methods and processes so as to evolve such mechanism as would reduce the number of man-hours required to produce a ton of coal. There was no short and easy way out of our present difficulties, and no catchword could take the place of steady and resourceful application and hard work. Incentive was essential, and human nature responded best to an incentive of a material character. It was therefore useless to expect capital and brains to do their utmost under the shadow of grave changes in our social system, and it was essential, if nationalisation was ruled out, that the problems of industries should be left to be solved by those engaged in them.

Water Power in Ireland.

The report of the Water Power Resources of Ireland Sub-committee has been issued, and states that 500 000 H.P. is available continuously, and can be economically developed in Ireland. The value of this power is put at £10 000 000 annually, and is equivalent to the power generated by the annual consumption of 7½ million tons of coal. In the opinion of the sub-committee, the development of this power is urgently necessary to replace existing steam plant with consequent reduction in coal consumption, to develop existing and to start new industries. The most economical method of dealing with the rivers of the country for power purposes is to construct the necessary works in the channels of the rivers, and not to attempt to seek high falls by the construction of costly head race channels. Detailed investigations, which were made of the Lower Bann, the Lower Shannon, the Lower Erne and the Liffey, show that considerable power is available in these rivers, as well as in the high level lakes in Donegal, Connemara, Kerry and Wicklow.

RECOMMENDATIONS.

The sub-committee recommend that the systematic gauging of rivers should be undertaken at once, that a large number of rainfall and evaporation stations be established througout the country, and that an authority should be established for the allocation of water for the various interests involved, a small royalty, payable to the State, being charged on the water power developed. It is also recommended that, in order to secure the development of water power, a service be established which should be charged with the duty of investigating the proposed schemes and formulating a policy for utilising the water power resources of the country.

SUGGESTED SCHEMES.

One of the witnesses, Mr. Theodore Stevens, M.Inst.C.E., submitted an outline of a scheme prepared by him in 1915 for the Irish Hydro-Electric Syndicate, which proposed to generate electric power for the manufacture of ferro-chrome. Mr. Stevens proposed to divert a portion of the Shannon water by the construction of a head race or canal to a site suitable for a power station; and on the river Erne he also proposed to construct a canal over 5½ miles long to carry the water to a power station with a head of 125 ft. He suggested four hydro-electric stations on the Shannon, between Killaloe and Limerick, with an installed electrical horse-power of 65 900, at a total cost at current prices of £2 834 000, or £43 per E.H.P. The average annual output would be 52 500 E.H.P. at an average cost of £54 per E.H.P. There would also be four stations on the Erne between Beleek and the sea, with an installed E.H.P. of 71 300, at a total cost of £2 060 000, or £29 per E.H.P. The average annual output would be 45 500 E.H.P., at an average of £46 per E.H.P. The works in both cases would not only preserve, but improve the fisheries, retain all water in the natural channel and develop more power, and at cheaper rates, than could be done by diverting the water.

As to the river Bann, Mr. Charles Meik, M.Inst.C.E., proposed the dredging of the bar at Toome and the formation of an improved channel from Lough Neagh to Lough Beg, at a total cost of about £350 000. All the current available could be used by the milling industry. In regard to the Liffey, Messrs. J. W. Griffith and H. H. Jeffcott propose six hydro-electric stations, the three principal sites being at Poulaphouca, Golden Falls and Salmon Leap. Automatically controlled power stations are proposed at Lockstown, Clogleagh and Connell Ford. The installed plant would have a total capacity of 29 600 E.H.P., and the estimated total cost of works and plant is put at £920 000 at present-day prices. The latter development would meet the power requirements of the Dublin district, where the load factor is low, and consequently the plant installed is large compared with that which would be required for a continuous load. The estimated cost is £31 per E.H.P. installed, or £111 per average E.H.P. developed during a year at the power sites. The cost of transmission to Dublin (including the transforming plant) is given at £293 000.

H.M. Consul at Oruro reports that in a tin-producing country like BOLIVIA there is in normal times a constant demand for grinding and crushing machinery, concentrating plants, &c. In this branch of the import trade the United States continue to hold a predominant position, though British goods have a good reputation. Their travellers, who make frequent visits to the various mining camps and keep in touch with extensions of plant, have a practical knowledge of the work, and have therefore a great advantage over the salesman who works from book and catalogue knowledge only. Electrical development is backward, but there is some water power available and there may be a demand for electrical plant later. At present the exchange position is against the import of American goods.

Commercial Topics.

Australian Wiring Rules.

The Wiring Rules of the Fire Underwriters' Association of Victoria were recently revised. The Rules of the Association, as well as those of the fire underwriters of the other states of the Commonwealth, are based on the code of the Institution of Electrical Engineers, with some modifications to meet Australian conditions for the supply of electrical energy at low and medium pressures.

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Anglo-Swiss Trade.

In a memorandum issued by the Department of Overseas Trade on the representation of British firms in Switzerland, it is suggested that better results are obtainable by a local agent than by a British traveller. His Majesty's consular officers will, if required, assist in the choice of a suitable agent. The majority of agents who would give their whole time are men of small means and do not possess sufficient capital to open business on their own account. Swiss firms prefer a reasonable credit, but the majority would be prepared to pay cash against documents.

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Belgian Contracts and Foreign Competition.

In a statement by the Commercial Secretary at H.M. Embassy at Brussels, the lack of success of British firms in obtaining the numerous important Belgian contracts which have been notified is attributed to the present adverse rate of exchange, and the ability of Belgian firms to supply the materials required. The majority of the contracts have been secured by Belgian firms, because British contractors had to quote prices in a currency which has depreciated by 100 per cent. Industry in Belgium has, with few exceptions, almost completely recovered since the Armistice, and the present trade depression makes firms willing to quote their lowest rates in order to obtain orders and secure employment for their operatives. The Belgian Railway Department recently examined the question of the participation of German firms in public contracts, and decided that no general rule could be laid down as to permitting foreign competition, but certain restrictions should be imposed favouring Belgian industry. Where Belgium is not necessarily dependent on foreign supplies it is proposed to give preference to tenders quoting unconditional prices in Belgian francs.

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Spanish Tariff Changes.

A new PROVISIONAL CUSTOMS TARIFF is to be enforced in Spain as from May 21, 1921, pending a revision of the tariff of a more permanent character. In view of the importance of the subject, we give below some of the principal items of interest to those in the electrical industry. In each case first-tariff and second-tariff rates are given. The first-tariff rates are in general 100 per cent. higher than those in the second, under which goods of British manufacture or origin are included.

Steel rails weighing 25 kilogs per metre, 18 pesetas 6 cents, and 9 p. 24c. per 100 kilogs ; ditto weighing less than 25 kilogs per metre and grooved rails for tramways, 24 p. and 12 p. 88 c. per 100 kilogs ; copper bars over 1 cm. in thickness, 87 p. 15 c., and 43 p. 60 c. ; copper bronze or brass wire 1 to 10 mm. in thickness, uncovered, 85 p. 50 c. and 42 p. 75 c. ; ditto under 1 mm. in thickness, 90 p. and 45 p. per 100 kilogs ; aluminium in bars, sheets, tubes or wire, 85 p. 50 c. and 42 p. 75 c. per 100 kilogs ; zinc in bars, lumps and scrap, 15 p. and 8 p. per 100 kilogs ; ditto in sheets and wire, 60 p. and 30 p. ; dynamos, electric motors, induction coils, resistance boxes, transformers and, regulators, up to 100 kilogs, and parts of the same, 300 p. and 150 p. per 100 kilogs ; ditto from 101 kilogs to 400 kilogs, 284 p. and 142 p. per 100 kilogs ; switchboards and cut-outs up to 400 kilogs and parts, 300 p. and 150 p. per 100 kilogs ; dynamos, electromotors, induction coils, resistance boxes, transformers, regulators, switchboards and cut-outs weighing 401 kilogs and upwards, 150 p. and 75 p. per 100 kilogs ; accumulators and electric cells and parts, 100 p. and 50 p. per 100 kilogs.

Electric cable and wire, covered with textile fibres, with or without insulating materials, total thickness being 1 cm. or more, 180 p. and 90 p. per 100 kilogs ; other cables and wire (covered), less than 1 cm. thick, 300 p. and 150 p. per 100 kilogs ; apparatus for telegraphs and telephones, electric meters and the like, including parts, 7 p. 50 c. and 3 p. 75 c. per kilog ; arc lamps and parts, except carbons, 4 p. 80 c. and 2 p. 40 c. per kilog ; carbons for arc lamps, 3 p. 00 c. and 1 p. 50 c. per kilog ; electrodes for metallurgy and other similar uses, 0 p. 60 c. and 30 c. per kilog ; incandescent lamps, with mounting, 24 p. and 12 p. per kilog ; incandescent lamps, without mounting, 30 p. and 15 p. per kilog.

Steam and gas engines, without boilers or flywheels, 105 p. and 52 p. 50 c. per 100 kilogs ; cylindrical steam boilers, 72 p. and 36 p. per 100 kilogs ; multitubular boilers, gas-generators and parts, 100 p. and 50 p. per 100 kilogs ; steam and gas-engines, petroleum, compressed air, and other similar engines, and parts, except flywheels, 160 p. and 80 p. per 100 kilogs ; cranes, fixed and movable, winches, and parts, 80 p. and 40 p. per 100 kilogs ; frames of iron or steel for railway and tramway carriages, with or without wheels and without motor, 54 p. and 27 p. per 100 kilogs ; ditto with motor, for tramways, 150 p. and 75 p. per 100 kilogs ; chassis of iron or steel, up to 1 000 kilogs, for road vehicles, with or without motor, 30 per cent. and 20 per cent. *ad val.* ; ditto, weighing more than 1 000 kilogs, 45 per cent. and 30 per cent. *ad val.* ; bodies of wood, in the white or unfinished, for all kinds of carriages, and wooden parts for same, 200 p. and 100 p. per 100 kilogs ; automobiles, open, with or without motor, 40 per cent. and 25 per cent. *ad val* ; ditto, closed, with or without engine, 50 per cent. and 35 per cent. *ad val* ; tramway cars for passengers, with or without motors, 225 p. and 112 p. 50 c. per 100 kilogs ; india-rubber, gutta-percha and similar material, unmanufactured, 18 c. and 12 c. per kilog.

Electricity Supply.

AYLESBURY Council will in future charge 1s. per unit for electricity supplied through slot meters.

All new houses of the AMMANFORD Urban Council are to be wired and fitted for electric lighting.

GRAVESEND Corporation proposes to spend about £3 300 in extending the supply mains to the King's Farm estate.

STRETFORD Urban Council has been authorised to put in an additional 5,000 kW set at the Trafford Park power station.

The HARROGATE Corporation has been authorised to raise a further loan of £45 000 for extensions of the electricity supply undertaking.

KINGSTON-ON-THAMES Council has received sanction to a loan of £18 000 for expenditure on extensions of the electricity supply undertaking.

Authority to borrow a further sum of £107 600 has been obtainned by WALSALL Corporation for the completion of the Birchills electricity station.

MANSFIELD Corporation has made a fresh agreement with the local tramway company under which the latter will pay an increased price or electrical energy.

The London County Council recently agreed to the borrowing of a further sum of £100 000 by the STEPNEY Borough Council for extensions of the electric supply undertaking.

The BEXLEY Urban Council has decided to install in 22 houses in the Welling housing estate electric immersing tubes for heating coppers instead of tenants having to utilise fuel or gas.

In connection with the scheme of the HULL Electricity Committee to HESSLE, it has now been decided to light those streets in which the electric mains are laid at the current rate for gas.

BUXTON Corporation has been authorised to borrow £500 for electricity meters. The Electricity Committee is considering the question of extending the supply mains in several additional districts in the Borough.

WORKSOP Urban Council has decided to carry out extensions of the electric supply cables at a cost of about £3 500, in order to provide a supply of electricity for several hundred houses which are being built, and also to the Shireoaks Colliery.

The Electricity Commissioners have submitted to the Minister of Transport for confirmation a Special Order authorising the supply by WEST HARTLEPOOL CORPORATION of electricity in a part of the parish of Stranton, in the Hartlepool Rural District.

SOUTHPORT Corporation Electricity Committee have made arrangements to adapt two of the old boilers, which were replaced some time ago by new plant, for the consumption of oil fuel in place of coal, and thus assist in maintaining a supply of electricity.

The MANORHAMILTON Electric Lighting Company has recently added plant of the value of £1 400 for the further developing of lighting and power demand in that progressive little Ulster town. Mr. T. C. Armstrong is engineer in charge of the undertaking.

SOUTHAMPTON Electricity Committee have conditionally accepted the tender for boiler-house foundations at £14 570, and negotiations have been opened with the Urban Council of Eastleigh and Bishopstoke in regard to the supply of electricity in bulk to the district.

The two NATIONAL KITCHENS in GLASGOW were faced with the risk of closing down last week owing to insufficient supplies of gas. Electric cooking apparatus was, however, installed at short notice by the Corporation Electricity Department and business is now proceeding as usual.

Application will be made to the Electricity Commissioners by BRISTOL Corporation for authority to borrow £200 062 for electricity supply purposes, including additional generating plant, the erection of a number of new sub-stations, alterations to existing ones, the extension of mains, and other work.

The Electricity Commissioners have given a general approval to the scheme for the extension of the ABERDEEN Electricity undertaking and tenders will be invited. The extensions will involve an expenditure of about £200 000.

It has been decided to withdraw from the Scottish Industrial Council for the Electricity Supply Industry.

An inquiry by the Ministry of Agriculture into the proposed draft Order constituting an OUSE AND DERWENT DRAINAGE BOARD, was held last week. Mr. P. J. Spalding, Town Clerk of York, asked for the insertion of clauses in the Order for the protection of the Navigation of the Uuse and Foss, and for their hydro-electricity works at Linton Locks, and their exclusion from the Order.

RUGBY Urban Council has decided to obtain additional transformers and to lay cables in four streets. On the past year's working there was a gross profit of £2 642 (against £2 000 in the previous year), but of this amount £2 470 has been spent for new cable and extensions. There has been an increase of about 200 in the customers and the wiring department has been adequately engaged during the last year, the amount of business done totalling £4 106, with an estimated profit of over £600.

BEDFORD Corporation has introduced a special tariff for electricity supply for small houses. Consumers who require not more than five 20-W lamps may adopt the following method : At the beginning of each quarter the householder will be required to declare the number of 20-W lamps (not exceeding five) that will be alight at any one time, and to pay, in advance, the sum of 4s. per quarter per 20-W lamp. If the amount so assessed be not paid within 14 days after the usual quarter days, the supply will be cut off without any further notice.

Hackney (London) Electricity Committee has reported to the Council that employers of the electricity department have refused in six cases to connect up premises in which it is alleged " the rates of pay for wiring work agreed upon by the National Joint Industrial Council have not been paid." In one case judgment was recently given in a Police Court against the Council, but an appeal to a Divisional Court is pending. In one of the other cases a summons has been issued against the Council, and the hearing has been adjourned until the decision of the Divisional Court is given. In the meantime the Committee is desirous of getting the Council's instructions as to the policy to be adopted, and these will probably be given this week. Under the peculiar circumstances, it will be interesting to see how the Council propose to get over the difficulties with their employees.

The chairman of the Birmingham Electric Supply Committee (Councillor H. K. Beale), in presenting the annual accounts last week, was able to show a good record for the year ended March. Nearly 137 000 000 units were sold, an increase of 9 000 000 units over the previous year. The increase in sales during the first half of the year was gratifying, but adverse trade and industrial conditions in recent months had a marked effect upon the output. The gross revenue from consumers exceeded the previous year's total by 21 per cent., the charge for all classes of supply during the year having advanced on the average by 0·262d. per unit, but the average increase in the cost had been 0·286d. per unit sold, the heaviest advance being in fuel. The gross profit was £299 786, compared with £292 535, and after providing for all capital charges, including £137 935 for redemption of debt, the surplus is £68 161, compared with £75 324 for 1919-20. The rates on the undertaking are now over £100 000 per annum, an increase of £31 781, and the extra income tax payable is £9 369, chiefly owing to the operation of the three years' average. During the year the renewals and special expenditure account had been charged with an expenditure of £53 212. Out of the surplus on the year's trading £53 000 has been transferred to renewals and special expenditure account in order to restore the balance of that account to approximately its former level, and in view of the heavy charge on the current year's account for interest on temporarily unproductive capital on the Nechells scheme, it has been decided to carry the balance of £15 151 to reserve. Additional capital of £600 000 was expended, mainly on the Nechells station scheme, during the year. The capital indebtedness has been reduced by £137 935. The expenditure during the year was £524 619, making a total of £3 369 905 to March 31.

Electric Traction.

By the aid of oil fuel the Leicester Corporation has been able to provide a tramway service this week, but electric power for industrial purposes is only available from 8 a.m. to 4 p.m.

Epsom Urban Council has fixed a minimum charge of 40 units per annum for all private consumers as from the June quarter's readings. For the new houses each tenant is to be charged 1s. 6d. per week on a seven lamp basis.

During the past year there was only a profit of £144 on the Blackpool Corporation electric tramway undertaking. In the 26 years of its existence it has contributed £132 000 to relief of the rates. In 1918 and 1919 £15 000 was given, and in 1920 £10 000, but in the current year the rates may have to meet a deficiency on the working.

Edmundson's Electricity Corpn. has been authorised to make a charge of 10d. per unit for electric current in Dorking as from May 7, and as from June 30, a minimum charge of 12s. 6d. per quarter up to 15 units for the winter quarters, and of 8s. 4d. up to 10 units for the summer quarters.

Newcastle-on-Tyne Corporation is applying to the Light Railway Commissioners for an order authorising the construction of a light railway commencing at North Gosforth in a junction with the tramroad of the Tyneside Tramways & Tramroads Company and terminating at Longbenton in a junction with the Corporation's tramways.

The tramway service of the Taunton Electric Traction Company is to be closed owing to a difference with the Town Council as to the charge for power. The undertaking is a small one and since 1905 there has not been a dividend. To add to the Company's troubles the Council has now increased the price of electric current, and hence the decision to close down.

In a Paper recently read on the municipal work of Derby before a meeting of the Municipal and County engineers, Mr. C. A. Clews, the borough engineer, stated that the Corporation used for refuse collection two two-ton electric vehicles, one five-ton steam lorry and one four-ton petrol lorry. The number of electrics was being increased, and the steam and petrol vehicles would be dispensed with.

On the past year's working there was a deficit of £1 142 on the Sunderland Corporation tramways. During the year 32 574 618 passengers were carried and the revenue was £157 324, the total income being £158 165. The working expenses were £136 667 11s. 10d., but after meeting the usual demands for interest and sinking fund there was a deficit as stated. In 1914 the wages of motormen and conductors amounted to £13 797 17s. 3d., while last year the amount was £45 573 19s. 7d.

Imperial and Foreign Notes.

A survey for a new Railway through the Hukong Valley to Burma is being made. It is probable, if sufficient water power is available for operating the line, that electric working will be adopted throughout.

The new wireless station at Port Elizabeth (S. Africa), which was opened on May 3, comprises a $1\frac{1}{2}$-kW set equipped with amplifier valve. It has a guaranteed range in daylight of 300 miles, but demonstrations have shown that that range can easily be exceeded, and under suitable conditions a range of over 1 000 miles may be attained. The station is equidistant between the Durban and Capetown stations, *i.e.*, 400 miles each way, and it ensures continuous wireless communication along the south-eastern coast of Africa.

The French Posts and Telegraphs Department has opened a public Wireless Service Between France and Norway.

The Director General of the Swiss Federal Railways has recently ordered 32 electric locomotives and four motor coaches, for which a credit of £1 000 000 has been granted.

A successful trial test was made last week of the U.S.A. Electrically-driven Dreadnought " Iennessee." In the trial all four propellers were working and an average speed of 21 knots was attained. Her engines developed 30 909 h.p.

The recent announcement that M. Bassett, a French engineer, had invented a process by employing pulverised coal instead of coke for making steel direct from the ore without the intermediate production of cast-iron, is attracting attention in Sheffield. As direct processes have been tried before and have failed to come up to practical requirements metallurgists are exercising caution before expressing an opinion on the subject.

The Paulista Railway Company, of Sao Paulo, Brazil, which is electrifying about 100 miles of its line, has ordered four electric locomotives from the United States. Two are for passenger traffic, and weigh 121 tons, with a horse power of 2 000 and 65 miles per hour maximum speed ; the remaining two are for freight and weigh 87 tons each, with a horse power of 1 500 and a maximum speed of 40 miles per hour.

Arrangements are being made for the amalgamation of all the tramway undertakings in Java, and it is proposed to form a new company, with a capital of 90 000 000 fl. The companies involved are the Batavia Electric, Kediri Stoomtram, Madoera Stoomtram, Malang Stoomtram Modjokerto St., Ned. Indische Tramweg Maatschappig, Oost Java, Passeroean, Proboling Semarang-Joana, Semarang-Cheribon and the Serajoedal companies. The aggregate mileage is about 2 700.

The French Senate has passed a Bill authorising the formation of a company to develop the water-power of the Rhone. According to estimates, the carrying out of the project would save 6 000 000 tons of coal a year. An additional 1 100 000 h.p. will be developed. There will be 18 power stations at suitable points along the river, the largest at Benissat, which will produce 250 000 h.p. The chief users of the power will be the city of Paris and the Paris, Lyons & Mediterranean Railway. All the railway lines within the quadrilateral Bellegarde, Lyons, Marseilles and Vintimille are to be electrified. From Benissat to Paris the distance is 280 miles, and it is proposed to transmit electrical energy to Paris by six cables through two main feeders, one passing by Dijon and the other by Nevers.

Our contemporary, " Engineering," reports a case of the failure of a conduit supplying a Swiss hydro-station supplying power for the St. Gothard Railway. The station was constructed in the valley of the Tessin, which derives its supply from Lake Riton. The conduit connecting the lake with the power station includes a tunnel section. The strata passed through proved to be of a somewhat unsound character, but it was thought that water tightness could be ensured by lining the tunnel with concrete grouted up solid with the backing. On starting-up the station, however, so much leakage developed in the tunnel section that the works had to be shut down, and they can now only be operated under the greatly-reduced head of 10 metres of water, instead of the 45 metres as originally intended.

An authoritative survey of Japanese Railway Construction and Extensions appeared recently in the " Far East Commercial Supplement " :—At present public interest centres in what is known as the Atami cut-off, which will reduce the journey between the capital and Osaka and open up the Izu peninsula. The Atami line will reduce the ruling gradient of 1 in 40 between Kozu and Numazu of the present Tokaido line. The length is over 30 miles, maintaining a ruling gradient of 1 in 100, with a minimum radius of curve of 20 chains. The work includes the building of eight stations (some signal stations included), 72 bridges and the excavation of 22 tunnels. The boring of the Tan-nayama tunnel has been commenced, and for the excavating work pneumatic excavators are used, with an air-compressor placed at each end of the tunnel. For carrying building materials and transporting excavated earth a light railway of 2 ft. 6 in. gauge is to be laid, electric locomotives hauling the trains. An electric generating station is to be built to supply the power at the western entrance of the tunnel. Till the completion of this station compressed air is to be supplied by steam engines placed at both sides of the tunnel. Some particulars of the railway construction work may be inspected at the Department of Overseas Trade

Telegraph and Telephone Notes.

The "Chancery" Public Telephone Exchange (at High Holborn, London, W.C.) was opened on Saturday last. The equipment is of the central battery type, with lamp signalling, and will accommodate 1,500 subscribers' lines. Some 520 lines have been transferred from Holborn, Central and City Exchanges.

The cable ship chartered by the Western Union Telegraph Company has been withdrawn from Miami, so that the landing of the cable connecting Florida with the British cable at Barbados cannot now be effected. The refusal to allow the connection is due to American cable interests, which feared that the Barbados-Florida connection would seriously injure American interests. A recent law gives the President control over cable landings.

The accounts of the Guernsey States Telephone Department for the year ended Dec. 31, 1920, show total receipts £10 153, and after providing for sinking funds, pension fund and £1 823 for depreciation, the net profit was £51. The number of lines of all kinds in use at Dec. 31 was 2 714 (increase 176), and the number of subscribers 2 208 (increase 167). The total number of subscribers and public telephone calls in the year was 1 668 767 (increase 13 844).

The French Postal Telegraph authorities propose to make an interesting experiment in Long Distance Telephony. They are desirous of putting Paris in telephonic communication with Casablanca, in Morocco, a distance of about 3 750 miles. M. Laffont, the Minister of Posts and Telegraphs, who will conduct the experiments in person, has left for Casablanca with a number of officials. If the experiments prove successful, it is intended to establish other long-distance telephone services, so as to link up Paris with various important centres in Europe.

Substantial progress has been made with the joining up of the underground telephone cables between Leeds and Wakefield, and between Leeds and York. The extension of the Bradford Exchange switchboard has progressed sufficiently to enable 220 additional subscribers to be accommodated. A local underground scheme in the south of Leeds was completed in April; 372 subscribers were transferred, and provision has been made for additional subscribers for a period of eight years. A local underground scheme has been completed at Ossett and 120 subscribers have been transferred. Local underground schemes have also been completed at Crosshills and Idle, 83 and 118 subscribers respectively having been transferred from open to underground wires.

Personal and Appointments.

The new Minister of Reconstruction in the German Government is Dr. Walther Rathenau, head of the A.E.G. of Berlin.

The Halifax Tramways Committee proposes to pay an honorarium of £300 to Mr. J. W. Galloway, tramways engineer, for extra services rendered by him in connection with the management of the tramways.

The salary of Mr. F. M. Fletcher, borough electrical engineer at Darwen, has been increased by £100 a year, and that of Mr. Newholme, tramways manager, by £50 a year, with a further £25 in each of the next two years.

The installation of the Prince of Wales as Chancellor of the University of Wales will take place at Cardiff on June 8, and among the honorary degrees to be conferred on the occasion is that of D.Sc. upon Prof. Andrew Gray, of Glasgow, the first professor of physics at the University College of North Wales, Bangor.

Mr. C. Wm. Skinner, a member of the staff of the I.E.E. from 1912 to 1919, and now of Fredk. A. Grant, F.A.I., was first in order of merit at the recent Associateship Examination of the Auctioneers' Institute, receiving the Silver Medal, Institute and Branch Prizes, and was also successful at the Surveyors' Institution Examination (Intermediate).

Readers of The Electrician will be interested to hear that Colonel and Mrs. Crompton will celebrate their Golden Wedding to-morrow Saturday, June 4, at Azerley Chase. This lies about six miles to the west of Ripon. While the Chase possesses great natural beauty, and is worth a visit on that account only, it will have an added interest on this occasion. We understand from Col. Crompton that old friends, whether in the electrical profession or not, who happen to be in the neighbouthood on that date, are invited to visit Azerley, and will be warmly welcomed.

Bankruptcies and Liquidations.

A receiving order has been made against Joseph Francis Lyons, electrical engineer, 27, Palmerston-street, and Frank-street, Consett, Co. Durham.

Reginald Percival Baker and Fredk. Clarence Stubbs, trading as Sheffield Electric Construction Company, 124, Pond-street, Sheffield, have been adjudicated bankrupt.

The first meeting of creditors of Wm. Aaron Davis, electrical engineer, 14, Basinghall-street, Leeds, will take place on June 2 at 24, Bond-street, Leeds, and the public examination on June 21 at the County Court House, Albion-place, Leeds.

The public examination of Saml. Horace Dougherty, trading as the Mersey Electric Company, 106, Kensington, Liverpool, will take place on June 27 at the Court House, Government Buildings, Victoria-street, Liverpool.

Chas. Philip Manners Downie, electrical engineer and factor, 355a, Westborough-road, and 88, Ronald Park-avenue, Southend-on-Sea, has been adjudicated bankrupt. The first meeting of creditors will take place on June 7 at 14, Bedford-row, London, W.C., and the public examination on July 6 at the Shire Hall, Chelmsford.

Catalogues, Price Lists, &c.

A four-page pamphlet which has been sent out by the Sterling Telephone & Electric Company, Ltd., 210/2, Tottenham Court-road, London, W.1, gives illustrated particulars and prices of the company's electric head and side lamps and electric horns.

Messrs. R. Rowell & Sons, Chipping Norton, have issued a leaflet giving an illustration with prices of their 4 in. and 6 in. all-steel adjustable spanners. This spanner is made from a drop steel forging, machined all over and then case-hardened with a mottled finish.

The Swedish General Electric Company, 5, Chancery-lane, London, W.C. 2, has issued its stock lists of two-phase and three-phase motors, single commutator motors, transformers, &c., and of "Century" single-phase motors, a.-c. oscillating fans and the d.-c. type of "K." motors.

Recent trade literature of the General Electric Company, Ltd., includes a folder (O.S. 2 393) containing particulars and prices of Osram gas-filled lamps, and a leaflet giving interesting and novel illustrations of a lady in a fancy dress representing the company's well-known "Kinarko" arc lamp carbons.

Another publication (V.I.2532,) of the General Electric Company, Magnet House, Kingsway, W.C.2, gives illustrated particulars and up-to-date information regarding the complete range of the Company's "Freezor" Fans. This seasonable publication makes its appearance in good time and shows a number of desk, ceiling, exhaust and ship fans for d.c. and a.c. circuits. A large stock of fans of all types has been accumulated in anticipation of the summer demands and deliveries can be made from stock.

A well-illustrated catalogue of over 60 pages has been issued by Messrs. Parmiter, Hope & Sugden, Ltd., Hulme Electrical Works, Manchester, which gives a full description of the "Fluvent" type of distribution gear and of the other forms of ironclad material manufactured by the company. The particulars given include the advantages, the capacity, weight and prices of the various types supplied.

A recent leaflet (No. 881) issued by the Simplex Conduits, Ltd., of Birmingham, gives a short description of the company's Unit System of manufacturing electric light fittings by means of which artistic fixtures for practically any position may be made up from a small number of interchangeable unit parts. The system, which is extremely flexible and economical, is especially suitable for those electrical engineers remotely situated from sources of supply of fixtures. Some good illustrations of fittings built up from Simplex unit parts are included.

The "Manchester Guardian" Commercial Year-Book is an attempt by the publishers of the "Manchester Guardian" to meet the need for a work which shall give the commercial community statistical and general information about the industrial activities of that city and allied information which they are likely to find equally useful. It is, of course, largely concerned with the cotton industry, though a gratifying amount of space is given to engineering, while the chemical dye, oil, timber, rubber, paper, and other industries are not forgotten. The book is excellently illustrated and if we may make one suggestion, it is that in subsequent editions a street map might be included.

Particulars of the "Twiss" solderless connectors are contained in list T. L. 3, which is being circulated by the Twiss Engineering & Electric Transmission, Ltd., 62/3, Queen Victoria-street, E.C. 4. These connectors provide a means whereby conductors may be jointed or alternatively ended off in a manner which provides perfect electrical contact without sweating, the mechanical strength being equal to that of the conductor itself. Illustrations are given of a number of applications to which the Twiss connector principle, that of a cone-grip, lends itself, including through connectors, terminals, lugs and teeing-off connectors. Those occupied with overhead transmission problems will be specially interested in the leaflet.

Obituary.

The death is announced of Mr. Robert Robertson, commercial manager of the Clyde Valley Electrical Power Company.

The death is reported of Mr. James Phillips, of Tredegar, for many years the assistant chief electrician to the Tredegar Iron and Coal Company.

The death recently took place of Mr. Henry Geen, a former Mayor of Okehampton, who for many years carried on business as an electrical engineer.

The death took place on May 23 of Mr. Ernest Brown, who had for 16 years been on the staff of the Northampton Electric Light Company, and for the past eight years foreman of the wiring department.

We regret to announce the death of Mr. Allan Ramsay Connal, A.M.I.E.E., which took place on the 21st ult. Mr. Connal was the London manager and engineer of Messrs. Johnson & Phillips, and was an associate member of the Institution of Electrical Engineers, a member of the Batti Wallahs and of the Electro-Harmonic Society, &c. He was a prominent Mason, and he will be missed by a circle of friends.

We also regret to announce the death of Mr. P. D. Hollings, manager of the Accumulators of Woking, Ltd., at the early age of 35. Mr. Hollings was trained as a chemist, and rendered good service during the war, especially in connection with improved aircraft and gun devices. Being an excellent linguist, he went to Russia in 1913 to organise the works of Leitner's Electrical Company at Moscow, and in 1915 he was appointed superintendentt of rain-lighting on the Great Western Railway.

Miscellaneous.

Prof. Einstein will lecture (in German) at King's College, Strand, on June 9, at 5.15 p.m., on "The Development and Present Position of the Theory of Relativity."

The thanks of the University of Oxford have been given to the directors of Barclays Bank, Ltd., for their donation of £1 000 towards the completion of the Dyson Perrins Laboratory of Inorganic Chemistry.

At the Bath and West Show, on Durdham Downs, Bristol, from May 31 to June 4, Messrs. Jennings, Ltd., of Pennywell-road, Bristol, are represented at stands Nos. 314 and 315, where they show a variety of joinery and wood goods of interest to builders, with examples of fret-cut arches, brackets, wall-board, asbestos tiles, and electric casings, also picks, shovels, tools for all trades, &c. The speciality at the stand is Messrs. Jennings' 270-page illustrated catalogue of builders' joinery and wood goods, price 2/0, post free.

The ladies of the Ediswan Ponders End Staff organised and carried out an extremely successful outing on the 21st ult. A party of nearly a hundred left the works in three large charabancs for Ruislip Common, where various games, sports, &c., were indulged in until tea time. After tea the party continued their journey to Uxbridge, where a dinner was served at the Chequers Hotel under the chairmanship of Mr. J. W. Elliott. A short concert, organised by Mr. A. P. Ambler, followed, and on the motion of Mr. Elliott a hearty vote of thanks was passed to the Ladies' Organising Committee.

The airship R. 33 assisted in regulating the traffic to the Derby at Epsom on Wednesday. The result was also announced by wireless telephone from the airship, which hovered over the route from London to the Downs, and communicated information by wireless to a ground station in touch with the police. The result of the race was received on the airship by Col. L. F. Blandy, D.S.O., Controller of Communications (Air Ministry) from a Marconi motor-car wireless telephone, placed near the grand stand. The Marconi telephone operated on a wave length of 800 metres, and that of the R33 on 900 metres.

Messrs. Vickers-Petters, Ltd., have drawn our attention to the fact that the Vickers-Petters oil engine is now being made in sizes up to 450 h.p., and not up to 300 h.p. only, as stated in the article on this equipment which appeared in our issue of May 13. The Vickers-Petters engines usually work on cheap crude and residual oils, though they will work on paraffin and other refined oils if required. The electric starting device which we described is withdrawn entirely from the combustion chamber after starting, this being a special feature of the system, as the starter is thereby not liable to damage from excessive heat.

The Secretary for Mines (Mr. W. C. Bridgeman) has appointed the following to serve on the Advisory Committee for the Metalliferous Industry :—

Sir Cecil Butt (*chairman*), Brigadier-General G. M. Jackson, Mr. Myles Kennedy, Mr. S. J. Lloyd, and Mr. Claud Edward Pease (as representatives of owners of iron-ore mines and quarries) ; Mr. H. Dick, Mr. T. Gavan-Duffy, Mr. W. Lewney, and Mr. Will Sherwood (of the workers) ; Mr. R. Arthur Thomas (owners of tin mines) ; Mr. J. Harris (workers in tin mines) ; Mr. A. Wilson (owners of lead and zinc mines) ; Mr. J. Wignall, M.P. (workers in lead and zinc mines) ; Mr. Falcon, Mr. F. H. Hatch, Ph.D., O.B.E., and Mr. Frank Merricks, C.B.E. (mining engineers) ; Mr. Frank W. Harbord, C.B.E. (metallurgist) ; Mr. T. C. F. Hall, Prof. Henry Louis, D.Sc., and Dr. James M. Maclaren (economic geologists) ; Mr. J. J. Burton (iron and steel industry) ; and Sir Kenneth W. Goadby, K.B.E. (medical science). Mr. F. C. Starling, of the Mines Department, will act as secretary to the Committee.

Imports.—The following are official values of electrical machinery apparatus and material imported into this country (*a*) during April, 1921, and (*b*) the aggregate figures from Jan. 1 to April 30, with increase or decrease compared with corresponding periods of 1920 :—

Electrical machinery, (*a*) £52 157 (decrease £34 164), (*b*) £299 073 (decrease £43 051) ; telegraph and telephone cables, submarine (*a*) nil, (*b*) nil (decrease £50) ; other than submarine, (*a*) £10 605 (increase £10 035), (*b*) £38 344 (increase £36 140) ; telegraph and telephone apparatus, (*a*) £37 028 (increase £22 419), (*b*) £125 460 (increase £77 921) ; other electrical wires and cables, rubber insulated, (*a*) £2 853 (decrease £2 327), (*b*) £10 622 (increase £1 897) ; with other insulations, (*a*) £4 302 (increase £2 256), (*b*) £42 999 (increase £23 997) ; carbons, (*a*) £7 913 (increase £1 297), (*b*) £40 984 (decrease £3 394) ; glow lamps, (*a*) £38 049 (increase £36 082), (*b*) £100 723 (increase £89 942) ; arc lamps and electric searchlights, (*a*) £844 (decrease £296), (*b*) £56 635 (increase £3 155) ; parts of arc lamps and searchlights (other than carbons), (*a*) £899 (increase £177), (*b*) £6 052 (increase £1 058) ; batteries, (*a*) £9 680 (decrease £220), (*b*) £59 518 (increase £35 311) ; meters and measuring instruments, (*a*) £16 921 (increase £12 657), (*b*) £85 060 (increase £65 938) ; switchboards, (*a*) £106 (increase £89), (*b*) £1 276 (increase £303) ; electrical goods and apparatus unenumerated, (*a*) £81 803 (increase £25 258), (*b*) £379 617 (increase £205 393). Total of electrical machinery, apparatus and material, other than uninsulated wire, (*a*) £263 160 (increase £73 563), (*b*) £1 195 363 (increase £494 560).

Exports.—The exports of electrical machinery, apparatus and material, (*a*) during April, 1921, and (*b*) from Jan. 1 to April 30, with increase or decrease compared with corresponding periods of 1920, were as follows :—

Electrical machinery, (*a*) £422 757 (increase £239 272), (*b*) £1 677 568 (increase £1 037 040) ; including railway and tramway motors, (*a*) £27 421 (increase £25 387), (*b*) £82 576 (increase £73 045) ; other generators and motors, (*a*) £219 070 (increase £124 560), (*b*) 927 343 (increase £574 015), and electrical machinery unenumerated, (*a*) £77 266 (increase £89 322), (*b*) 667 649 (increase £389 980) ; telegraph and telephone cables, submarine, (*a*) £387 949 (increase £298 671), (*b*) £674 881 (increase £162 060); other than submarine, (*a*) £127 081 (increase £39 354), (*b*) £607 854 (increase £303 771) ; telegraph and telephone apparatus, (*a*) £130 680 (increase £50 230), (*b*) £576 321 (increase £193 134) ; other electrical wires and cables, rubber insulated, (*a*) £162 914 (increase £41 866), (*b*) £556 577 (increase £192 326) ; with other insulation, (*a*) £229 724 (increase £84 159), (*b*) £830 310 (increase £298 714) ; carbons, (*a*) £3 178 (decrease £8 024), (*b*) £43 636 (increase £1 3337) ; glow lamps, (*a*) £53 499 (increase £18 184), (*b*) £191 642 (increase £136 587) ; arc lamps and searchlights, (*a*) £11 146 (increase £768), (*b*) £3 976 (decrease £1 248); parts of arc lamps and searchlights (other than carbons), (*a*) £1 006 (decrease £370), (*b*) £3 023 (decrease £676) ; batteries, (*a*) £74 436 (increase £39 054), (*b*) £291 912 (increase £156 595) ; meters and measuring instruments, (*a*) £43 452 (increase £7 095), (*b*) £159 665 (increase £53 580) switchboards, (*a*) £22 507 (increase £16 957), (*b*) £68 567 (increase £39 381) ; electrical goods and apparatus unenumerated, (*a*) £198 537 (increase £70 636), (*b*) £902 162 (increase £434 405). Total of electrical machinery, apparatus and material, other than uninsulated wire, (*a*) £1 858 866 (increase £918 852), (*b*) £6 688 094 (increase £3 019 006).

Institution Notes.

The annual meeting of the Verband Deutscher Elektrotechniker is to be held in Essen from May 28 to June 2.

The Glasgow meeting of the Institution of Electrical Engineers has been cancelled owing to the coal crisis.

The Friday evening discourse at the Royal Institution on June 10 will be delivered by Dr. A. G. Webster on "Absolute Measurements of Sound." An extra discourse will be delivered on June 17 by Sir J. J. Thomson on "Chemical Combination and the Structure of the Molecule."

The Institution of Civil Engineers has presented to his Majesty in Council a petition for the grant of a supplemental charter, and this has now been referred to a Committee of the Privy Council. Petitions for or against the supplementary charter should be sent on or before June 30 to the Privy Council office.

The autumn meeting of the Iron & Steel Institute is to be held in France from September 5 to 10. An opening meeting will be held in the Hall of the Comité des Forges, Paris, where the Bessemer Medal will be formally presented to Mr. Ch. Fremont, and certain Papers will also be read and discussed. Subsequently the party will be grouped into three sections, Group 1 leaving for Lorraine and Luxemburg, Group 2 for Creusot, and Group 3 for Normandy, while visits to various places in the vicinity of Paris will also be made. All members will return to Paris on September 9, and to London on Saturday.

The following members have been nominated to serve on the Wireless Section Committee of the Institution of Electrical Engineers for 1921–1922 :—*Chairman :* Dr. G. W. O. Howe. *New Nominations for membership of the Committee :* Mr. B. Binyon, O.B.E., Dr. W. H. Eccles, Mr. G. H. Nash, C.B.E., and Mr. C. C. Paterson, O.B.E. The following will continue to serve as members of the Committee : Sir Charles Bright, F.R.S.E., Mr. R. C. Clinker, Prof. C. L. Fortescue, Mr. A. Gray, Admiral of the Fleet Sir H. B. Jackson, G.C.B., Capt. H. J. Round, M.C., Mr. A. A. C. Swinton, F.R.S., and Mr. L. B. Turner. Not later than 14 days after the publication of the Committee's list of nominations, any five members of the Wireless Section may nominate any other duly qualified person to fill any vacancy by delivering such nomination in writing to the Secretary of the Institution, together with the written consent of such person to accept office if elected, but each such nominator shall be debarred from nominating any other person for the same election.

Business Items, &c.

The Midland Supply Company have removed to 53, Summer-row, Birmingham, where future correspondence should be addressed.

The address of the Mackenzie, Holland & Westinghouse Power Signal Company, Ltd., is 82, York-road, King's Cross, London, N.1. Telephone : North 2415-7.

The London Shafting and Pulley Company has removed to Northdown Works, Northdown-street, King's Cross, London, N.1. Telephone : North 196.

Norman Warwick and Alfred Walker, trading as Warwick & Walker, electricial engineers, 107, Church-street, Birkenhead, have dissolved partnership. Debts by Mr. Walker.

Messrs. E. H. Bissell & Company, Ltd., agents for a French firm of manufacturers of moulded parts for the electrical trade, are making an interesting display of their products at the French Chamber of Commerce of London, 153, Queen Victoria-street, E.C.4.

Mr. W. J. Mathews, 74, Greenway-avenue, Taunton, lately sales manager of Messrs. Newtons, Ltd., has been appointed sole agent of the Electric Construction Company, Ltd . for the South-West of England. Inquiries for electrical machinery (both d.c. and a.c.) and for switchgear, sent direct to the Company's Wolverhampton's works, or to Mr. Mathews, will receive immediate attention.

Messrs. Malcolm & Allan, Ltd., electric power and lighting contractors, of London, Glasgow and Edinburgh, notify us that their London manager, Mr. H. S. Davidson, has left their service, and Mr. H. Francis Smith is now their London technical manager. Mr. Smith was in the employ of Messrs. J. G. White & Company for many years in South America. Mr. H. S. Butler will continue as manager of their commercial branch.

Tenders Invited and Accepted.

Hackney (London) Guardians want tenders by June 11 for the supply of a petrol or electric ambulance. Quotations to the Clerk, 2, Sidney-road, Homerton, E. 9.

West Ham Guardians want tenders by June 16 for three months' supply of electrical fittings, engineers' oils, &c. Forms of tender from the Clerk, Union-road, Leytonstone, E. 11.

Manchester Electricity Committee want tenders by June 17 for 12 months' supply and erection of static transformers. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Dundee Corporation invite tenders for a motor-generator consisting of a 400-V d.c. motor, and a generator to give 75 V 130 A at 800 revs. per min., with starter and regulator. Tenders to the City Architect, 81, Commercial-street, Dundee, by June 6.

The Metropolitan Water Board wants tenders by June 11 for the supply of stores, including electric lamps, wires and accessories, iron pipes, castings, metals, oils, &c. Forms of tender from the Chief Engineer, 173, Rosebery-avenue, E.C.

The directors of the Liverpool Overhead Railway require tenders by June 6 for 12 months' supply of electrical fittings, insulating tapes, rubber material, ironmongery, oils and grease, &c. Forms of tender can be obtained at 31, James-street, Liverpool.

Tenders are invited up to July 11 for the supply to the Postmaster-General's Department, State of Tasmania, of switchboard material (Schedule T.317). Specifications from the Office of the High Commissioner for Australia, Room E.5, Australia House, Strand, W.C.2.

The Borough Council of King William's Town (S. Africa) invites tenders for steam-driven electrical generating machinery, boilers, switchgear and cable. Specifications from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C.2, to whom tenders by June 25.

The Uruguayan Ministry of Public Works invite tenders for three electric gantry cranes and a "Temperley"-type aerial transporter for the port of Paysandu. Tenders (in Spanish) by June 28. A translation of the specification may be seen at the Department of Overseas Trade.

It is notified that the date on which all tenders for the supply of plant and material for the electrification of the Cape Town-Simonstown & Durban-Pietermaritzburg Railway lines has been extended to noon, July 5. Tenders to the High Commissioner for the Union of South Africa, Trafalgar-square, London, W.C.

Llandaff & Dinas Powis Rural District Council invite tenders for the supply and laying of e.-h.-t. feeder, with switchgear, sub-station equipment, complete system of feeders and distributing cables, with services, for about 800 houses. Specifications, &c., from the engineer, Mr. R. Howard Fletcher, B.A., M.I.E.E., 20-22, Queen-street, Cardiff, and tenders to the clerk, Mr. M. Warren, Park House, Cardiff, by June 22.

The Wairoa (N.Z.) Electric Power Board invite tenders for the supply of material for an 11 000/3 300 V 600 kW outdoor sub-station, including four 200 kVA transformers (11 000/1 900V), insulators, air-break switches fuses, lightning arresters and choke coils, accessories, &c. Tenders (by July 31) to Messrs. Hay & Vickerman, Wellington, N.Z. Specifications may be inspected at the Department of Overseas Trade.

The New Zealand Public Works Department invite tenders for the supply and delivery at Lyttelton of two 50-kVA, two 100-kVA and two 200-kVA condensers, in connection with the Lake Coleridge electric power supply scheme (Section 116); and also for 10 single-phase oil transformers for the Waikato power scheme for converting three-phase current at 50 cycles, the voltage ratio being 50 000/11 000. Tenders by June 28 to the Secretary of Public Works, Tenders Board, Wellington.

New Zealand public works department also invite tenders for suspension type porcelain insulators to carry 110 000 V 50-cycle transmission lines in connection with the Waikato power scheme. Tenders by August 9 to the Secretary, Public Works Tenders Board, Wellington. Specifications may be seen at the Department of Overseas Trade.

Tenders are invited for the supply of the following plant and material for the Municipality of Bulawayo (Rhodesia):—(a) two sets of gas-producing plant, (b) gas engines, (c) 3, with alternative of 4, three-phase 300-kW generators, (c′) alternative steam plant, (d) main switchboard, (e) switchgear distribution and transformer houses, (f) poles and cross-arms, (g) insulators and shackles, (h) h.-d. copper wire, (j) three-core cable, (k) insulated cable, (l) lighting arresters and choke coils, (m) transformers, (n) bus-bar copper, insulators and Crosby clips, (p) stay rods, stay wires and swivels. Specifications from Messrs. Davis & Soper, 54, St. Mary Axe, London, E.C. 3, to whom tenders by Aug. 3.

Barnsley Corporation has accepted the tender of the Western Electric Company (at £5 821) for the extension of mains in Huddersfield-road.

For the supply of cable Bradford Electricity Committee has accepted the tender of Callender's Cable & Construction Company at £3 481.

Bethnal Green (London) Borough Council has placed a contract for the supply of cable with the British Insulated & Helsby Cables, Ltd, at £7 102 12s.

Callender's Cable & Construction Company has secured the Lowestoft Corporation contract for the supply of feeder cables and joint boxes at £3 509.

Bedford Corporation has accepted the following tenders: Babcock & Wilcox, pipework, £4 525; British Thomson-Houston Company, e.h.t. switchgear, £5 282; Bedford Engineering Company, jib crane, £2 086 10s.

Patent Record.

◆

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

135 486 Pintsch, Akt.-Ges J. Electric gas lamps with glow discharge. (6/11/19 Patent of Addition not granted.)

137 324 Odion & Cayrol. Electric battery. (25/4/14.)

137 326 Bultemann. Process for the manufacture of an electric insulating material (29/1/19.)

137 526 Armstrong. Electrically-heated cooking device. (27/6/16.)

138 366 Goldschmidt. Excitation of oscillating circuits. (18/11/13.)

140 745 Colner Elektromotorenfabrik. (J. Bruncken.) Induction motors. (25/9/18. Addition to 136 156.)

142 451 Industrial Research Corporation. Controlling mechanism for electric circuits. (28/4/20.)

143 842 Automatic Telephone Manufacturing Co., Ltd. Telephone systems (28/5/19.)

144 611 Automatic Telephone Manufacturing Co., Ltd. Battery charging systems. (11/6/19.)

145 022 Ateliers de Constructions Electriques du Nord et de l'Est. Arrangements for the coupling of two alternating-current electric systems in parallel. (22/1/14.)

Comprises a pair of alternating-current generating networks coupled in parallel, and a series commutating generator placed in series with the feeding cables between said generating systems and adapted to compensate for the impedance of the said cables.

145 072 Siemens-Schuckertwerke Ges. Suppression of sparking at the interruption of conductors, traversed by current. (29/7/19.)

145 775 Soc. Anon. des Établissements L. Bleriot. Regulating means for electric machines. (20/2/19.) Addition to 130 575.

146 302 Krupp Akt.-Ges. Continuous-current gyroscope motor. (18/11/15.)

147 485 Zeiss (Firm of). Electric current interrupters. (28/5/18.)

147 801 Soc. Francaise Radio-Electrique. Electric transformers or self-induction coils. (20/5/15.)

149 673 Krupp, Akt.-Ges. F. Electric magnetic overload cut-outs. (7/8/19.)

151 353 Green. Suspending means for electric light fittings. (26/1/20.)

152 609 Muller. Arrangement and construction of sparking-plugs for internal-combustion engines. (16/10/19.)

155 783 Pintsch Akt.-Ges. J. Electric lamps operating with luminous discharge (12/12/17.)

161 208 White & Davenport & Co. Electrical ignition means for internal combustion engines. (3/11/19.)

161 211 Malatesta. Glow or incandescent electric lamps. (4/11/19.)

161 212 Bourne & Darge. Methods and means for covering metal cores in the manufacture of electrodes. (4/11/19.)

161 241 Hockly. Telephone receivers, transmitters and other electric or magnetic acoustic or vibratory apparatus. (29/12/19.)

161 245 Ranklin & Van Raden & Co. Electric generators and motors. (31/12/19.)

161 256 B.T.-H. Co. (G.E. Co.) Signalling systems applicable to wireless receiving systems and other purposes. (2/1/20.)

Current of audible frequency is impressed upon the grid circuit of two electron discharge relays, and a receiving device is so associated with the plate circuits of the two relays that normally no current of audible frequency flows in the receiving device, but when current from a source of signalling current of an inaudible frequency is impressed upon the grid circuit of the two relays the currents of audible frequency in the plate circuits are varied differently, and current of audible frequency thereby caused to flow in the receiving device.

161 263 Coan. Electric and like kettles. (3/1/20.)

161 266 Radio Communication Co. Ltd. & Binyon. Electric oscillation arcs. (3/1/20.)

161 277 Fenny. (Magnovox Co.) Telephone transmitters. (6/1/20.)

161 283 Automatic Telephone Mfg. Co., Smith & Savin. (Partly communicated by Automatic Electric Co.) Dial switches as used in automatic telephone or like systems. (7/1/20.)

161 295 Ward. Generation of electricity by means of the rise and fall of tides. (8/10/20.)

161 297 Automatic Telephone Mfg. Co. & Remington. Mine signalling or like systems in which the main signals are given by a number of impulses transmitted in succession. (9/1/20.)

161 313 Siemens Bros. Dynamo Works & Crowley. Electric motor driving arrangements. (15/1/20.)

161 404 Saunders Electrical Co. & Saunders. Electrical accumulators. (26/2/20.)

161 448 Grenfell, Murray, Erskine, Robinson & Crowther. Radio navigational systems. (23/4/20.)

Relates to a wireless transmitter in which the orientation of the directional radiation is varied uniformly at a given frequency, and in which the transmission is controlled by varying the energy of transmission or by interrupting the transmission uniformly at a different given frequency not a whole multiple or divisor of the first frequency.

161 449 Robinson & Crowther. Electromagnetic wave-receiving systems. (23/4/20.)

Comprises wireless apparatus adapted with two angularly disposed rotatable direction-finding coils or aerials, and with a low-frequency alternator or oscillating valve which acts between the grids of two rectifying valves connected to the coils or aerials so that signals are received from one valve circuit during one-half of the low-frequency oscillation, and from the second valve circuit during the other half of the low-frequency oscillation.

161 497 Prentice. Electric distribution or fuse boards and the like. (17/8/20.)

161 990 Lambert. Track contact stud-boxes for electric railways. (27/10/16.)

162 012 Roddis. Electric heat producing element and applications thereof to apparatus or articles. (5/11/19. Cognate Application 31 711/19.)

162 015 Chamberlain & Hookham, Ltd., & James. Electricity meters. (20/11/19.)

162 019 Benson & Callenders Cable & Construction Co., Ltd. Devices for electrically measuring the lengths of electric cables. (3/12/19.)

162 039 Imray. (Bosch Akt.-Ges. R.) Rotating interrupting devices for high-speed sparking apparatus. (15/1/20.)

162 042 Coles, Cowper-. Machine for the automatic and continuous production of seamless boxes, lamp sockets and other articles by electrolysis. (16/1/20.)

162 059 Reyolle & Co., Ltd. (Staveren J. C. van). Protective arrangements for electric distribution systems. (20/1/20.)

162 061 Higginson & Carey-Gavey Syndicate Ltd. Electrical step-by-step devices for indicating and other purposes. (20/1/20.)

162 067 Eccles & Vincent. Wireless telegraphy and telephony. (21/1/20.)

162 068 Tucker. Device or apparatus for testing the sparking plugs of internal combustion engines. (21/1/20.)

162 086 Foster. Electric switch of the tumbler type. (26/1/20.)

162 088 Cheshire & Summerhayes. Electrically-heated irons. (26/1/20.)

162 093 The British Thomson-Houston Co., Ltd. (General Electric Co.) Electric protective devices. (27/1/20.)

162 097 Hoghton & Portholm Aircraft Co., Ltd. Wireless telegraphy and telephony. (28/1/20.)

Consists in connecting the primary coupling coil of a regenerative transformer as a shunt to the oscillatorycircuit, and in series with the grid of the valve and connecting the secondary coupling coil of the regenerative transformer in series with the sheath and the source of high potential, whereby a wider range of wave lengths can be covered and spark or continuous waves received over this range without altering the self-inductance of the primary or secondary of the regenerative transformer, and whereby the self-heterodyne condition can be maintained without difficulty on the shorter values of wave length.

162 286 Small & Smith. Transmission gearing for electric motors. (14/1/20.)

APPLICATIONS FOR PATENTS.

November 30, 1920.

33 849 Erskine-Murray & Robinson. Determining direction of electro-magnetic waves.
33 853 Wade. (Mills.) Wireless signalling.

December 1, 1920.

33 874 Woodburn. Electric resistance welding.
33 897 Callender. Electric light fittings.
33 903 Turnock. Fuses for electric circuits.
33 933 Automatic Telephone Mfg. Co. Telephone systems. (3/12/19, U.S.)
33 941 Holden. Electric soldering irons.
33 942 B. T.-H. Co. Methods of protecting transformers.
33 951 McKenzie Holland & Westinghouse Power Signal Co. (Cie Generale de Signalisation.) Electric controlled signal mechanism.
33 953 Shaw. Incandescent lamps, &c.
33 955 Brydon. Employment of retroactively-coupled thermionic tubes, &c.
33 965 Metropolitan-Vickers Electrical Co. Transformers.
33 994 Damey. Switches.
34 017 Whiddington. Wireless direction finding apparatus.

December 2, 1920.

34 022 Beswick & Gaskell. Electric signal system.
34 028 Lilliecrop. Electric torch, &c
34 033 Bull. Ceiling rose and connector box.
34 040 Kohn. Speed regulation of induction motors. (20/12/19, Germany.)
34 041 Automatic Telephone Mfg. Co. Relays.
34 042 Automatic Telephone Mfg. Co. & Roseby. Telephone systems.
34 092 Boswell Electric lighting systems for motor cycles, &c.
34 105 Siemens-Schuckertwerke. Protective apparatus for ring mains, &c. (2/12/19, Germany.)
34 108 Ellis. Incandescent lamps.
34 117 Metropolitan-Vickers Electrical Co. Electrolytes. (9/12/19, U.S.)
34 126 B. T.-H. Co. (G. E. Co.) Manufacture of carbon.
34 129 Silica Synd. & Reynolds. Thermionic valves.
34 146 Etablissements S.I.C.C.A. & Bordeau. Electric ignition. (6/1/20, France.)

December 3, 1920.

34 157 Gath. Means for locking switch plugs.
34 158 Worrall. Electric radiation.
34 169 Bosch (R.) Akt. Ges. Magneto-electric ignition machines. (3/12/19, Germany.)
34 179 Sutherland. Recording telephone calls, &c.
34 201 Gunstone. Induction coil systems.
34 208 Hall (J) & Co. & Ostins. Switches.
34 218 B. T.-H. Co. (G. E. Co.) Switches.
34 236 Soc. Française Radio-Electrique. Regulating frequency of alternating currents. (6/12/19, France.)
34 238 Automatic & Electric Furnaces, Ltd., & Coleman. Electric heating element.
34 250 Wincousin Electric Co. Rheostats. (25/10/15, U.S.)
34 260 Merz & McLennan & Weeks. Large-scale power production.
34 261 Merz & McLennan & Weeks. Production of steam for carbonisation plant for large-scale power production.
34 265 Wickett. Electric treatment of ferrous metals during casting.

December 4, 1920.

34 276 Xardell. Electric heaters. (13/4/20, U.S.)
34 301 Amberton. Time lag devices.
34 315 Scott-Taggart. Relay devices, &c.
34 316 Scott-Taggart. Radio signalling systems.

December 6, 1920.

34 366 Adamson. Fuses for electric circuits.
34 400 Anderson. Electric lamp-holder.
34 408 Donnithorne. Interrupters for induction coils, &c.
34 409 Donnithorne. Electric switch.
34 411 Hearn. Electric heating apparatus.
34 447 Jobl. Electric machinery.
34 469 Morris-Airey, Preston, Shearing & Fortescue. Generation of continuous waves for wireless telegraphy, &c.

December 7, 1920.

34 493 Turnock. Switch contacts.
34 506 Cohen & Mauborgne. Radio apparatus.
34 522 Hoffmann. Electric pocket lamps. (4/11/19, Germany.)
34 523 Hinton. High and low-frequency shunt circuits, &c.
34 537 Byrne. Electrical apparatus.
34 543 B.T.-H. Co. (G.E. Co.) Electric light fittings.
34 554 Macdonagh. Heating or resistance elements.
34 560 Oesterreichische Siemens-Schuckertwerke. Controlling alternating-current motors. (29/1/16, Austria.)
34 574 Maschinenfabrik Oerlikon. Distant control of regulating devices of electric vehicles. (30/12/19, Switzerland.)
34 602 Bryan & Tatham. Dynamos and motors.

December 8, 1920.

34 651 Lancashire Dynamo & Motor Co. Apparatus for changing velocity, ratio, &c., of rotatable parts.
34 655 Electric Heating & Hardware, Ltd., & Wineberg. Electric ovens.
34 677 Reyrolle & Co. & Linslow. Switches.
34 726 B.T.-H. Co. (G.E. Co.) Regulating systems for electric circuits.
34 738 Strohmenger. Welding electrodes.

December 9, 1920.

34 768 Hope. Electric lamp-holders and shade carriers.
34 784 Jones. Plug switches, &c.
34 787 Whiting. Generation of electricity for ships, &c.
34 804 B.T.-H. Co. (G.E. Co.) Motor control.
34 809 Automatic Telephone Mfg. Co. Telephone systems. (20/12/19, U.S.)
34 829 Richard. Electric horn switches.

December 10, 1920.

34 868 Baron. Cut-outs.
34 883 Belleand & Barrolier. Mercury electric lamp. (14/8/20, France.)
34 895 Elverson. Terminals for high-tension cables.
34 903 Kaisser. Mercury switches for electrical apparatus. (15/12/19, Germany.)
34 905 Fabriques des Montres Zenith. Magnetos. (26/4/20, Switzerland.)
34 918 Nobbs. Electric heating apparatus.

December 11, 1920.

34 953 Pirelli General Cable Works & Martinez. Fixing ends of strands of cables.

December 13, 1920.

35 019 Bill. Fuse-boards.
35 026 Foster & Grocott. Ceiling rose.
35 027 Lancashire Dynamo & Motor Co. Changing velocity ratio of two rotatable parts, &c.
35 036 Davis. Electrical connectors.
35 047 Donovan. Automatic electric switch.
35 066 Brown, Boveri et Cie (A. G.). Apparatus for measuring temperature of winding in electric machines, &c. (12/12/19, Switzerland.)
35 084 Gurney. Electric lamp sockets and switch devices.
35 086 Sayers. Electric machines.

December 14, 1920.

35 109 & 35 110 Tritsch. Electric-signalling lamps.
35 111 Joyner & Butler. Electric heaters.
35 156 Main. Operating guides and trolley pole-wheels for tramcars, &c.
35 175 Antinoro. Safety fuses.
35 188 Bobat (J.) et Fils. Electric winch.

Companies' Reports, &c.

The total receipts of the Havana Electric Railway, Light & Power Company, Ltd., for 1920, were $11 477 937, and the net profit was $4 108 516. A dividend of 6 per cent. was paid on the Common shares, a sum of $1 222 987 added to depreciation, and $3 629 898 carried forward.

The receipts of the Rothesay Tramways Company, Ltd., for the past year amounted to £21 345, and with £1 692 brought forward, the available total was £5 562. The directors recommend placing £1 000 to reserve and a dividend of 3 per cent. on the ordinary shares for year, carrying forward £1 609.

The directors of the North Melbourne Electric Tramways & Lighting Company, Ltd., announce that in consequence of the strikes in Australia and the increased cost of fuel, materials and wages, the company will not be in a position to pay the interest due on 1st inst. on the five per cent. debentures.

The 1920 accounts of the Aster Engineering Company, Ltd., show an available balance (with amount brought forward) of £57 165. After providing for depreciation, a dividend of 7½ per cent. has been paid on the ordinary shares, and £40 573 carried forward, subject to excess profits duty and corporation tax.

The directors of the India Rubber, Gutta Percha & Telegraph Works Company, Ltd., regret to report that owing to the coal strike it was found necessary to close works at Silvertown on April 22, and there is at present no indication when normal work can be resumed. Under the circumstances they cannot recommend payment of an interim dividend on the ordinary shares.

The directors of the Electric Construction Company, Ltd., recommend a final dividend at the rate of 7 per cent. per annum on the preference shares, and a final dividend at the rate of 9 per cent. per annum on the ordinary shares, making 7½ per cent. for the year, and also a bonus of 2½ per cent. on the ordinay shares, all less tax.

After providing for debenture and other interest, the accounts o the La Plata Electric Tramways Company, Ltd., for the year 1920 show a profit of £6 879, which, added to the amount of £10 652 brought forward, and after allocating £3 000 to reserve, leaves a balance of £14 531 to be carried forward, subject to corporation profits tax.

For the year 1920 the accounts of Kalgoorlie Electric Power & Lighting Corporation, Ltd., show a profit of £10 708, compared with £5 452 for 1919. After providing for debenture interest and £9 500 for depreciation, there remains to be carried forward a balance of £108. Debentures amounting to £7 500 were paid off during the year, leaving only £7 500 outstanding.

The directors of the Oriental Telephone & Electric Company, Ltd., recommend (subject to audit) payment of the following final dividends for the year 1920 :—3 per cent. on the preference shares (less tax), making a total of 6 per cent. for the year ; 6 per cent. on the ordinary shares, making a total of 10 per cent. for the year; and a bonus of 2 per cent. on the ordinary shares (all tax free).

At the meeting of the City of Santos Improvements Company, Ltd., on Monday, the chairman (Mr. E. Henderson) said that the revenue of the company's tramways showed further expansion, and there was a satisfactory increase in the number of passengers carried during the past year, the total being nearly 23 000 000. Further rolling stock would have to be provided in the near future to meet the growing traffic. The extremely moderate charges made for public lighting had encouraged the municipality to authorise extensions of the system and increased illumination.

The directors' report of the Direct Spanish Telegraph Company, Ltd., for the year ended Dec. 31 last, states that after including the balance from 1919, and paying income tax and excess profits duty for the year 1919, there is a balance of £46 638, which the directors propose to apportion as follows : Dividend on preference shares at 10 per cent. per annum (£3 000), dividend on ordinary shares at 10 per cent. per annum (£6 465 10s.), further provision on account of investment fluctuations (£7 000), transfer to reserve fund (£5 000), leaving to be carried forward, subject to excess profits duty and Corporation profits tax, £25 173. As on former occasions the dividend on the ordinary shares is paid tax free. The Company's cables have worked well during the year, and duplex working on the Bilbao cable has been installed with satisfactory results.

The gross earnings of the the Shawinigan Water & Power Company for 1920 were $3 943 359 ; the operating expenses amounted to $228 467, power purchased to $643 119, maintenance and repairs $187 687, taxes and insurance $118 117, general expenses $122 705, and water storage rentals $117 719, leaving $2 525 543. Interest on 5 per cent. consolidated mortgage bonds absorbed $250 000, on the 5½ per cent. first refunding mortgage sinking fund gold bonds $306 131, on the 7½ per cent. six-year gold notes $148 726, and general interest $11 642. A sum of $200 000 was transferred to depreciation reserve, leaving net revenue $1 609 043, plus balance from 1919 ($30 550), making $1 639 593, less dividends for year, $1 400 000. Transferred to reserve and sinking fund $50 000, to fire insurance reserve $20 000, to pension fund $5 000, to reserve for taxes $125 000, leaving surplus $39 593. The dividend of 1¾ per cent. on the common stock for the quarter ending June 30 is payable on June 27.

The gross receipts of the Anglo-Argentine Tramways Company, Ltd., for the year 1920 were £4 413 165, and the expenditure amounted to £3 198 028. Adding interest on investments and deposits, &c.

£44 513), and deducting the annuity to City of Buenos Ayres Tramways Company (£70 660), interest and sinking funds on debenture stocks (£587 821), and the sinking fund for redemption of preference and ordinary shares (£7 295), and also taking into account the amount brought forward (£175 510), the total is £769 385. The following distributions were paid during the year in satisfaction of all the arrears and current dividends on the 5½ per cent. first preference shares: In July, dividend for year to June 30, 1918 (£176 000); in October, dividend for year to June, 1919 (£176 000); and in December last, dividend for 18 months to Dec. 31, 1920 (£264 000). The directors now recommend payment of a dividend of 5½ per cent. on the second preference shares in satisfaction of arrears to Dec. 31, 1916 (£137 500), leaving to be carried forward £15 883.

The sum of £133 172 has been allocated out of revenue to general renewals fund, against £97 000 in 1919. The number of miles open for traffic was 395½, the actual mileage run during the year being 61 303 692, and the number of passengers carried 432 636 355. The traffic receipts received the benefit of revised fares from April, 1920, and show an increase of £886 981, or 28·36 per cent. The working expenses were 75·60 per cent., compared with 79·91 per cent. in 1919, traction expenses being £52 970 lower than in 1919, due to decrease in cost of fuel.

New Companies.

The following list is compiled from information supplied by Messrs Jordan & Sons, Ltd., company registration agents, Chancery-lane London, W.C.2 :—

AUTO SPECIALISTS, LTD. (174 823).—Reg. May 23. Capital £2 000 in £1 shares, to carry on business of motor and general engineers and electricians. Reg. office: 13, Gerrard-street, Shaftesbury-avenue, W. Private company.

AYLESBURY MOTOR COMPANY, LTD. (174 646).—Reg. May 11. Capital £6 000 in £1 shares, to acquire and carry on business of motor, electrical and general engineers. Directors: W. H. Perry, Ellen F. C. Perry and R. R. Gordon-Barrett. Reg. office: 48 and 50, Kingsbury-square, Aylesbury, Bucks. Private company.

BELL & SORSBY, LTD. (174 694).—Reg. May 13. Capital £2 000 in £1 shares, to acquire and carry on business of engineers. Directors: E. G. Bell, C. M. Sorsby, T. Addy and A. Etherington. Private company.

BRITISH SCOTT TELECATOR COMPANY, LTD. (174 725).—Reg. May 17. Capital £25 000 in 22 500 £1 preference and 50 000 1s. ordinary, to acquire invention in relation to Telecator for locating defects in working of internal combustion engines. Directors: W. T. Parez and A. J. Barber. Reg. office: 16, Eldon-street, E.C. 2. Private company.

CARNATION MOTORS, LTD. (174 826).—Reg. May 23. Capital £1 000 in £1 shares, to carry on business of garage proprietors and automobile and electrical engineers. Director: A. W. Jessop. Reg. office: 91, Langsett-road, Sheffield. Private company.

COMBINATION METALLIC PACKING COMPANY (1921), LTD. (174 648).—Capital £5 000 in £1 shares, to acquire and carry on business of packing manufacturers and dealers in metallic and other packing. Directors: W. Matteson, W. M. Brown and G. H. Mackrow. Reg. office: Hillgate, Gateshead. Private company.

GEORGE RADCLIFFE & COMPANY, LTD. (174 754).—Reg. May 18. Capital £800 in 750 £1 preference and 50 £1 ordinary shares, to carry on business of plumbers, gasfitters, electricians and sanitary engineers. Directors: Florence K. Radcliffe and Stanley Radcliffe. Reg. office: 131, Holton-road, Barry Dock, Glam. Private company.

H. J. HARDING, LTD. (174 831).—Reg. May 23. Capital £8 000 in £1 shares, to carry on business of motor, electrical and general engineers. Directors: H. J. Harding, F. W. Douds and J. R. Smith. Reg. office: Low-road, Sunderland. Private company.

JAMES ATKINSON & SONS (BLACKBURN), LTD. (174 758).—Reg. May 18. Capital £3 000 in £1 shares, to carry on business of mechanical engineers. Reg. office: 23, Dickinson-street, Blackburn. Private company.

LACY-HULBERT & COMPANY (1921), LTD. (174 812).—Reg. May 20. Capital £4 000 in £1 shares, to carry on business of pneumatic and general mechanical and electrical engineers. Directors: C. E. L. Lacy-Hulbert, A. G. London, and D. G. Halstead. Reg. office: Boreas Works, Beddington, Croydon, Surrey. Private company.

Forty Years Ago.

("The Electrician," June 4, 1881).

Electric Light in Glasgow.—The Brush light was recently introduced into a large retail warehouse in this city.

The City & Guilds Institute.—The Prince of Wales has accepted the presidency of this Society, and has promised to lay the foundation stone of the Central Institution at South Kensington.

Royal United Service Institution.—The *Journal* of this Institution (No. CIX., 1881) contains, amongst other Papers, that read by Mr. R. E. Crompton, "On the Progress of the Electric Light," in January last, with the discussion thereon.

Gas v. Electricity.—At the quarterly meeting of the Manchester District Institution of Gas Engineers, held at Buxton, on Saturday, the 28th of May, the president, in the course of some remarks, said that "he, as one having some experience in electric lighting, could say that it was only by the use of the most modern improvements in gas-making machinery that they could compete with the electric light."

Benn Brothers Journals.

Some Features of the Current Issues.

"Aeronautics": "Disposal of Airships"; "Terms of Government Offer"; and "Detroit Air Meeting Regulations."

"The Cabinet Maker": "The Decoration of Furniture"; "Practical Polishing"; and "Painted Chairs in the Seventeenth Century."

"Chemical Age": "Chemical Engineering Group: Annual Meeting, Dinner and Presidential Address in London"; "Colloidal Clay and the Hydrolysis of Oils and Fats (II.), by F. E. Weston, B.Sc., F.I.C."

"Farm & Home": "Successful Farming: Special Course of Agricultural Education"; "Bristol and Bath and West Show"; and "The Rules of Good Husbandry."

"The Fruit-Grower": "Apple Culture Problems: Biennial Fruiting" "Control of Onion Smut"; and "The Railways Bill."

"The Gas World": "Pyrometry in Industry"; "Reinforced Concrete Construction"; and "Sulphur in Coal."

"Hardware Trade Journal": "The Manufacture of Hollow-Ware (II.)"; "India's Demand for Hardware"; and "The R.M.T.P.S. Anniversary Festival."

Arrangements for the Week.

WEDNESDAY, June 8th.

Institution of Electrical Engineers—Wireless Section.

6 p.m. At Savoy-place, Victoria Embankment, London, W.C. Paper on "Electric Oscillations along Straight Wires and Solenoids," by Prof. J. S. Townsend, F.R.S.

THURSDAY, June 9th.

Optical Society.

7.30 p.m. At the Imperial College of Science, South Kensington, London, S.W. Paper on "Achromatism," by Mr. Horace Lee, B.A., and demonstration of Universal Measuring Machine of the Société Genevoise.

FRIDAY, June 10th.

Physical Society.

5 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Lecture on "Stability of Atoms," by Sir Ernest Rutherford, F.R.S.

Royal Institution.

9 p.m. At Albemarle-street, Piccadilly, London, W. Discourse on "Absolute Measurements of Sound," by Dr. A. G. Webster, Ll.D.

Prices of Metals, Chemicals, &c.

Tuesday, May 31

		Price.	Inc.	Dec.
Copper—				
Best selected	per ton	£74 0 0	—	£1 15 0
Electro Wirebars	,,	£77 0 0	—	—
H.C. wire, basis	per lb.	0s. 11¾d.	—	—
Sheet	,,	1s. 0½d.	—	—
Phosphor Bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. 3¾d.	—	—
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1¼d.	¼d.	—
Wire, basis	,,	1s. 1¼d.	¼d.	—
Pig Iron—				
Cleveland Warrants	per ton	£6 10 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£27 0 0	—	—
Lead Pig—				
English	,,	£24 0 0	—	£1 10 0
Foreign or Colonial	,,	£22 10 0	—	£1 17 6
Tin—				
Ingot	,,	£173 15 0	—	£10 10 0
Wire, basis	per lb.	2s. 4⅝d.	—	1⅜d.

Salammoniac.—Per cwt. 75s.-70s.
Sulphur (Flowers).—Ton £14 10s.
,, (Roll-Brimstone).—Per ton £14 0s.
Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £31.
Boric Acid (Crystals).—Per ton £69.
Sodium Bichromate.—Per lb. 7½d.
Sodium Chlorate.—Per lb. 4¼d.

Rubber.—Para fine, 10½d.; plantation 1st latex, 8½d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Company, Ltd.

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Notes.

Problems of Wireless Transmission.

FROM the practical or operating wireless engineer's point of view the discussion which recently took place before the Wireless Section of the Institution of Electrical Engineers was disappointing. Mr. C. F. ELWELL in his opening remarks postulated that to provide a radiotelegraphic service over a distance of several thousands of miles, the value of the energy which would be required at the receiving end to operate satisfactorily the receiving devices must first be decided upon. Obviously the value selected in accordance with this rule must be obtainable under the worst operating conditions. Mr. ELWELL went on to point out that large discrepancies existed in the results given by various formulæ now in use, and suggested as subjects for debate mathematical treatment, alternative methods of measurement of received field strength, methods of determination of the field strength necessary to ensure a reliable service, and ways and means of obtaining and co-ordinating data from actual measurements. The subject is, it is obvious, an intensely practical one, and it is therefore unfortunate that the majority of the speakers with the notable exception of those representing the Marconi Company allowed themselves to be drawn into the fascinating by-ways of theory, and to discant on matters upon which it will be difficult to build practical results.

A Matter of Experiment.

THIS matter, in our view, is mainly one for experiment. Such experiments should not be impossible to carry out. In fact in the course of the discussion Messrs. ECKERSLEY and LUNNON showed that they had been carried out, and their work should be largely extended. For with the perfection of transmitting apparatus of various kinds, notably the arc, the employment of higher aerial structures, and with the use of the valve for reception, we now possess reliable means of transmitting large amounts and detecting very small amounts of power by ether radiation. But there are at least two vital things which we do not know—how much energy is necessary at a given spot to give good readable signals with modern receiving gear over a whole year, and what the value of the factor given by the height of aerial multiplied by the kilowatts must be at the transmitting end to give this received energy. The true and full solution of this question can only be obtained by the aid of a large number of workers and for this reason we incline to the idea of employing the assistance of the numerous amateurs who are now interested in wireless matters in the same way as is already successfully done by the Meteorological Office. Certain speakers during the discussion cast doubts on the efficiency of such an arrangement, but we think that with a little organisation these could be overcome without difficulty. We hope that before long further discussion on this matter will take place and that it will then be directed to more practical matters.

Progress of Electrical Research.

FROM the quarterly report of the British Electrical & Allied Industries Research Association, a summary of which we give in another column, it will be seen that the Council of the Association is engaged on a comprehensive programme of research. Much useful preliminary work has been carried out and a still wider scheme of activities is to be undertaken. Tests and experiments have been carried out on various insulating materials, including mica and micanite, transformer oils and oil switches. In regard to conductors it is reported that conclusions of wide application may be drawn from investigations of the thermal and moisture conditions of the soil; the mathematical formulæ developed in three-core cable work are being checked over a wide range, and experimental work is progressing on methods of measuring dielectric losses and the effects of grouping and spacing cables. The report on electric control apparatus is being issued in sections dealing with the phenomena of switching and arcing based on information collected from power station engineers and others, while the Association is co-operating with the Home Office in testing mining switchgear. Altogether the Report seems to be a good record of activity which should have important results for the electrical industry, and we congratulate the Director and Secretary, Mr. E. B. WEDMORE, on the work performed.

The Engineers' Club.

We are pleased to be able to announce that the movement for the formation of an Engineers' Club for London has now taken concrete form and the long desired wish of many engineers seems to be within a measurable distance of being gratified. It has been definitely decided to form a company for the purpose of completing the task of organising the Club; Mr. E. Manville, M.P., has been elected president, and the present executive committee, which is a good and representative one, has been converted into the first general committee. Mr. E. L. Hill, who has been responsible for much of the preliminary work, remains Honorary Secretary. Already about 1 700 engineers have undertaken to become members, and it is confidently anticipated that the number will reach 5 000 before the end of the year. The annual subscription for town members has been fixed at 10 guineas, for country members five and overseas members two guineas. Negotiations are proceeding for the acquisition of suitable premises, and as these are likely to prove successful no long delay is likely to elapse before the Club will be ready to receive and cater for its members.

The Wrong Idea.

The "Birmingham Post" is very exercised in its mind because the trading Departments of the Birmingham Corporation have either no surpluses available on the year's trading or have placed those surpluses to their reserve funds instead of using them for the relief of the rates. In the case of both the Electricity and Tramways Departments there is a surplus amounting in the latter case to no less than £171,162, all of which is placed to reserve. We agree with our contemporary that, with repair and maintenance still below pre-war level, and with costs soaring ever higher, this is a wise course to adopt, but we cannot subscribe to the implied reproach that even under these circumstances something ought to have been found for the relief of the rates. It has always been our policy, and we reiterate it, that when adequate provision has been made for reserve any other surplus in municipal trading departments should be liquidated by reducing the charges for the services rendered. It is only in this way that the health of the undertaking can be built up so that it can weather periods of depression with the minimum of damage.

An Interesting Frequency Problem.

The necessity for some early decision on the frequency question, a matter to which we have often called attention, is demonstrated by some figures given by Mr. B. G. Lamme in a Paper recently read before the American Institute of Electrical Engineers. It appears that in America the advantages of the electric drive were recognised by iron and steel manufacturers before a public supply was available with the result that a standard frequency of 25 has been adopted in many of these plants, that offering at the time more advantages than a frequency of 50 or 60 cycles would have allowed. With the coming of the large central station for the general supply of electrical energy for all purposes, however, a frequency of 60 cycles has been generally adopted, and in consequence iron and steel manufacturers are confronted with the problem of how best to utilise the public supply in plants which were entirely designed for a frequency of 25 only. While it is recognised that the whole matter is too complex, and contains too many varied elements to allow of an entirely general satisfactory solution, the various possibilities to which the problem gives rise are discussed, and the lesson is one which is not without its usefulness to us in the reorganisation of our supply arrangements.

The Atomic Process in Ferro-Magnetic Induction.

In a Paper published by the Royal Society in 1890 Sir Alfred Ewing suggested a modification of Weber's theory of the magnetisation of ferro-magnetic substances by showing that the control exerted on each elementary magnet by its neighbours was sufficient to explain the phenomena of susceptibility and hysteresis. But since that time our view-point on these matters has changed, and it is, therefore, interesting to see that in a recent Paper before the same Society Sir Alfred reconsiders this theory both in the light of modern views regarding the structure of the atom, and of the X-ray analysis of crystal structure by Sir W. H. and Prof. W. L. Bragg. From the results of this analysis it appears that the rotatable Weber magnet is an attribute of the atom, not of the chemical molecule. It is not the atom itself, but probably an electron system within the atom. Metallic iron is now known to be an aggregate of crystals in each of which the space-lattice is the centred cube, with its atoms most closely grouped along the trigonal axes. It is along these axes that the Weber elements will point. Consequently an iron crystal is not magnetically isotropic.

The Magnetising Process.

An important characteristic of the magnetising process in iron, as Sir Alfred Ewing points out, is that there is a small quasi-elastic or reversible part preceding the much larger changes which involve hysteresis. This corresponds to a reversible deflection of the Weber magnets through a small angle, generally of an order of 1° or less. The theory of the equilibrium of a row of magnets is considered, and experiments in which rows of Robison magnets with ball ends have their equilibrium upset by an extraneous field confirm the theory. From the known value of the magnetism of saturation, the moment of a single Weber element is estimated and the field is calculated which would break up rows of magnets set in the space-lattice close enough together to bring the reversible deflection within the above limit. The field so calculated is far larger than the field that suffices to produce strong magnetisation in iron, which suggests that the ordinary laws of force between magnetic elements cease to apply at interatomic distances.

Compulsory Purchase of Tramways.

As readers of The Electrician are aware, local authorities are entitled, under Sec. 43 of the Tramways Act, 1870, to acquire compulsorily at the end of 21 years the undertakings of tramway companies upon paying the "then value," but without allowance for past or future profits, or any compensation for compulsory sale. The difficulty is to say what the "then value" means, and many lawyers have waxed fat on interpretations. Some guidance on this point may be obtained from the recent litigation on the arbitrator's award in the case of the purchase of the Oldham, Ashton and Hyde Electric Tramway Company by the local authorities concerned. Notice to purchase was given on May 1, 1918, but owing to the war the arbitrator (Sir Maurice Fitzmaurice) did not make his award until September 13, 1920. This amounted to £142 174. The arbitrator took into consideration "the value of the purchased undertaking measured by what it would cost to construct and establish the undertaking at the date of the notice, as if it had not existed at that date, but taking into account a proper deduction in respect of depreciation."

The Effect of Depreciation.

The local authorities contended that certain items should be reduced further owing to depreciation, and ultimately Mr. Justice Rowlatt held that there must be allowed as part of the value the remuneration of the engineer, subject to depreciation, and interest on capital during construction as a part of or an accretion to the capital employed and subject or not to depreciation according to whether the money was spent on depreciating things, such as rails, or on non-depreciating things, such as excavation work. The cost of raising capital was disallowed, but the amount awarded for preliminary expenses was sanctioned.

The Question of a Bridge.

In the Provisional Order authorising the construction of the tramway a provision was inserted, at the instance of a railway company over whose lines the tramway passed by a bridge, that if they required to make structural alterations to the bridge the promoters should temporarily divert the tramway. Some years later the company did so require and the tramway was diverted. It was held that the cost of diversion could not be allowed, either as part of the cost of construction or otherwise. The Company appealed, but by a majority the Court dismissed the appeal. Subsequently, the local authorities claimed an allowance for depreciation as from the date of the purchase, *i.e.*, May, 1918, but the parties have wisely compromised the matter, and the company has now accepted the offer of £125 000 made by the authorities. This will enable the directors to return the whole of the capital to the shareholders with an appreciable premium. Quite a satisfactory result!

Electricity in Mines.

A pamphlet of 73 pages, containing the General Regulations as to the installation and use of electricity in mines, together with a revised edition of the official explanatory Memorandum of the Regulations, has recently been issued by the Home Office. As electrical plant is now used so extensively in collieries, both below and above ground, a close acquaintance with the official code is a matter of the greatest importance not only to the managers of mines, to electricians and others in charge of plant, but also to manufacturers of electrical apparatus for colliery purposes. It is well known that the majority of the electrical accidents which occur in mining work are due to carelessness and many of them could undoubtedly be avoided by complying with the official rules. The explanatory memorandum, which occupies over 50 pages and is clearly written, will prove of great assistance in cases of doubt or difficulty, or where there may be alternative methods of complying with a Regulation.

Progressive China.

We are accustomed to look upon China and its people as super-saturated with conservatism, fond of very ancient precedents and addicted to the observance of immemorial customs. Judging by a recent announcement of the Ministry of Communications of the Chinese Republic, we shall have to alter our views of this old but interesting country. The Minister of Communications, who appears to combine the functions of our Minister of Transport and Postmaster-General, would no doubt be looked upon by our bureaucrats as a very ambitious and dangerous kind of reformer, for he has appointed a Commission to consider a scheme for *eliminating red-tape* in the departments of the Ministry. The Commission will, it is further announced, "devise ways and means of preventing circumlocution in the transaction of official business and institute up-to-date office methods in order to avoid undue delay and duplication in the work of the Ministry." What a pity it is that some similar investigation cannot be made into the ways of Whitehall and St. Martin's-le-Grand officials, whose principal activities seem to consist in the creation of fresh offices and in increasing charges for public services!

British Red Tape.

Now, let us contrast the Chinese position with the latest exploit of our Postmaster General, who occupies, in some respects, a position similar to that of the Chinese Minister of Communications. Faced with a deficit in his accounts our Mandarin can only propose as a remedy an increase in the charges for carrying printed matter, postcards, &c. An outcry is raised, and rightly so, against the new rates, and he makes a trifling concession in regard to picture postcards. For if a picture postcard "bears no writing except date and names and addresses of sender and addressee, formulas of courtesy, or of a conventional character not exceeding five words or initials, and when it is marked not to go as an inland postcard but as an inland printed paper" it will continue to be carried for one penny, but not otherwise! What trifling with an important business matter! It will take a large staff to answer the conundrum when is a picture postcard not a picture postcard, and so no doubt the British red-tape bonds will be still further strengthened. However, the most serious part of the new proposals is the disastrous effect they will have upon the whole trade of the country, but more especially upon our Colonial and Foreign trade. In addition, they will tend to weaken the links that bind the scattered parts of the Empire, and they will assist our trade rivals. Our merchants and exporters are already experiencing severe competition in the British Dominions and Colonies, in China, South America and elsewhere, and the increased charges, which will limit the circulation of British trade journals periodicals, catalogues and similar publications in these important commercial markets, can only add to the difficulties of our traders at a time when they need every encouragement that they can get. To us it is incredible that a House of Commons, which is supposed to be composed mainly of business men, can allow such an act of folly to be perpetrated by the head of a Government department, or rather by the Government, for the Cabinet (on the principle of collective responsibility) must take its share of the blame.

Hampering Scientific Investigation.

We are not surprised to learn from the fourth Report of th Conjoint Board of Scientific Societies that scientific investigation is being seriously hampered by the heavy cost involved in the publication of results. An exceptional number of Papers are being communicated to the Scientific Societies, including many held up during the war, while the resources of the Societies, which have not increased, are insufficient to publish even the normal pre-war number. The country is thus in danger of being seriously handicapped at a time when the re-habilitation of industry is in serious need of scientific assistance. Much of the Report is occupied with a short abstract of the third Report of the Committee on the Water Power of the Empire. Too little is being done to ascertain the total resources, or to secure uniformity in investigation and record. It is, therefore, suggested that steps should be taken to convene an Imperial Water Power Conference in London at which the various Dominions and Dependencies of the Empire should be represented. The outcome of such a conference might well be the creation of an Imperial Water Power Board with powers to carry out a comprehensive policy for stimulating, co-ordinating and, where necessary, assisting water power development throughout the empire. The Board has also dealt with questions relating to the formation of National Research Committees, in connection with the International Research Council formed in 1919, with the collection of scientific data in the former German Colonies, with instruction in technical optics and several other matters.

London Electricity Supply Statistics.

The Return made by the London County Council of electricity supply data in the London and Home Counties Electricity District, though dated 1918-20, has been issued at an appropriate time. For it should be of some assistance to those occupied in the many problems connected with the reorganisation of electricity supply in the district, the enquiry into which is to be held next week. The Return gives particulars of the various supply undertakings in the area, analyses the accounts of the municipal undertakings for the year ended March 31, 1919, and of the supply companies for the year ended December 31, 1919, and also contains statistics of the capacity, the capital raised and expended, the output, units sold, prices and much other information relating to the various systems. The return is, in fact, so useful that it is to be regretted that it is so unnecessarily belated, for though the task of compiling it is not easy, we should have thought it possible to bring the municipal information up to March 31, 1920, at least. An interesting comparison is given of the average price obtained by local authorities and companies for the different classes of supply, from which we gather that the average charge for public lighting in London by local authorities is 2·3d. per unit and by companies 0·77d., but for private lighting and power the figures are 1·3d., and against 5·76d. and 2·21d. per unit respectively by the companies. A somewhat similar condition of affairs applies in the extra-London area. It would be interesting to know why.

Substitutes for Platinum.

The situation with regard to the platinum supply in Germany has reached such a pitch, principally owing to the exchange question, that a very careful search has been made for substitutes which, while being less in price than platinum, will give the same results. In an article in a recent issue of "Elektrotechniker Zeitschrift," Dr. K. Arndt discusses this question, and points out that at the present time in the lamp industry "platinette" is being very largely used for leading in wires. This material consists of an alloy of iron and nickel. Alternatively, wires coated with platinum are used. In this category a nickel-steel wire, with a copper coating has recently been tried. It appears that the larger lamp factories mostly prepare the wire themselves in different ways, but so that it shall have the same coefficient of expansion as glass, and preferably give off no gases when it is fused into the bulb. The use of platinum for contacts, the article shows, has long been given up; while for telephonic apparatus Siemens & Halske largely use tungsten. The hardness of this metal, however, makes it very difficult to work, and it is not easy to make a satisfactory point-contact with it. Such shifts are not conducive to cheap and easy production.

Ball Bearings and Electrical Machinery.

It would be interesting to know the reason for the prejudice that appears to exist among electrical engineers against the employment of ball bearings in electric motors. This disinclination may be due either to innate conservatism, from which we should like to think electrical manufacturers are more free than other classes of the community, or to certain unfortunate occurrences which have caused breakdown, and have been rightly or wrongly attributed to the employment of this auxiliary. If the latter is the true explanation the case certainly requires further examination, for as we showed in an article in a recent issue the effect of employing ball bearings in motors is to enable a mechanical efficiency of about 99 per cent. to be obtained, combined with an increased rating and a lower maintenance and lubrication bill, decreased depreciation charges and an increased life. A formidable list of advantages to which attention might well be paid. These points are well brought out in an article by Mr. P. Howden which appeared in a recent issue of the "English Electric Journal." He states that experience with 10 50-H.P. squirrel cage induction motors running at 710 revs. per min., fitted with ball bearings, with the belts kept tight owing to overloads up to 60 per cent. being a normal occurrence, and with a running period of 115 hours per week for 2½ years, showed that the bearings at the end of that time had experienced no appreciable wear. A 60-H.P. slip-ring motor driving a pump through gearing gave equally good results for the same period, the only repairs necessary being due to a fitter's carelessness. On the other hand, during the same period there were 17 failures with motors fitted with ordinary bearings resulting in the burning out of stator coils. He further points out that ordinary bearings require frequent inspection, while belt and roller bearings need only be examined at quite long intervals. Apart then from the advantages to which we have already referred, the use of ball bearings seems to lead to a material reduction in the number of electrical failures owing to the absence of oil accumulation in the windings and to the correct air gap being maintained. These results go in fact to show that there are considerable advantages in employing this class of bearing for electrical work, and we hope the matter will be examined with the attention it undoubtedly deserves.

Artificial Light for Sports Courts.

Following the introductory formal business at the annual meeting of the Illuminating Engineering Society on the 31st ult., a discussion on the use of artificial light in connection with various games was opened by Mr. J. S. Dow. As is well known, artificial light has been used with very fair success for covered tennis and racquets courts, &c. Its use for outdoor games, such as golf, football or cricket, requiring a considerable area, is more problematical, though even here Mr. Dow appeared to think that the difficulties might not prove insuperable in the future. The discussion turned chiefly on ball games, the lighting of gymnasiums, &c., being comparatively easy. Artificially lighted lawn tennis courts under cover are a great boon in winter. Mr. Dow described the methods in use at the Dulwich Covered Courts, at the Prince's Club and elsewhere. It was remarked that on covered courts for lawn tennis the almost invariable practice is to have dead black surfaces for court and surroundings, and white balls and lines. Apparently this is an attempt to simulate contrast conditions out of doors. From the lighting standpoint the problem would be much easier if the procedure were reversed—*i.e.*, light surfaces used for court and surroundings, so as to diffuse the illumination, and black balls, as is usual in squash racquets courts. This would diminish the considerable cost of artificial lighting, and would help to avoid certain difficulties, such as the inconvenient effect of direct reflection off the court surface, which rapidly becomes polished by the movement of players' feet. Generally speaking, it was suggested that hitherto insufficient use has been made of diffused lighting for games; distributed lights are apt to cause glare and sharp shadows, unless very carefully screened. Artificial lighting for many games undoubtedly presents difficulties, but only the fringe of the subject has yet been touched. Artificial light is at least under human control, whereas natural light is not, and conditions out of doors, with alternations of glaring sunlight and heavy clouds, are not necessarily ideal. Games play such an important part in our national life that the use of artificial light well deserves study, and we are glad that the Illuminating Engineering Society has initiated discussion of the subject.

The Electricity Supply Bill.

As no progress has been made with the Electricity Supply Bill, which was introduced by the Minister of Transport in April last, we are afraid that the prospect of the measure becoming law this year is not very bright. Only about six weeks of the Parliamentary Session remain, and in view of the contentious character of some of the Government Bills, and bearing in mind that there is to be no Autumn Session this year, there will hardly be sufficient time for the consideration of the Bill which is encountering an unexpected amount of opposition. Our readers are aware of our views upon the character of the proposed legislation, which is merely the necessary complement of the Electricity Supply Act of 1919 In order to carry out the electricity supply reforms and the general policy outlined in this Act it is most desirable, if not essential, that it should be supplemented by adequate financial and other powers to enable the proposed Joint Electricity Authorities and their constituent parts to perform their duties and powers in connection with the generation and supply of electricity.

Need of Continued Progress.

However, we must accept the situation, disappointing though it be, and it only remains to see whether a way out of the threatened impasse can be devised. It is obviously essential for the welfare of the country that there should be no halting period in the progress of the electric supply industry. There never was a time when economy in the production and manufacture of goods was more needed than at present, and this can only be effected by a more extended use of mechanical appliances and by the continued expansion of the principle of the electric drive in factories and workshops. This is the most effective way of reducing costs and of lowering prices, but this method cannot be employed as extensively as it might be without that cheap and abundant supply of electricity—those " rivers " of electricity—about which we heard so much at the time of the last General Election and during the progress through Parliament of the 1919 Act. This year's Bill is considered in some quarters to be necessary for any genuine progress being made with the work of reorganising the supply industry and for the complete co-ordination of existing undertakings, and while we think that some of its provisions, especially those relating to finance, are highly desirable, if not, perhaps, absolutely essential at the moment, we believe that substantial progress can be made under some of the provisions of the Electric Lighting Act of 1909.

Electric Lighting Act, 1909.

Though some of the clauses of this Act, especially Section 6, relating to what is known as " Fringe " Orders, and Section 4, which confers powers in regard to bulk supply, have been frequently employed in the interests of electricity undertakers, yet the Act contains provisions which have been seldom exercised, but they may now prove to be very useful for municipal undertakers in the not unlikely event of this year's Bill being abandoned. For instance, there is Section 8 of the Act which contains this useful and extensive power: " The Board of Trade may, with the concurrence of the Local Government Board, by Provisional Order make such provisions as appear to them necessary or expedient, by the constitution of a Joint Committee, or Joint Board or otherwise, for the joint exercise of all or any of the powers under the Electric Lighting Acts, or this Act or any Provisional Order by two or more local authorities as respects any area of supply consisting of the whole or any parts of the districts of those authorities in any case where it appears to them that the joint exercise of those powers would be expedient."

Scope of the Powers.

It seems to us that the Electricity Commissioners, as well as local authorities, have in this section practically all the powers they require for the constitution of a Joint Electricity Board or Joint Authority—the precise title is quite immaterial —for the various electricity districts when they are finally defined. As our readers know, all the powers and duties of the Board of Trade are now vested in the Ministry of Transport and the Electricity Commissioners, and the authority of the Local Government Board in regard to the sanctioning of loans for electricity supply has also been transferred to the Commissioners. In addition, Section 3 of the 1909 Act confers useful powers for the breaking up of streets for laying mains into an area of supply from a generating station, and Section 5 enables a supply of electrical energy to be given to railways, tramways and canals partly outside the area of supply of an authority.

Existing Joint Boards.

In virtue of Section 26 of the Electricity (Supply) Act, 1919, the Commissioners can now exercise by means of a special order all the powers which were formerly conferred by a Provisional Order, so that there need not therefore be any break in the development of electricity supply, but the rate of progress will depend upon the extent to which local authorities are anxious to avail themselves of the existing statutory powers and upon their willingness to co-operate with one another. There are several instances of Joint Boards of local authorities operating electricity supply and tramway undertakings, but we need only refer to the case of Stalybridge, Hyde, Mossley & Dukinfield Joint Tramways & Electricity Board which has been very successful in its operations. What four municipal councils have found it possible to do should be equally within the capacity of 10, 20 or more such authorities.

Joint Authorities Preferable.

Of course, it would be much better to set up the more representative Joint Electricity Authorities contemplated in the Electricity Supply Act, but in the absence of adequate powers these cannot be created at present; or if they are appointed, they cannot perform their functions properly. Joint Boards of local authorities can, however, be established. Certain matters may have to remain in abeyance until the position is made clear by further legislation. For instance, the transfer of the purchase rights of local authorities to the Joint Boards, the demand for an extension of the periods allowed to companies for distributing electrical energy in their existing areas and the desirability of associating the supply companies with the work of the proposed Boards. On these and on other questions there is some doubt as to the precise legal position, and additional further legislation in order to clarify the situation.

The main thing, however, is that there need not be any break in the activities of the Electricity Commissioners; they can continue the work of defining and delimiting electricity areas, the investigation of existing sources of supply and the collection of data; their powers are sufficiently wide to enable them to bring great pressure to bear upon both municipal and company undertakers in order to co-ordinate and standardise methods of supply and distribution, and they can, apparently, set up Joint Boards or Committees of local authorities as temporary substitutes for Joint Electricity Authorities.

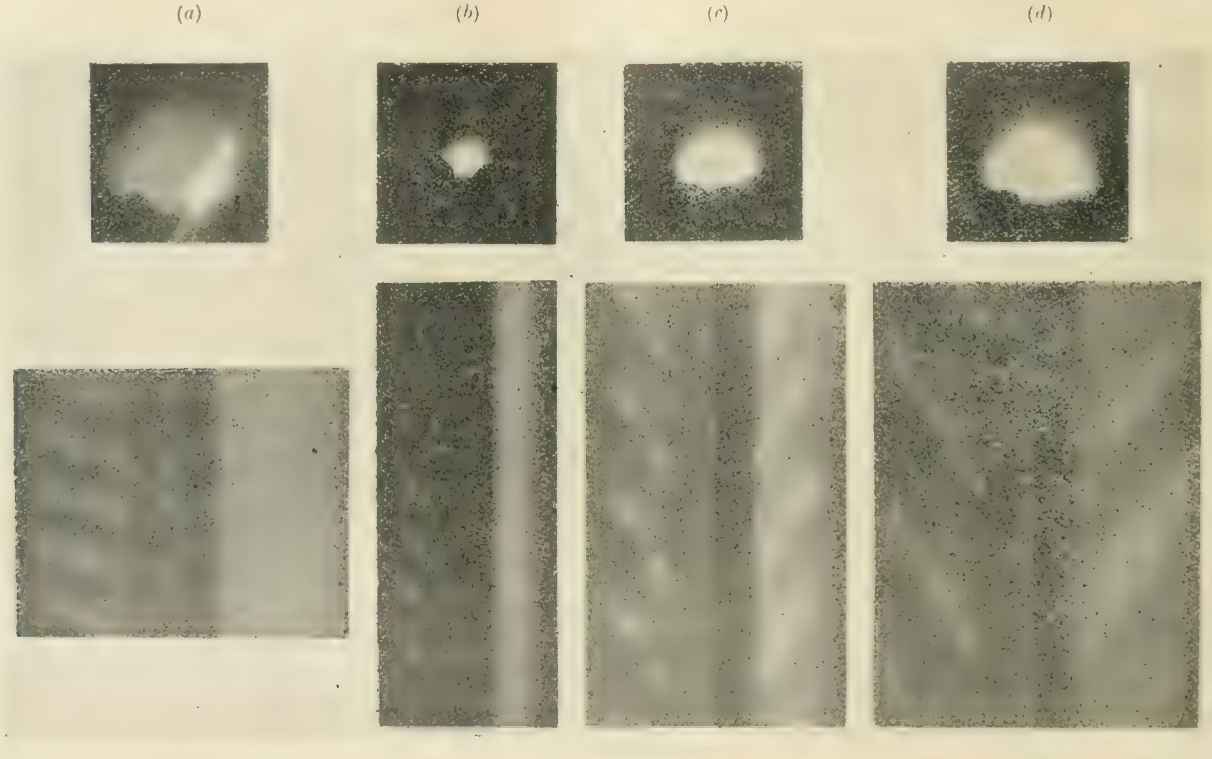
Some Improvements in the Poulsen Arc.

By Prof. P. O. PEDERSEN.

(*Concluded from page* 686.)

EXPERIMENTAL VERIFICATION.

That the above explanation is correct is very clearly verified in Fig. 9, showing side views and crater oscillograms of oscillating arcs in too strong, normal, and too weak magnetic fields. Part (*a*) of Fig. 9 shows the working of the arc in too strong a field. The arc is travelling too fast and too far and the arc voltage is accordingly too high. Part (*b*) represents the normal "one step" working of the arc, the field intensity having its most advantageous value. In this case the arc regularly strikes at the edges of the electrodes once in every period, and the arc is travelling at a comparatively slow speed, the crater paths therefore being rather short and the arc voltage low. In part (*c*) the field is too weak. The arc in this case generally makes two "steps," re-igniting every second time at the edges of the electrodes. The mean length of the arc is too long, the arc voltage accordingly too high. In part (*d*) the field is still weaker, and the arc generally makes three steps.



(*a*) (*b*) (*c*) (*d*)

FIG. 9.—SIDE VIEWS OF ARCS AND CORRESPONDING CRATER OSCILLOGRAMS. ANODE TO LEFT. $\lambda=9\,000$ m. $I_0=20$ Amps.

Part (*a*)—Magnetic field too strong. $H=1250$ gausses. ($V_0=120$ V).
Part (*b*)—Normal magnetic field. $H=355$ " ($V_0=60$ V).
Part (*c*)—Magnetic field too weak. $H=265$ gausses. ($V_0=100$ V)
Part (*d*)—Magnetic field too weak. $H=225$ " ($V_0=118$ V).

It is thus evident that too weak a field will result in an increase of the supply voltage, as the potential difference required during the period of actual burning increases with increasing arc length. The efficiency therefore decreases, when the field is too weak. At the same time, the constancy is affected. If, for instance, the arc regularly makes two "steps," two slightly varying periods are obtained. This affects the resonance curve. The conditions become still more complicated if the number of "steps" varies irregularly, and resonance curves with a "flat top" are then obtained.

Between the above explained view of the operation of the Poulsen arc and the theory developed by the late Prof. Th. Simon of Gottingen and his pupils there is a rather great difference (see the above-mentioned Papers, *b*, *c*, *e* and *f*).

THE DYNAMICS OF THE ARC.

It will be evident from the foregoing that the "dynamics" of the arc and the development of a sufficiently high extinguishing voltage are among the most important points to be considered. Any theory which does not take these points into due consideration will, more or less, be doomed to failure. This is, for instance, the case with all theories based on a single, one value arc characteristic.

How far the view given here is an advance over the theory of the Simon school is probably best ascertained by a consideration of to what extent the two theories are able to explain the influence of magnetic fields of different intensities. We have seen that our view has been quite successful with regard to this question. The theory of the Simon school, on the other hand, has not been able to throw much light on this point. The easiest way to prove this is to quote the last edition (1916) of Zenneck's excellent text book: "It . . . . . was already pointed out that a transverse magnetic field, which is very advantageous for the energy of the oscillations, is very disadvantageous for their regularity. . . . This also explains why the strength of the transverse magnetic field is in general not made very great, sacrificing a further increase in the energy of the oscillations." The existence, in every particular case, of a certain field intensity H^0 giving maximum efficiency and greatest constancy is not mentioned; to say nothing about the dependency of H^0 on wave length, gas density, supply current, and r.f. resistance.

That the theory of the Simon school does not suffice to give a satisfactory explanation of the influence of the magnetic field is a natural consequence of the fact that this theory mainly considers the ignition voltage which, in itself, is independent of the intensity of the magnet field; this field only influences the conditions existing while the arc is burning and its influence is greatest at the end of the period—*i.e.*, at the moment of extinction when the velocity of the arc is greatest. This is the reason why our view, in which the main points are the "dynamics" of the arc and the extinction voltage, gives such a simple explanation of the influence of the magnetic field.

METHOD FOR REDUCING THE INTENSITY OF THE MAGNETIC FIELD—THE "IDEAL" ARC.

On the other hand a reduction of the field intensity below H^0 in Fig. 6 would possibly offer a number of advantages: (1) The reduction of the field intensity is in itself of great advantage in large arcs*. (2) The efficiency of the arc would probably increase as indicated by the curve *abc* in Fig. 6. (3) In weak fields the arc would work in the one-peak manner. *A regular one peak working is of advantage as it would give a radio frequency current curve of almost perfectly pure sinusoidal shape and thus eliminate any disadvantage which may be caused by sudden bends in the current curve.* As shown in Fig. 10, such single peaks have also been obtained in a regularly working arc—starting once in every period from the edges of the electrodes—with a carefully regulated weak field and with the right distance between the electrodes. Thus regulated the arc may burn for a long time with only one peak on the arc voltage in each period, especially if the electrodes have a suitable shape. But, generally, this state is not very stable, being liable to change over to the "two step working" shown in part (*c*) in Fig. 9.

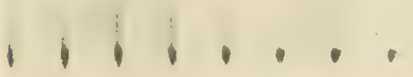


FIG. 10. GEHRCKE-OSCILLOGRAM OF THE ARC VOLTAGE IN A MAGNETIC FIELD JUST TOO WEAK TO GIVE STABLE "ONE STEP" WORKING. TIME BEING MEASURED FROM RIGHT TO LEFT.

The problem is thus to reduce the field intensity considerably below H^0—or rather below the point *b* in Fig. 6—and at the same time induce the arc to work regularly "one step." This may be done, and done quite easily, by employing a water-cooled copper shoe (cooling shoe) on the cathode in order to limit the travel of the arc along the cathode (see Figs. 11 and 12). *C* is the cathode (carbon); *Cu* the water-cooled anode (copper).

As an arc can exist only when the cathode crater is in an incandescent state, such a cooling shoe will effectively prevent the arc from travelling further out along the cathode even if the field is so weak that the arc would do so without the cooling shoe. At the end of the period the arc—having reached the edge of the cooling shoe—must therefore necessarily be extinguished and simultaneously a new one start at the edges of the electrodes.

This view was fully confirmed by the results of our experiments with a cooling shoe of which a few are tabulated below.†

Table I.

Wave-length = 9 800 *m.*; $L = 13 \times 10^6$ cm.; $C = 18\,650$ cm.; R = about 5 ohms; V_a = Arc voltage; I_0 = Feeding current; I = H.F. current; I_m=current through magnet coils.

V_a.	I_0.	I.	I_m.	H Gausses.	Cooling Shoe.	Form of Field.
372	71	50	0·9	1 500	with shoe ...	homogeneous
376	71	50	2·8	2 200	without shoe.	

The results tabulated above is only one of a long series of measurements but this one is characteristic of the results obtained throughout.

In order to further test the correctness of this view of the working of the arc with cooling shoe, we have taken a number of Gehrcke-oscillograms of the arc voltage in an arc with cooling shoe. They all show a regular one-step and one-peak working of the arc.

Another advantage is that the arc burns still more steady with the cooling shoe than without it. This is quite natural, as the arc now travels exactly over the same distance along the electrode in every period, the crater path being sharply limited by the cooling shoe, where the carbon burns away in quite a steep form, as is shown at *a*, Fig. 12. Without the cooling shoe the carbon burns away, as shown by the dotted line *a-b*. Without the shoe the arc may here incidentally travel further out in one period than in another, which will cause a small variation in the wave length.

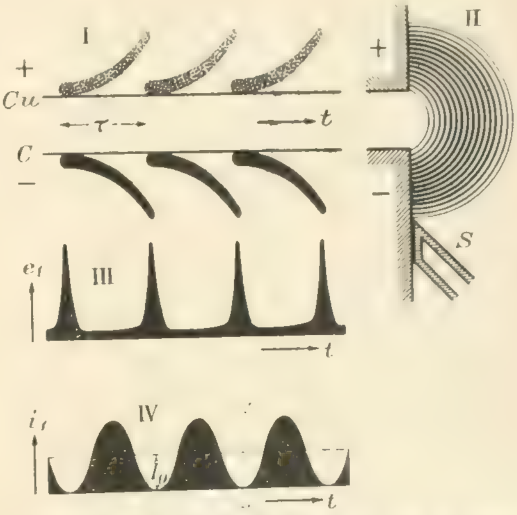


FIG. 11. DIAGRAMMATIC REPRESENTATION OF THE WORKING OF AN ARC WITH COOLING SHOE, S.

THE COOLING SHOE IN PRACTICE.

There is no trouble at all in maintaining the cooling shoe. The angle which the surface facing the arc is forming with the axis of the electrode is of some importance and the distance from the edge of the electrode to the edge of the shoe should be finely adjusted. The length of the distance depends on the wave-length and on the value of the current. The shoe must not be moved towards the cathode edge after the arc has been burning for some time, as otherwise the arc will then burn underneath the tip of the shoe and melt it. The arc with a shoe is extremely easy to start and to manipulate.

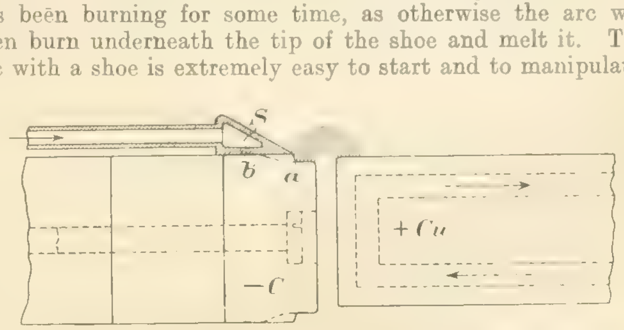


FIG. 12.—CATHODE WITH WATER-COOLED SHOE, S. THE CATHODE IS ROTATED SLOWLY.

The wear on the carbon is very small and very regular, and the same carbon may, therefore, be used for a very long time, especially if the relative height of the cathode and anode can be adjusted according to the wear on the carbon. In this way we have used the same carbon continuously for many hours. Some peculiarities noted from the experiments on cooling shoes may be mentioned. When the carbon has burned with the shoe for at least one revolution, the shoe may be temporarily removed without appreciably altering the working of the arc; but, after a little while, the arc becomes unsteady and the field intensity must be increased. The reason for this is quite evident. As long as the carbon retains its steep profile at *a*, the arc will, when once started, have a tendency to burn in the same way without the shoe as with the shoe. But as soon as the carbon profile approaches the line *ab*, the arc changes over to working two or three steps. A continuous working under the improved conditions is only possible with the use of the shoe. Turning down the carbon to the profile shown in full lines in Fig. 12 and then using it without a shoe has also been tried, but no practically useful results were obtained in this way.

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* A Paper by L. F. Fuller ("Proc." Inst. Rad. Eng., Vol. VII., pp. 449-497, 1919) gives valuable information about the difficulty of obtaining a sufficiently strong magnetic field in large arcs.

† Patented in Denmark and other countries.

In order to illustrate the difference between one peak and two peak working we have in Fig. 13 shown the arc current and arc voltage in the two cases, part *A* representing two peak and part *B* one peak working. A very important advantage of the one-peak working lies, as mentioned before, in the elimination of the sudden bends in the current curve at the points where the arc is extinguished and re-ignited with the two-peak working. These sudden bends indicate the existence of some of the higher harmonics in the radio frequency current and they may cause free oscillations in the antenna and other near-by conductors. The radiations caused by these harmonics and free oscillations may cause interference at neighbouring receiving stations when conditions are unfavourable. All these effects may, of course, if necessary, be eliminated by methods similar to those used for the same purpose in connection with large thermionic tube generators and in connection with mechanical alternators with static frequency changers or they may be eliminated in other ways.* But it is of course simpler if the current curve is without any bends at all, and with regular one-peak working the current curve is almost exactly a pure sine curve, and the above mentioned disturbances reduced to an absolute minimum. Probably no other radio frequency generator is able to give so smooth a sine curve. An arc working regularly one-step and one-peak may properly be called an ideally working Poulsen arc.

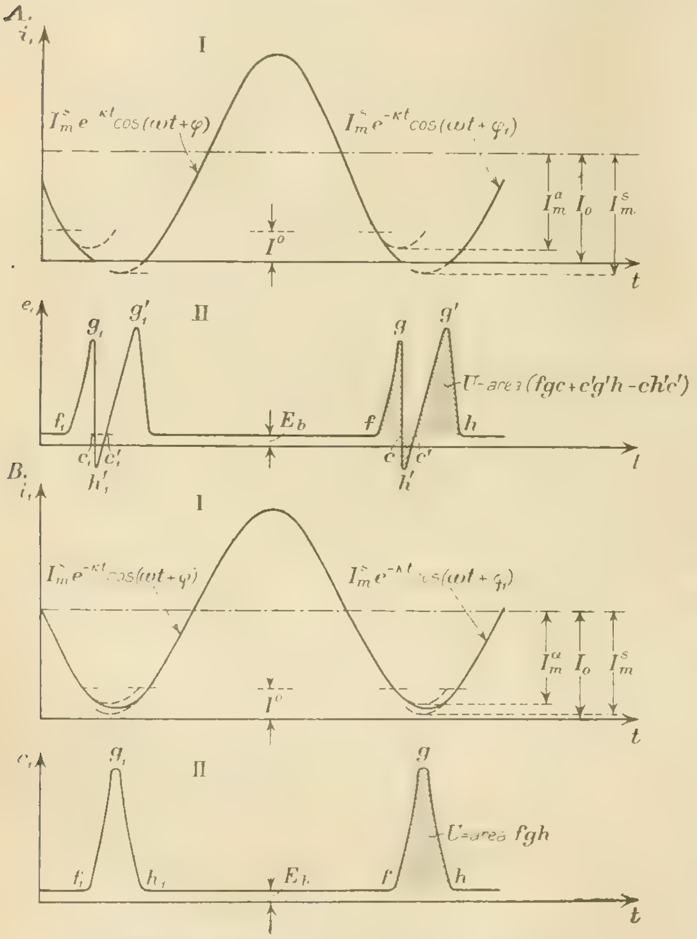

FIG. 13.—ARC CURRENT i_1 AND ARC VOLTAGES e_1.
A for two-peak working. *B* for one-peak working.

THE EFFICIENCY OF THE ARC.

The efficiency of the arc depends upon the shape of the arc voltage curve. For the sake of simplicity we will only consider those cases where the choke coils are of such a value that the feeding current, I^0, may be considered constant. The total energy supplied to the arc, and the oscillating circuit during each period is then determined by

$$A=\int_t^{t+\tau} I_0 e_1 dt \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where e_1 is the arc-voltage and τ the period.

We will further confine our consideration to the case where the arc-voltage is equal to E_b for any value of the arc current greater than I^0, where I^0 is very small compared with I_0 (*see* Fig. 13 *A* and *B*). Most of the feeding current will—under these circumstances—whether the arc voltage has one or two peaks—pass through the arc while the arc voltage has the value E_b; the energy consumed in the arc is, therefore, approximately given by

$$B=I_0 E_b \tau \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

The amount of energy, *D*, delivered to the oscillating circuit in each period is consequently determined by

$$D=A-B=\int_t^{t+\tau} I_0(e_1-E_b)dt=I_0\int_t^{t+\tau}(e_1-E_b)dt=I_0 U, \quad (5)$$

where *U* is the area shown in Fig. 13 *A* or *B*.

The efficiency, *y*, is therefore determined by

$$y=\frac{D}{A}=\frac{U}{E_b\tau+U}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

The efficiency will for large arcs often be about 50 per cent.* No great increase in the efficiency of the arc was directly obtained by the use of the cooling shoe. Other means have, however, been found which substantially increase this efficiency and which will be described in a later Paper.

In conclusion, I desire to acknowledge my indebtedness to Mr. J. P. Christensen for the excellent help he has given me in this work.

Hydro-Electric Power in Queensland.

Mr. V. R. Crowley, who recently presented reports to the Queensland Government on the hydraulic resources of the State, states that in districts south of the Mackay all the rivers cease to flow, or flow slowly, during part of the year, and in no case would it pay to construct reservoirs for power purposes alone. Storage schemes which would provide power for generating electrical energy are recommended on the Dawson and Fitzroy rivers. The *Tully River* is, however, the most attractive proposal from the hydro-electric point of view, though the *Barron* scheme is the best commercial proposition because of the large demand for power which could be secured fairly close at hand in Cairns and the Mulgrave Valley. At the Barron falls, 16 miles from Cairns, the available discharge of water fell to 30 cub. ft. per second in October, 1915, but has not reached so low a figure since that time. The power obtainable from that discharge would be 1 870 H.P., and if a dam 70 ft. high were constructed at the Tinnaroo Range 10 000 H.P. of plant could be operated 12 hours a day. A plant of 3 000 kW, erected in a power house at Mervyn Creek, and a small dam 15 ft. in width are recommended. This smaller scheme would cost about £45 000, including the cost of the dam, pipe line, generating plant and 33 000-V transmission line to Cairns.

At *Salt Water Creek* the power available (over 3 000 H.P. on a 12-hour basis) would be sufficient for all requirements at Townsville for some years. It is recommended that a 750 H.P. plant be installed, and that current be transmitted to Townsville, 40 miles away.

One of the best reservoir sites in Australia is near the Spring Creek on the upper *Dawson River*. A dam 150 ft. high and 500 ft. in length at the top would back up the water for 80 miles in the river. The catchment area above the proposed site of the dam is 8 890 square miles, and it is estimated that 500 000 acre-feet could be impounded. There would be sufficient water to develop about 20 000 H.P.

Though smaller than the Dawson, the *Fitzroy River* proposition is nearer to a big centre of population. A dam 35 ft. high would store 300 000 acre-feet of water and about 1 850 H.P. could be made available for power purposes, while 100 000 acres of land between the dam site and Rockhampton could be watered. Additional dams on the Isaacs and Mackenzie rivers and a gravitation scheme (with dams above the Spring Creek) in the Killarney district are recommended for irrigation.

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* F. A. Kolster, "Re-enforced Harmonics in High Power Arc Transmitters." "Proc." Inst. Rad. Eng., Vol. VII., p. 648, 1919.

* L. F. Fuller, "Proc." of the Inst. of Rad. Eng., Vol. VII., p. 461. Fuller states that 50 per cent. is a theoretical limit for the efficiency, which limit normally is reached, but which cannot be passed. This is a mistake. There is no such theoretical limit. It will not offend any physical principles to have arc generators with even 90 per cent. efficiency.

The Annual Meeting of the Iron and Steel Institute.

At the annual meeting of the Iron and Steel Institute held recently a number of Papers dealing with applications of electricity in the iron and steel industry, or discussing problems arising in metallurgical processes, were presented.

Slip-lines and Twinning in Electro-deposited Iron.

In a Paper on the above subject Mr. W. E. Hughes drew attention to wave-like markings in samples of electrolytic iron. These the author believes to be "slip-lines" the origin of which has been explained by Ewing and Rosenhain. The deposits referred to were made from sulphate and chloride of iron solutions on cylindrical cathodes cut from solid metal, sometimes iron and sometimes brass. The appearance of the slip-lines is shown in various micro-photographs, from which the following conclusions are drawn :—(*a*) The lines are common to deposits from both the chloride and the sulphate solutions ; (*b*) They are formed whether the deposition is conducted at high or at low current density ; (*c*) The temperature of deposition does not seem to determine whether the lines are present or absent ; (*d*) They are found in deposits of various thicknesses.

Thus formation of lines does not depend on electrolyte temperature or current density, nor on thickness of deposit. However, there is one type of deposit, *i.e.*, from a bath containing much suspended matter, in which no lines are formed—at least none observable at a magnification of 1 800 diameters—sharp movements of the cathodes may cause the lines to appear apparently because the oxide particles are not allowed to settle down and are only included in the deposit to a relatively small extent

Evidence is put forward in favour of the theory that these markings are slip-lines Thus in 1877 Mills pointed out that when metals are deposited electrolytically on the bulb of a thermometer the mercury is seen to rise, owing to contraction of the deposit. Others have observed the same effect, and G. G. Stoney, who found that nickel deposited on one side of a steel rule was "stopped off" on the other, calculated a maximum figure for the tension of nickel of 19·2 tons per sq. in. These researches indicate that electro-deposited metal is the locus of forces of contraction of great magnitude. An abrupt change of direction of the lines gives rise to the term "twinning." This is illustrated in the original Paper. The explanation of the formation of twin-crystals is uncertain ; in the iron deposits while there was mechanical stress there was no annealing.

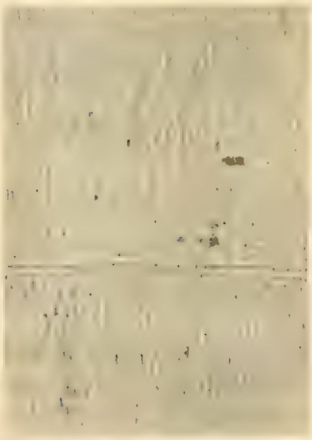
Fig. 1.—Deposit showing Annular or "Wavy" Lines at Low Magnification. ×150.

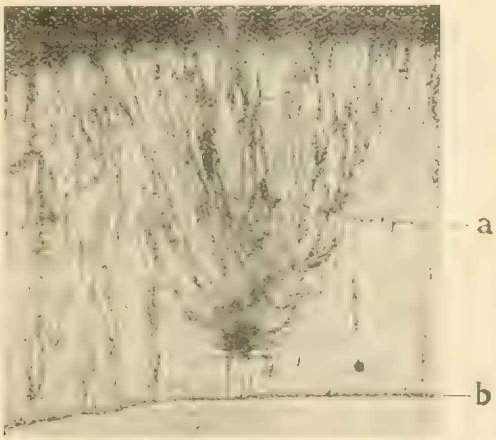

Fig. 2.—Lines (*a*) due to Interruption of the Deposition can be distinguished from "Slip-lines" (*b*) in this Photograph. ×150.

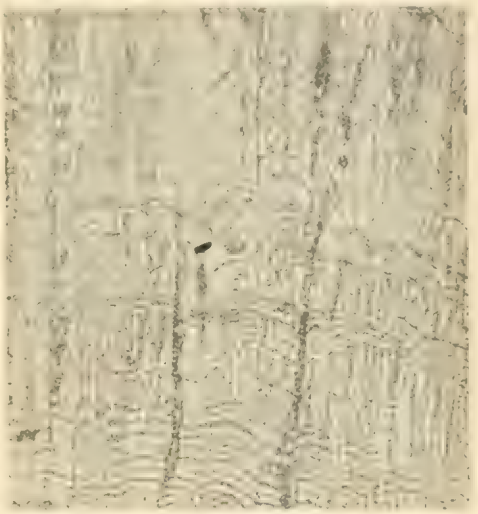
Fig. 3.—Annular or "Wavy" Lines at Higher Magnification. Twinning and "Slip-lines" are both Visible. ×450.

Rontgen Spectrographic Investigations of Iron and Steel.

Dr. Arne Westgren, of Gothenburg in Sweden, gave an interesting account of the application of a 40 000 V Rontgen tube, operating at 15-20 mA, to determine the structure of iron and steel. The experiments were made at the University of Lund. It is remarked that atoms of iron at ordinary temperatures and at 800° to 830° C. are oriented in exactly the same way ; hence it would appear that, contrary to the view sometimes expressed, iron does not undergo any allotropic transformation at 768°C. On the other hand, the crystal lattice of austenite and of pure iron at 1 000° C. is quite different. The author, after a brief summary of the theory of crystal investigations, gives the results of investigations on a considerable variety of qualities of iron and steel. The most important results are summarised as follows :—

1.—Hull's result that iron at ordinary temperature (α-iron) has a cube-centred cubic lattice structure is verified.

2.—At 800° to 830° C., that is, within the so-called β-iron interval, the iron atoms are oriented in exactly the same way as in α-iron. Allotropy being in the author's opinion equal to polymorphy for solid crystalline bodies, this means that β-iron cannot be considered as a separate modification of iron.

3.—In austenite and in iron at 1 000° the iron crystals have face-centred cubic lattices. This is consequently characteristic of γ-iron, and a fundamental difference in crystallographic respect is found between α- and γ-iron.

4.—In martensite iron is in the form of its α-modification. This is the case also in high-speed steel of ordinary composition, hardened at 1275°.

Finally it is remarked that modern crystal investigation methods offer great promise in metallographic research. Having once found the lattices of metals and metal alloys and the laws for the forces governing lattice equilibria, it ought to be possible theoretically to determine the strength of the systems on a scientific basis, instead of, as hitherto, dealing with this problem by purely empiric methods.

The Scientific Control of Combustion.

While not in itself electrical the device described by Mr. Ringrose in his Paper on the above subject is of considerable interest as applying to all works where fuel economy is important. Such economy is dependent upon keeping a systematic check in flue-gases or gas evolved from gas producers. Producers working under similar conditions as regards fuel yet vary 50 to 60 per cent. in efficiency (*i.e.*, in one case 60 tons of fuel as compared with 50 tons in the other are consumed to produce the same amount of heat). To ensure scientific control of combustion continuous records of the amount of CO_2 in the gases are necessary. The instrument devised by the author for this purpose depends on a novel principle. The presence of any material capable of absorbing moisture inside a sealed porous pot will give rise to a vacuum, which can be readily registered by a manometer-tube containing coloured liquid. Thus by introducing a cartridge of calcium chloride we can record the amount of moisture present in the air, this being indicated by the degree of vacuum produced. The CO_2 apparatus similarly consists of a closed porous pot containing a few granules of soda lime. A certain definite height of liquid corresponds with a given percentage of CO_2 and readings accurate to within ½ per cent. can be readily obtained. This is placed in the atmosphere which it is desired to investigate.

In the original Paper the author shows illustrations of apparatus based on this principle. The estimation of CO_2 is particularly important in connection with producer furnaces, and a second form of instrument suitable for this purpose (the W.R. Producer or Water Gas CO_2 indicator) is also illustrated. It is believed that this will prove very useful as a check on water gas plants.

The Cleaning of Blast Gases.

Mr. S. H. Fowles's Paper on this subject is devoted mainly to the performance of a plant erected at the Palmer's Engineering and Shipbuilding Company's works in the early years of the war. The plant was in operation within 18 months and ran continuously for another 18 months with 20 to 30 per cent. overload. Among the reasons for advocating the cleaning of blast furnace gas are:—(1) the recovery of potash; (2) the possible development of an additional 3-4 million h.p. from waste blast furnace gases in this country, in addition to reductions in coal bills, speeding up of works, and undertaking much of the work at present done by coal-fired boilers; (3) the superseding of the old steam-driven blowing engines and the rendering of blowing by large and efficient gas engines an easy proposition; (4) the fact that the electrical equipment of large works could be done on a larger scale and at lower cost than anticipated.

The Paper is divided into two main sections, first dealing with the contents of the gas and methods of using it and second with the Halberg-Beth dry gas-cleaning plant. On an average about one million cub. ft. of gas per hour is developed from blast furnaces and hitherto the whole of this has been consumed by furnace auxiliaries; much coal has also been burned for steam-raising for the blowers. Flue-gas cleaning was hitherto very expensive. In an analysis of the performance of the gas-cleaning plant it is shown that the net saving per week through fuel saving attained £520. The hot stove temperature was also raised from 800° to 1 100° F. and the make of pig iron increased by 10 per cent. With the same quantity of gas made 8 500 h.p. extra was obtained, which will be increased to 12 000 h.p. in the near future. The power supply of the works, previously purchased and amounting to 88 000 kW-hrs. per day, is now produced entirely from waste gas at about 20 per cent. of the original cost per unit.

The next section of the Paper deals with boiler firing, after which the gas-cleaning plant is described. Analysing the comparative methods of the three forms of gas-cleaning plants available, viz., the wet process, the dry process and the electrostatic process, the author remarks that with the wet process boiler firing is out of the question, while the moistness of the gas would mean higher maintenance costs for engines. The electrostatic cleaner is comparatively new and so far power costs of running and initial costs have been high. After cleaning the gas is not yet in a sufficiently clean state to be used for engines and must undergo further treatment, making maintenance costs still higher. The dry process is neither a "dry hot" nor "cold wet" process, but stands between the two. While possessing all the advantages required by gas engines, it has so far been proved to be free from the drawbacks of the two previous types, being moderate in first cost, economical to maintain, easy to operate and flexible in respect of furnace operation. It gives a clean dry gas for engines, of reasonable temperature for stoves and industrial heating. Moreover, a continuous gas supply is maintained if the fans are accidentally stopped, the engines continuing as usual without interruption.

Long Distance Wireless Transmission.

At the last meeting of the Wireless Section of the Institution of Electricial Engineers a discussion on "Long Distance Wireless Transmission" was opened by Mr. C. F. **Elwell** of whose remarks we give an abstract below.

In planning a radiotelegraphic service over several thousands of miles the value of the energy required in the receiving aerial, or coil, in order to operate satisfactorily the receiving devices must first be decided. The value selected must be obtainable under the worst circumstances, *i.e.*, the minimum value for the year, which at night and during the winter will be exceeded. Thus throughout a whole year between Arlington and Darien stations a minimum audibility of 200 was found, whereas signals of audibility 50 000 were sometimes obtained.

Differences of Opinion.

Some difference of opinion exists as to this value. Dr. L. W. Austin recommends a minimum of 6×10^{-10} W for all-the-year communication near Washington. The Nauen station produces signals of this strength in American receiving aerials. At Bordeaux the 1 000-kW arc transmitter and 250-metre towers produces 20×10^{-10} W. Prof. Howe has indicated 400×10^{-10} W as a suitable figure for good receiving conditions. These figures represent a fair factor of safety seeing that Prof. Vallauri in 1919, at Leghorn, measured energies of from $0{\cdot}1 \times 10^{-10}$ W to 1×10^{-10} W.

The Essentials of a Transmission Formula.

A transmission formula enabling the engineer to specify the amount of power required at the transmitting station several thousand miles away is next needed. For short distances (25 to 50 miles) the following formula is available:—

$$h_s I_s \quad \frac{\lambda d R i_r}{377 h_r}, \qquad \ldots\ldots\ldots \qquad (1)$$

where I_s=current in transmitting aerial in amperes; I_r=current in receiving aerial in amperes; h_s=effective height of transmitting aerial in kilometres; h_r=effective height of receiving aerial in kilometres; λ=wave-length in kilometres; d=distance in kilometres; R=total resistance of the receiving circuit in ohms.

At greater distances than 50 miles the magnetic field would be less than that given by this formula, on account of the absorption of the energy of the wave as it travels along. To allow for this decrease, a factor must be added to the right-hand term, and the formula becomes

$$h_s I_s = \frac{\lambda d R I_r}{377 h_r} \sqrt{\left(\frac{\sin\theta}{\theta}\right)} \varepsilon^{0{\cdot}0015 d/\sqrt{\lambda}},$$

which is known as the Austin-Cohen transmission formula. Dr. Fuller has adopted 0·0045 instead of 0·0015 and substituted for λ the term $\lambda^{1{\cdot}4}$. The factor $\sqrt{(\sin\theta/\theta)}$ accounts for the curvature of the earth, in that θ is the angle subtended at the earth's centre by the sector representing the distance between the two stations. For short distances this factor reduces to 1. The factor 0·0015 is sometimes represented by the letter alpha. Other values of α have been proposed. In the Sommerfeld theoretical formula the exponential factor is $\varepsilon^{0{\cdot}0019 d/\sqrt[3]{\lambda}}$. Dr. Eccles suggested for night transmission a value of α of 0·0002.

Various Data.

However, neither the Austin-Cohen nor the Fuller formulæ can be relied upon in serious design work. Prof. Howe has calculated tables purporting to give the power required at the transmitter for various distances up to 6 000 miles in order to give the necessary minimum strength of signal. Prof. Vallauri has attempted to calculate the value of $h_s I_s$ for Annapolis and obtained, with the Austin-Cohen formula, values of from 170 to 530, and with the Fuller formula values of from 24 to 75. The real value of $h_s I_s$ for Annapolis is known to be about 30.

Measurements recently made on board the "Aldebaran," sent out by the French Minister of the Marine to measure the strength of signals emitted by Nantes and Lyons confirm the general opinion that the Austin-Cohen formula is not reliable for distances greater than 2 200 miles.

No Reliable Transmission Formula.

Thus there is no reliable transmission formula and the time seems to be ripe for a new determination of α. A single term will probably not cover such variables as transmission over land and sea. Possibly for $\alpha d/\sqrt{\lambda}$ we shall have to substitute a factor of the form of $(\alpha d + \beta d')/\lambda^n$, where d represents distance over sea, and d' distance over land. Many data carefully taken in all parts of the world will be needed for a proper determination of α or its equivalent.

Fortunately the apparatus necessary for the measurement of I_r the received current, is not expensive High-power continuous-wave stations are numerous and one may commence on those close at hand, leaving the measurement of the smaller I_r to be obtained from American stations until after they have perfected their methods of measurement. The Radio Research Board might be induced to co-ordinate all these data.

Standard Methods Necessary.

A standard method of carrying out the measurements might be developed and printed forms distributed to those desirous of obtaining data. One of the first steps will be for the owners of all stations to measure the effective height of their aerials. It is possible that the measurement of the value of $h_s I_s$ for any given transmitting stations will become as common in the future as the measurement of its wave-length is to-day. This ability to control the $h_s I_s$ of any given station may furnish means of control of the abuse of power.

Some Debatable Aspects.

It is possible again, that no formula can be evolved either mathematically or empirically, because there is no reason why the distribution of the field due to a given transmission should be symmetrical. If no universal transmission formula can be evolved it may be necessary to trace polar diagrams around certain wireless centres, or certain countries, not only by means of measurements taken close up to the transmitting station, but also at greater distances. It would seem by no means certain that curves would retain the same shape, as the distance from the aerial is increased. The following debatable aspects of the question are suggested: (1) Mathematical treatment; (2) Alternative methods of measurement of received field strength; (3) Methods of determination of the field strength necessary to ensure a reliable service; (4) Ways and means of obtaining and co-ordinating data from actual measurements.

The Work of the Radio-Research Board.

Commenting on Mr. **Elwell**'s opening, Admiral of the Fleet, Sir **Henry Jackson** said that the Radio Research Board was co-ordinating the results of radiations measured simultaneously at various stations. Before, however, this could be properly done it would be necessary for the recording arrangements to be standardised. The human ear was not an accurate recording instrument, and it would therefore be better if the quality of the signal strengths received from two stations simultaneously emitting radiation was taken as a basis. When the Austen-Cohen formula was applied to very long distances there was one factor which seemed to carry more weight than it should do, that was the effective height of the transmitting aerial. If the Heaviside layer was not perfectly concave there must be distortion, and it was therefore wrong to assume that the reflected image would retain its exact proportions. A lengthy series of systematic observations such as the author proposed, even if they only led to negative results, would be useful.

The Occasional Range.

Mr. **Andrew Gray** said that in addition to the continuous range suggested by Mr. Elwell a useful factor was the occasional range at many long distance stations at present. This range could be improved by improving the receiving apparatus, or, in other words, by using their existing powers more economically. The Marconi Company had been working in this direction and he hoped it would be possible to publish some useful information before long.

Capt. H. J. **Round** said that reception during the night time and in the winter was becoming more troublesome. At this time of year in the night signals measured near London were only one-fifth or one-sixth of the average of the strength in the day time, while the strength of the atmospherics was also considerably greater. He suggested it would be better to measure the strength of the signals in some unit like micro-volts per meter of vertical aerial rather than in watts, and the maximum voltage given by the atmospherics could be calculated in the same way.

Prof. C. L. **Fortescue** said that Duddell and Taylor and Austen had shown that the formula given by Mr. Elwell approximated to actual conditions over short distances, but for long distances various allowances had to be made and there was a vast amount of evidence that round the earth there was a sort of spherical mirror which acted as a reflector.

Ratio between Received Signals and Atmospherics.

Capt. L. B. **Turner** said that what the radio engineer wanted was a sufficiently large ratio between the power received from the signals and the power received from the atmospherics. With the present amplifying arrangements the actual power received was not important, and the primary power was therefore almost a matter of indifference. For this reason it was not always wise to select the wave-length which gave the greatest power in the antenna. As the wave-length increased the received power from the signals also increased, but so did the power received from the atmospherics.

Prof. E. W. **Marchant** agreed with Capt. Turner's point of view and hoped that more care would be taken to state what the aerial current was in particular tests, because he felt that that was the controlling factor. The best method for measuring received currents must also be determined. The telephone was not a very accurate method, and his attempts to use an Einthoven galvanometer in connection with valves had not been altogether successful. Co-operation between experimenters in this country and those on the other side of the Atlantic was necessary so that a really systematic and scientific set of observations could be obtained.

Capt. A. H. C. **Trench** said that the Austen-Cohen formula was satisfactory up to certain range, and above that range the Fuller formula could be successfully employed. It was useless to search for one value of α which would be suitable under all conditions.

Some Chelmsford Experiments.

Mr. P. P. **Eckersley** gave a detailed account of the results obtained at Chelmsford in receiving signals from the Marion and New Brunswick stations. The ratio between the experimental results and those given by the Austen-Cohen formula in the first case was 1·82 and in the second case case 1·89. This coincidence proved that the exponential part of the formula was correct, while the other factor was incorrect. These figures seemed to point to the fact that the effect of reflection developed gradually.

Mr. F. C. **Lunnon** gave some details of the apparatus used in the test described by Mr. Eckersley. A closed circuit dummy aerial was employed in connection with a variable resistance, so that signals received in it were of the same strength as those in the real aerial. The dummy aerial was necessary to compare the strength of the two sets of signals. The arrangement also prevented the mixing up of atmospherics with the local signals which had been a disadvantage in a similar method used by the Vallauri. The whole of the apparatus had been put into a sealed box so that any direct effect on receiving gear was reduced to a negligible amount.

Standardisation of Received Energy.

Major A. C. **Fuller** said that the first step towards improving present conditions was to standardise the energy required for reception in any given area. This involved a minumim standard reception efficiency. Probably the chief factors were amplification and selectivity, and the best results were obtained by combining these into selective amplification.

Mr. N. **Lee** said that what was wanted was plenty of data of a reliable kind. Measurements should be made in other units than watts. The great objection to the use of an integrating device, such as an ammeter, was that it registered the atmospherics as well as the real signals. Better results could be obtained by comparing the strength of the signals with those from a local aerial and adjusting the local E.M.F. until equality was obtained.

A Criterion of Reasonableness.

Prof. G. W. O. **Howe** said that the results given by Mr. Eckersley contradicted Mr. Elwell's statement that he (Prof. Howe) had used an enormous factor of safety in suggesting his formula. It would be interesting to know what Mr. Elwell's criterion of "reasonableness" was, if he did not think the figures given by the Austen-Cohen formula were more unreasonable to them at the present time than the present powers used across the Atlantic would have appeared to wireless engineers 20 years ago.

The **Chairman** (Prof. W. H. Eccles, F.R.S.) said three different factors were included in the exponential part of the Austen-Cohen formula, and that being so it was remarkable that the formula was so simple and so reliable. He agreed with Mr. Gray—a factor of real importance in determining the value of a service was the average hours per day that it could be worked.

The Need for Organisation.

Mr. J. **Mamlok** in a written communication said the obtaining of reliable quantitative data on long distance radio communication was of considerable interest from the point of view of our knowledge of the atmosphere and of the electrical phenomena which took place in it. The study of atmospherics, which was undertaken before the discovery of wireless telegraphy, could now be resumed with the advantage of being able to use modern wireless instruments and plant. The establishment of a general mathematical formula for long-distance transmission seemed to be impossible in view of the extreme irregularities of such transmission. The work to be undertaken would, therefore, be very extensive and would require an elaborate organisation to carry out observations and to record results over a period of years. For this purpose meteorological stations would appear to be particularly suitable, and the results obtained should be of value not only from the radio telegraphic but from the purely scientific point of view.

Books Received.

[Copies of the undermentioned works can be had from The Electrician Office on ceipt of published price, plus postage.]

"Engineering Electricity." By R. G. Hudson. (London: Chapman & Hall.) Pp. viii+190. 13s. 6d. net.

"Engineers' Constants for the Slide Rule and How They are Obtained." By J. A. Burns. (London: Percival Marshall & Company.) Pp. 78. 3rd edition. 2s.

"Power Factor Correction." By A. E. Clayton, B.Sc. (London: Sir Isaac Pitman & Sons.) Pp. xi.+108. 2s. 6d. net.

"The Measurement of Steady and Fluctuating Temperatures." By R. Royds, M.Sc. (London: Constable & Co.) Pp. xi.+162. 16s.

"Heat Transmission by Radiation, Conduction and Convection." By R. Royds, M.Sc. (London: Constable & Co.) Pp. viii.+238. 24s.

"Heat Transmission in Boilers, Condensers and Evaporators." By R. Royds, M.Sc. (London: Constable & Co.) Pp. viii.+302. 24s.

"Kinema Operators' Handbook." By W. S. Ibbetson. (London E. & F. N. Spon.) Pp. vi.+151. 4s. 6d. net.

"Lichttechnik." By Dr. Ing. L. Bloch. (Berlin: R. Oldenbourg.) Pp. xix.+591. M. 126.

"Electrical Handling of Materials." By H. H. Broughton. Vol. II. (London: Benn Brothers, Ltd.) Pp. xv.+292. 25s.

The Shimizu-Wilson Cloud-Condensation Apparatus.

In our notice of Sir Ernest Rutherford's lectures on "Electricity and Matter,"* we mentioned that Mr. TAKEO SHIMIZU, of Japan, at present working in the Cavendish Laboratory, had devised and demonstrated a modification of the cloud-condensation apparatus, which Mr. C. T. R. WILSON first brought before the Royal Society in April, 1911. This modification, constructed like the original Wilson apparatus by the Cambridge Scientific Instrument Company (now Cambridge & Paul Instrument Company, of Grosvenor-place, S.W.1), was exhibited at the recent Royal Society Conversazione. We illustrate this novel, practically automatic apparatus, by the aid of which the continuous emission of α and β particles can conveniently be watched, and the tracks of the particles and of electrons, liberated by X-rays, can be observed and photographed.

MODIFICATIONS IN ORIGINAL APPARATUS.

In its principle the apparatus is as simple as the original Wilson apparatus, and the modifications introduced were required to permit of continuous observations, and of varying the experimental conditions. Mr. Wilson used a single expansion and considered a very sudden expansion essential, for which purpose he connected the space under the moving piston to another, previously evacuated space. Mr. Shimizu found that the sudden expansion is not necessary, and that he can make the phenomena continuous by the use of a piston reciprocating at a rate adjustable between 50 and 200 periods per minute. The chamber, 55 mm. in diameter, seen at *K* on the photographs, Figs. 1 and 2, at the top of the pump, is covered by a glass plate. The experimenter stands in front of the pump (Fig. 1) which he may drive with the aid of either the hand wheel, *B*, or an electric motor. The crank, *A*, drives the upright connecting rod, *C*, which in its turn actuates the horizontal connecting rod, *D*, the end of *D* slides in a sleeve, *E*, which rocks free in the piece, *F*, itself adjustable in the horizontal direction by means of the screw, *G*. This adjustment of *F* alters the length of the stroke given to the piston rod, *H*, which is connected with the middle of *D*. The expansion ratio of the stroke can, by these means, be varied while the instrument is in operation.

A similar adjustment is required for the period during which the electrostatic field of the apparatus is kept live. If there were no field the ionic nuclei of a cloud, formed during an expansion, would not have time to dissipate during the subsequent compression stroke, and patchy clouds would settle on the glass, as could be seen during the demonstration.

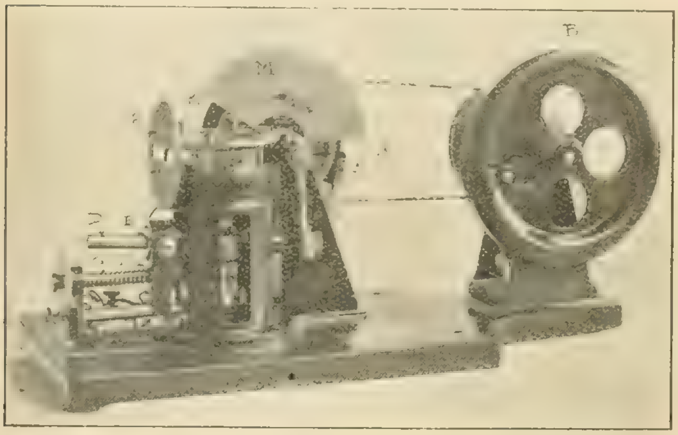

FIG. 1.

The field is vertical; a film of gelatin, rendered conducting, on the inside of the glass plate of the condensation chamber, serves as the negative electrode, and the piston as positive electrode. The commutator, *L*, which turns with the crank, *A*, discharges this condenser system just before the moment of the cloud formation, and this discharge period can be varied, similarly as the stroke of the piston, by adjusting the contact brush, *Q*, which traverses the commutator, *L*. The lead segments, *M* and *N*, which are bolted to the disc carrying the commutator, form an adjustable shutter for the admission of X-rays at the proper intervals when X-ray experiments are to be made.

PHOTOGRAPHING THE RAYS.

The radio-active substance is introduced into the chamber through the small tube *O* (Fig. 1). From the speck of radium salt, α rays, formed of minute water globules, are then seen to be emitted irregularly in all directions; the rays remain distinct for a sufficiently long period to be photographed, when a strong illumination is used. A horizontal parallel beam of light, entering through the screen, *R*, passes right through the chamber; for ordinary observation a small point-o-lite lamp is supplied. As the diameter of the chamber is only 55 mm., the full length of α-ray tracks in air cannot be observed. But the length of track is quite sufficient to show that the tracks are generally straight lines, but may be kinked and mark small or large deflections, if the particle should collide with a molecule. Regularity as to the direction is not to be expected since the emission of particles in any particular direction seems only to be subject to the law of chance; the experiments by Geiger, bearing upon his point, were referred to in our account of Sir E. Rutherford's lectures mentioned. In the Shimizu apparatus the velocity of the α-rays can be reduced by interposing a mica screen. A small screen can also be placed on the piston to cut off the α-rays, except at the moment of greatest expansion. To render the tracks more visible, the surface of the piston is covered with a rather thick layer of gelatin, containing 10 per cent. of Indian ink; the black gives a good background for the rays. When the apparatus is started in the first instance any dust originally present in the air of the chamber is deposited by a few expansions and caught by the gelatin. Leakage must carefully be avoided, of course, as any eddy currents would destroy the tracks. Mr. Shimizu has taken many stereoscopic pictures on kinematograph films, and the Cambridge & Paul Instrument Company hope soon to put also a suitable stereoscopic camera on the market as an accessory to the expansion apparatus.

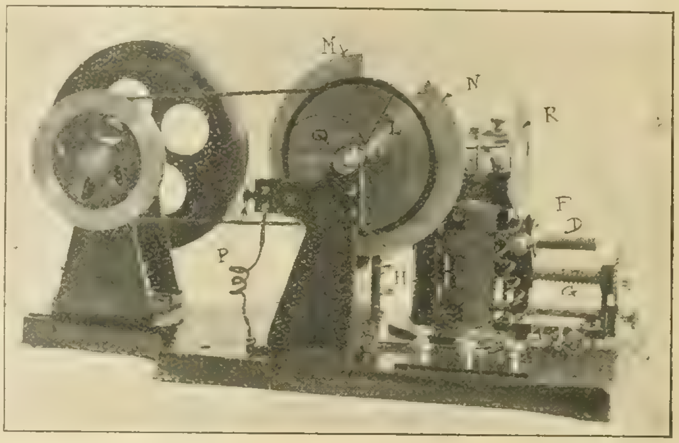

FIG. 2.

Automatic Hydro-Electric Stations.*

By T. A. E. BELT.

The article describes an automatic station and a remotely controlled station which have been in service for some time, and a third system of stations soon to be installed. Two years of operation of the Iowa Railway & Light Company's automatic station has shown that the cost of inspection and maintenance is a fraction of 1 per cent. of the fixed charges.

EXPERIENCE WITH IOWA PLANT.

The automatic hydro-electric generating station of the Iowa Railway & Light Company at Cedar Rapids, Iowa, was put into operation in 1917. The generating equipment consists of three 400-kw., 0·8-power-factor, two-phase, 60 revs. per min., 2,300-volt vertical, waterwheel-driven synchronous generators, which tie into a system having 20 000-k.v.a. in steam turbo-generators at the main station.

Water for driving the generators is obtained from the Cedar River. The automatic station, which is connected to the steam station by two single-phase, concentric, 600 000-circ. mil. cables, 3 000 ft. in length, feeds its output into the steam-station bus, from which distribution is made. A motor-operated wicket gate, for each waterwheel, is controlled by a contact-making ammeter regulating the generator load. The generators have individual float switches set to close their contacts at slightly different water levels, and are started in the same sequence as that in which the individual float-switch contacts close. When the water level falls the generators are closed down in the reverse order from their starting. In the steam generating station are control switches, wired in parallel with the float-switch contacts through pilot wires; thus the starting of any automatically controlled unit is independent of the height of the water in the forebay. Generators may be closed down by opening control switches, and cannot be restarted until such switches are again closed.

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* THE ELECTRICIAN, April 15, 1921, p. 457.

* Abstract of an article in the "Electrical World."

Pilot wires carrying the secondary current of current transformers connected in the individual generator leads are run from the automatic generating station to the steam-operated station, so that the load on each generator is indicated at the steam plant. Experience has proved that these pilot wires are not necessary and could have been omitted without decreasing the reliability of operation of the automatic station. Excitation for the generators is obtained from either one of two induction-motor-driven exciter sets. Each exciter, which has sufficient capacity for supplying three generators, is rated 100 kw., at 125 volts, and is driven by a 2,300-volt, two-phase, 1,200-revs. per min. squirrel-cage induction motor.

The plant has produced over 6,000,000 kw.-hr. with a total cost of inspection and maintenance amounting only to a small fraction of 1 per cent. of the fixed charges. Thus the cost of the power delivered is determined only by the fixed charges.

The correct sequence of operations in the starting of the plant is obtained by segments on the drum of a motor-driven controller. The closing of the float-switch contacts or the control switch in the steam plant starts the motor which drives the drum controller. The first segment of the controller to make contact causes a contactor to close, which throws full voltage on the induction motor of one of the exciter sets. In two or three seconds the induction motor comes to speed, taking only about six times normal current, and the exciter builds up to 125 volts.

Another segment of the drum controller then causes the motor-operated waterwheel gate to open sufficiently to drive the waterwheel and generator at 70 revs. per min., corresponding to 70 cycles. The controller then stops until the generator comes to a speed of 55 revs. per min., when the closing of a centrifugal switch, mounted on the shaft of the generator, starts the controller motor again. The generator, without field excitation, is connected to the bus, in series with a reactance, which prevents an excessive flow of current, its speed being about 60 revs. per min. The drum controller next causes the field of the generator to be excited at a low value, enabling the generator to pull into synchronism. Ultimately the field of the generator is strengthened to normal value. The reactance in the generator leads is then short-circuited and the controller motor is stopped, leaving the controller in the full running position. A contact-making ammeter connected to a current transformer in the generator leads controls the wicket gate, which opens until the generator delivers full-load current.

The generator operates with a constant excitation, the value of which is adjusted for normal load. When the water level is low and normal load cannot be carried with full gate opening, the over-excitation of the generator takes care of part of the lagging current of the system.

Starting the Generators.

Each generator requires for starting only 39 sec. from the time the waterwheel gate begins to open until the generator is connected to the bus and the starting reactance short-circuited. Within 45 sec. from the first operation the generator carries full load. No mechanical jar is perceptible, and when the generator pulls into step with weak field excitation serious current surges are not experienced.

When the water is low the contacts of the float switch open, causing the contactors in the generator leads to drop out and disconnect the generator from the bus. The gate motor then closes the wicket gate and returns the controller to the off position, thus closing down the generator and the waterwheel. The unit may also be closed down by opening a control switch in the steam station. In case of over-heating of the bearings, temperature relays close down the unit in trouble. Speeds and voltage of the generators are determined by the frequency and voltage of the steam station.

The remotely-controlled hydro-electric generating station was installed about six months ago by the Ontario Power Company. The generator equipment consists of one 500-k.v.a., 11,500-volt, 50-cycle, three-phase generator directly connected to a Pelton water-wheel. The new plant uses the entire flow of the stream, and provision is made to by-pass water around the water-wheel when it is not running. Pilot wires regulate the opening of the motor-operated needle valves and the operator in the main station has complete control over the load.

Details of the Control Scheme.

Two small transformers which are connected to the bus in the control station step up the potential from 220 volts to 2,300 volts for transmission to the automatic plant, where it is again stepped down to 220 volts to operate the by-pass and needle valve motors. The three limit switches are used. The control switch used to start the automatic plant energises a relay operating the by-pass motor in the correct direction to close the valve. When the by-pass valve is partly closed another limit switch makes contact, closing a circuit which controls the motor, driving a limit switch and its needle valve, which controls admission of water to the water-wheel. Before the by-pass valve completely closes the first needle valve begins to open, and before the first needle valve completely opens the second needle valve begins to open The reverse operation is obtained during the closing down period.

In the original article the author describes in detail the operation of this automatic system, involving the use of limit switches, centrifugal switches, contactors, voltage regulators, &c., which play a part in the sequence of operations in starting up. Precautions are also taken against short circuits or over-voltage, by the aid of contact-making voltmeters inserting suitable resistances. Thermostat relays installed in the bearings cause the station to close down in the event of over-heating.

In a proposed automatic system, soon to be installed, several low-head water-power plants will be operated. Only one plant, containing one 240-k.v.a., 120-revs. per min., 2,400-volt, three-phase, 60-cycle generator, with a transformer bank to step the potential up to 22,000 volts, is to be installed at the present time.

The automatic station will tie into the transmission system, which is fed by two 150-k.v.a. steam-driven generators. The steam station will be operated at all times, but when the system load demands a greater generating capacity the hydro-electric plant will automatically start.

In the original article the author also describes the proposed method of operation for this station. The methods are similar in principle to those outlined above.

The Manufacture of the Fellows Magneto.

The magneto industry in this country is interesting from the fact that it was practically non-existent before the war, and was developed with great rapidity to meet the national requirements. Among the firms which became prominent in this way was the Fellows Magneto Company, whose works we had an opportunity of inspecting recently. They are situated at Park Royal and are equipped on modern lines with automatic and semi-automatic machine tools. Extensions are also being equipped so that the Company will be in a position to deal with a very large output.

The electrical part of the work is chiefly confined to the armature shop. Here we saw the armature in its various stages of construction. The core is first insulated with impregnated silk. It is then wound with the primary and secondary windings, the two being joined internally. Hand-worked machines are used for this purpose as it is found that hand work results in far fewer faults than when the machines are power driven. The individual layers of the winding are insulated from one another by silk and paper alternately, and the outer (secondary) winding is finished off with linen and varnished, giving the appearance seen in Fig. 1.

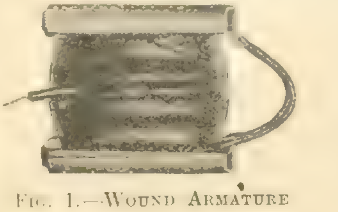


Fig. 1.—Wound Armature Core.

Mechanical Assembly.

The mechanical assembling is then taken in hand so that the armature is made complete with slip-ring and bearings, as shown in Fig. 2. The necessary condenser is fitted inside the righthand-end, near the winding, and is made up of mica and tinfoil. The finished condenser is tested by applying a steady pressure of 440 V across the terminals. If it appears to be sound, it is then placed in parallel with a 220 V circuit which is being interrupted. The armature as a whole is tested by passing an interrupted current through the primary and noting whether a 9-mm. spark discharge is obtained from the secondary. As an 8-mm. spark is the most that such an armature is intended to give, a 9-mm. gap provides an ample test.

The body of the magneto is made of aluminium, and this is cast round the soft-iron pole pieces. The body is machined by special tools, so that it can be readily fitted with the permanent magnets and the parts carrying the bearings, &c.

The Contact-breaker.

The most delicate part of the magneto is the contact-breaker, which is operated by a cam so as to open the primary circuit at the required moment. This takes place twice for every revolution of the armature. The mechanism is carried by the end of the armature spindle and can be easily inspected, as seen in Fig. 3. The high-tension distributor is run by toothed gearing from the same end of the spindle.

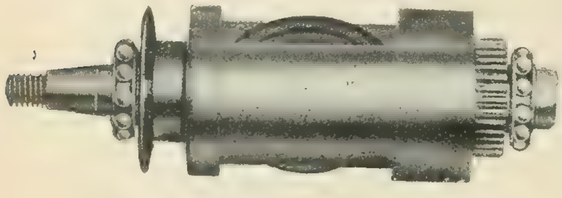


Fig. 2. Armature Complete with Slip Ring and Bearings.

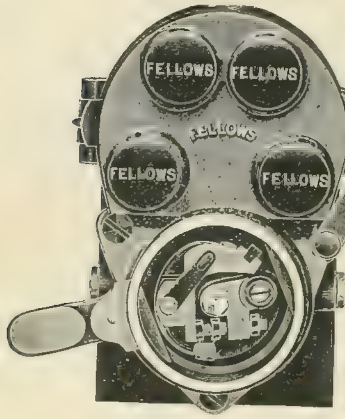


Fig. 3.—Complete Magneto, Showing Interrupter Exposed

For the distributor a rubber compound is used. The material is moulded into the required shape, the necessary number of metal insets for the high-tension circuits being previously fixed in the mould. The Company have a special moulding department for this purpose and are therefore independent of outside supplies. The interior of the distributor is turned up by means of diamond tools, as it is not possible to turn a sufficiently smooth surface of the insulating material between the insets if ordinary steel tools are employed. It is necessary that the quality of this surface should be good, for otherwise a deposit of carbon would form from the carbon brush which sweeps over the distributor and would eventually become a short circuit between the various sparking plugs.

Ball bearings are used throughout, and in some of the types automatic lubrication is used which lasts for several years without attention. The method adopted is that of using a semi-solid lubricant in a chamber adjacent to the ball races, so that there is a gradual flow into the latter. This is a great advantage because many drivers lubricate too much and some lubricate insufficiently.

Testing Arrangements.

The finished magnetos pass through the testing-room, where each is given an 8-hours run at the maximum speed, followed by a run for two hours at the lowest speed that is required in practice. No magneto is allowed to leave the factory unless the sparking is satisfactory under both these conditions.

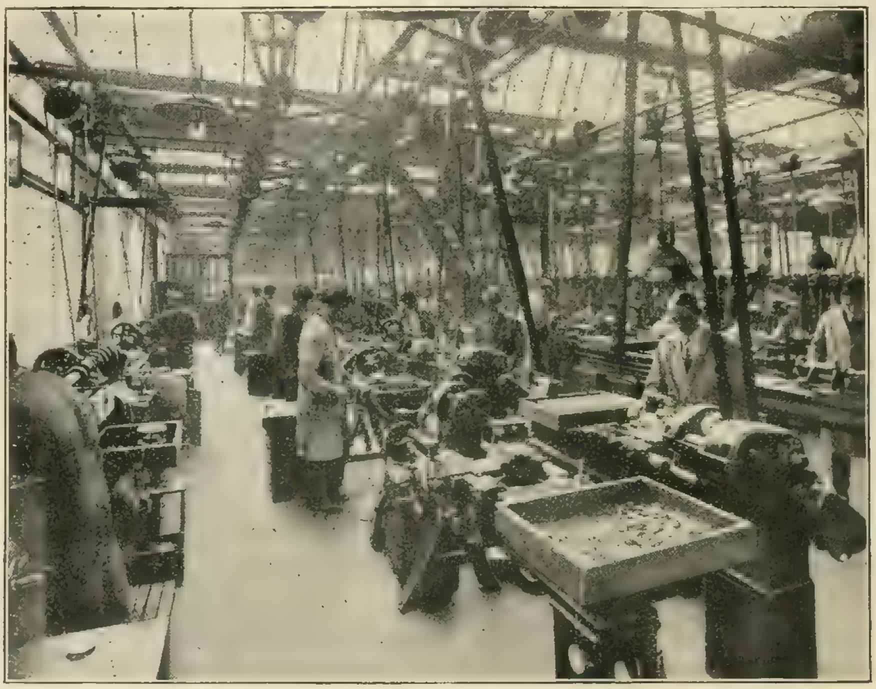


Fig. 4—A View in the Lathe Shop.

The types of magneto most commonly required are those for four and six-cylinder engines, but the Company have now developed a miniature type for use on motor bicycles. It is remarkably compact and light.

An idea of the equipment of the works will be gathered from Fig. 4, showing part of the lathe shop. Many special tools are in use, including special plant for gear cutting. Further, there is a well-equipped tool shop where the necessary tools and jigs are made to ensure precision in the finished products. Thus it will be seen that the Company is excellently equipped for manufacturing in large quantities magnetos of a high quality.

Radio Apparatus for the Mercantile Service.

During the war vast strides were made in the progress of radio telegraphy. It is not surprising, therefore to find a number of these developments finding their way into peace time wireless. The installations of Messrs. R. M. Radio, Ltd., embody many of such improvements as are best suited to the service of the mercantile marine, the main aim of their designer being to make the parts of the apparatus readily accessible, and to give small bulk combined with efficiency and easy manipulation.

Three separate types of apparatus have been adopted: the $1\frac{1}{2}$-kW, $\frac{1}{2}$-kW and $\frac{1}{4}$-kW spark sets. The $1\frac{1}{2}$-kW and $\frac{1}{2}$ kW installations closely resemble each other in electrical design and differ chiefly in dimensions and external appearance. In order to explain the system adopted more fully, a description of the $1\frac{1}{2}$-kW installation will therefore suffice.

$1\frac{1}{2}$-kW Spark Installation.

This set will give a normal range of transmission by day of 500 miles over open water. The main transmitter, with the exception of the signalling key, is contained within a cabinet of polished mahogany teak or other suitable hard wood of substantial construction and measuring 5 ft. in height, 3 ft. 6 in. in width, and 2 ft. front to back. The lower portion, which contains the motor, automatic starter, transformer and primary oscillating circuit, is made with double walls and front, lined with cork dust to deaden the sound of the spark. The upper portion comprises the controlling switchboard and the loading-coil cabinet which contains the secondary oscillating circuit with the loading coils, wave-changing switches, send-and-receive switches, &c. (*see* Fig. 1).

A notable feature of the set is the pedal controlling the sending and receiving switches whereby the operator can start the motor alternator and change over from reception to transmission merely by depressing the pedal, leaving his hands free for operating. Upon releasing the pedal the motor alternator is stopped, and the receiver connected with the aerial in place of the transmitter.

Motor Alternator.

The motor alternator comprises a 2-kW motor running off the ship's mains, and an alternator giving an output of $1\frac{1}{2}$-kW at 100 V, with a frequency of 350 cycles at a speed of 2 300 revs. per min.

The discharger is of the synchronous rotary spark-gap type, mounted on one end of the motor alternator. The construction of this apparatus is novel, the usual practice of having a rotating star wheel and two fixed electrodes being reversed (*see* Fig. 2). The fixed electrodes comprise the two halves of a crown with inward pointing projections, while the rotating portion consists of a pair of electrodes placed diametrically and connected together, which cause discharges from successive pairs of the fixed projections. One advantage of this arrangement is the efficient cooling of the electrodes which have the heaviest work, they being in this case the rotating element. Provision is made for setting the phase by rotating the fixed crown, and the gap length can be adjusted by screwing the rotating electrodes in or out.

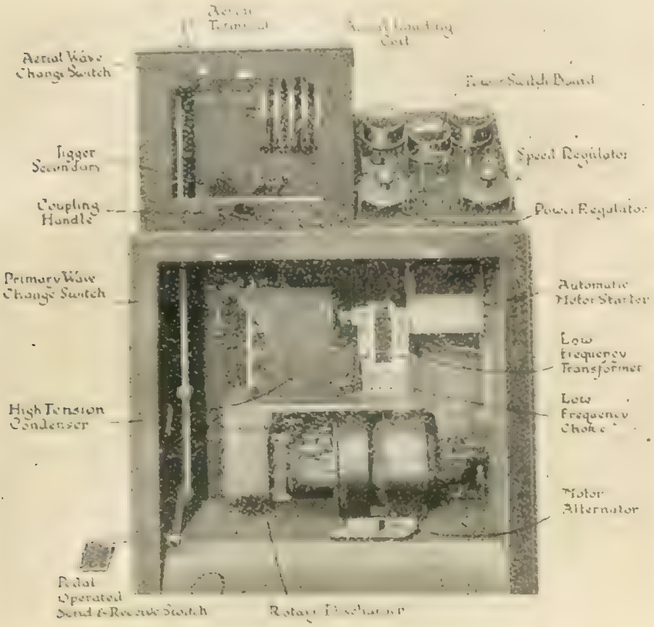


Fig. 1. —Interior Arrangements of 1½-kW Spark Set.

Primary Oscillating Circuit.

The primary oscillating circuit including the condensers and the jigger primary, together with the transformer, are all mounted upon a platform supported by the motor alternator and discharger housing, so that the whole may be readily slid forward for examination or adjustment.

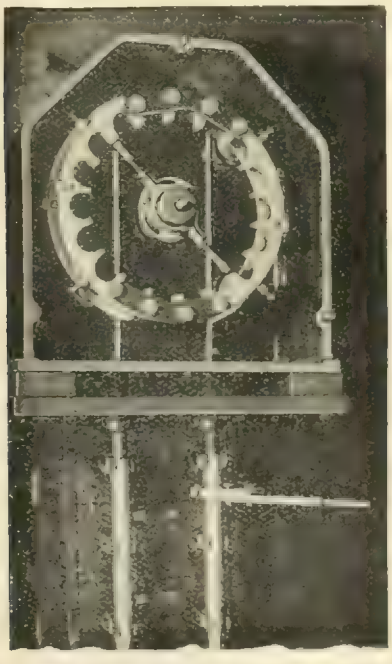


Fig. 2. Showing Construction of Discharger.

The coupling between the primary and secondary oscillating circuits is adjustable by a controlling handle which varies the angle between the primary and secondary of the jigger.

The controlling switchboard carries direct-current and alternating-current ammeters to indicate simultaneously the input and output of the motor alternator, and a voltmeter with change-over switch by which either the direct-current or alternating-current voltage may be read as desired.

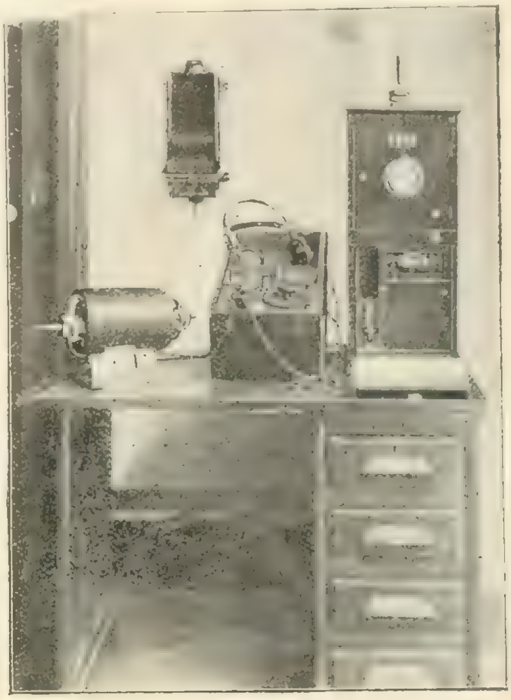


Fig. 3. View of ½ kW Emergency Spark Set.

Field regulating rheostats are also provided whereby the speed, and consequently the spark frequency, may be varied over a comparatively wide range, and the power of the transmitter reduced to a minimum to avoid unnecessary "jamming" when approaching port or signalling at short distances. A double-pole change-over switch enables the operator to connect the transmitter with either the main alternator or the emergency set as may be desired.

The wave-changing switches are operated by a handle projecting from the loading-coil cabinet, within easy reach of the operator's hand, provision being made to transmit on four different wave-lengths, namely 300, 450, 600 and 800 metres.

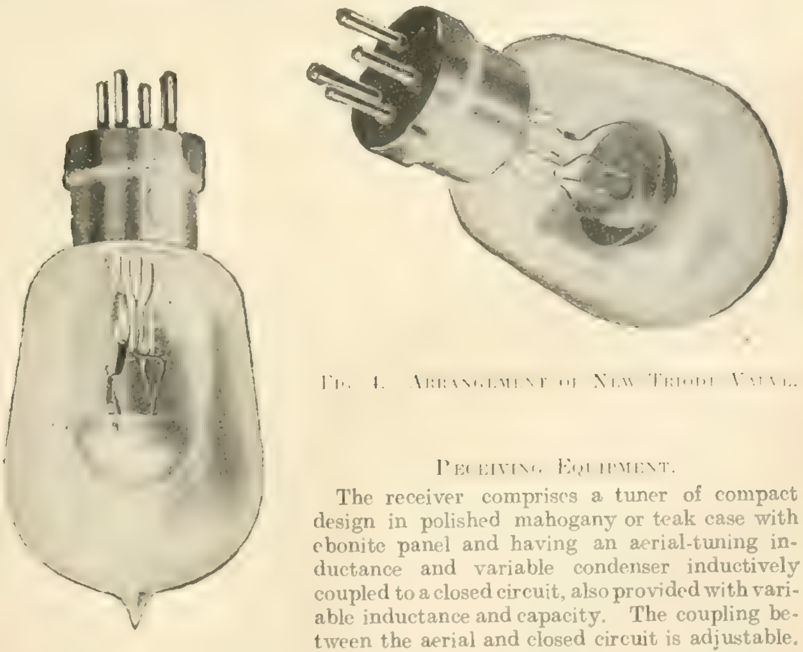


Fig. 4. Arrangement of New Triode Valve.

Receiving Equipment.

The receiver comprises a tuner of compact design in polished mahogany or teak case with ebonite panel and having an aerial-tuning inductance and variable condenser inductively coupled to a closed circuit, also provided with variable inductance and capacity. The coupling between the aerial and closed circuit is adjustable. A double-pole switch enables the operator to change over from a comparatively untuned condition when "listening-in" to a highly tuned condition when receiving individual messages. A high-note shunted buzzer is provided for testing the receiving circuits. The tuner is readily removable, and can be used as a wave-meter, either with or without buzzer.

Triode Valve Detector.

A triode valve of an entirely new design is employed, which is of great sensitiveness and robust construction. The general shape and construction can be seen from the illustration, Fig. 4. The anode and grid electrodes are made in the form of hollow hemispheres supported so that they are concentric with each other, and are constructed of nickel. The filament is made of 2·4 mils pure drawn tungsten wire bowed into the form of a semi circle, and concentric with the other two electrodes. The bulb is so exhausted that there is a slight trace of gas left, and in such a manner that this triode may be said to function as a soft valve.

When used as a detector in conjunction with a receiver there is a total absence of the usual parasitic and microphonic noises, neither does the triode tend to produce noises due to alternating currents by induction. These faults are generally experienced with the usual well-known type of French valve. The characteristic curves are of the general type where a triode of a soft tendency is employed.

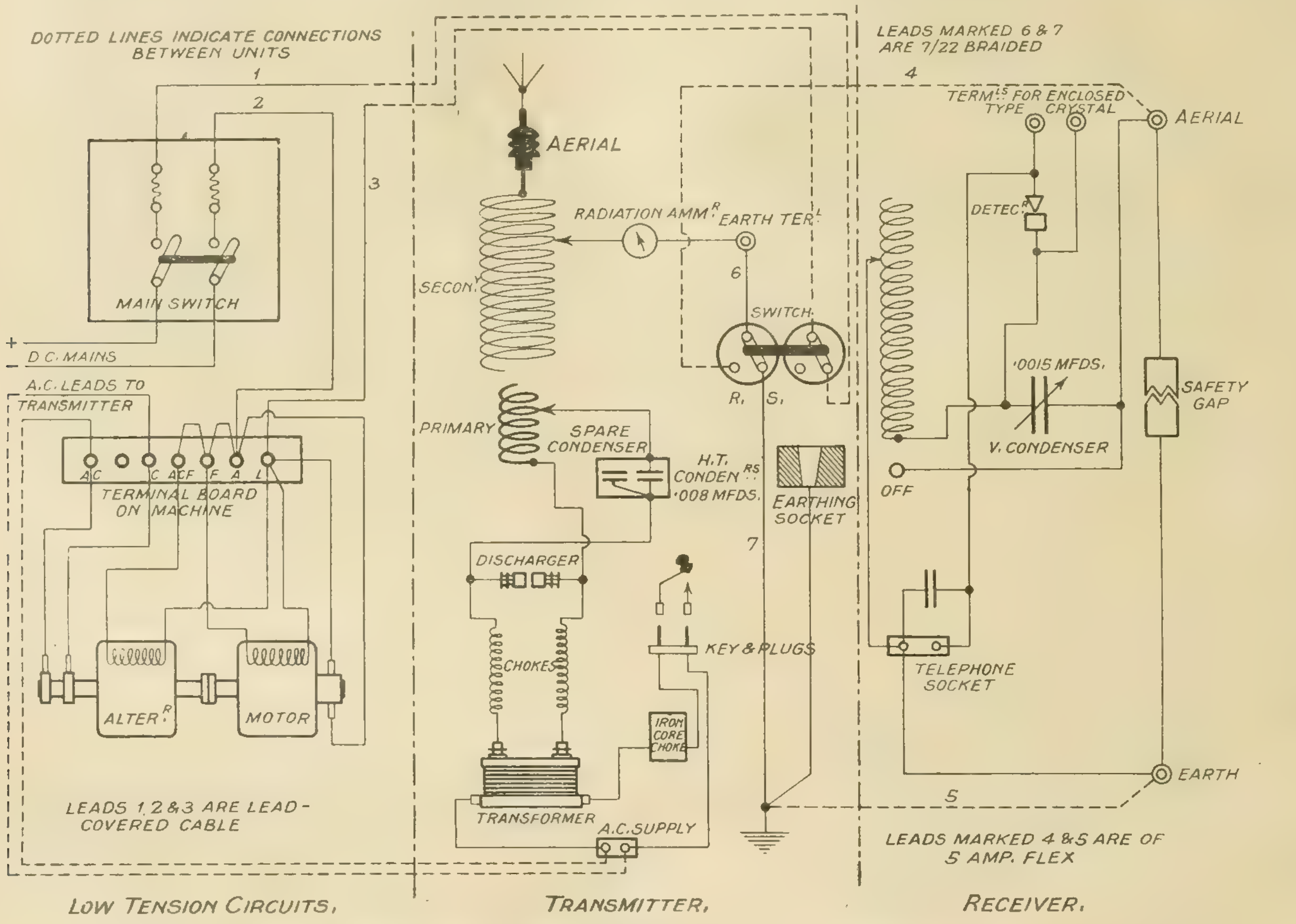


Fig. 5.—Connections of Messrs. R. M. Radio, Ltd., Ship Apparatus.

An alternative crystal detector is provided for use in case of emergency or at the choice of the operator. This consists of a revolving drum carrying eight pairs of crystals mounted in small ebonite cartridges. Rotation of the drum brings the cartridges successively into action so that an insensitive crystal can be changed in an instant.

Emergency Set.

The emergency set comprises a 24-V accumulator battery of sufficient output to drive a small motor alternator for six hours on a continuous signalling load. The battery is made up in 6-V units as it is found convenient to use the same sized cells for both the emergency battery and the filament batteries for the valves. A specially designed charging board ensures that each unit shall be used in rotation to avoid danger of deterioration.

The motor alternator for this emergency set consists of a ½-h.p. direct-current motor direct coupled to an alternator giving an output of ½ kW at a suitable frequency for operating the primary oscillating circuit of the main transmitter, a separate spark gap with adjustable electrodes taking the place of the rotary gap. This can be clipped on to the connecting tubes above the rotary discharger housing when required.

The emergency apparatus for the ½-kW installation consists of an accumulator battery capable of running the main equipment for six hours at full power, together with a suitable charging board.

Where a range of 100 miles or so is all that is desired the ½-kW set illustrated in Fig. 3 will do all that is necessary. The range of transmission obtainable varies according to the size of the aerial which it is possible to rig on the vessel, from about 20 miles in the case of a small motor launch to about 150 miles in the case of a large yacht or coasting vessel.

Transmitting Apparatus.

The transmitter is contained in a cabinet of polished teak, mahogany or other suitable hard wood and measures approximately 22 in. in height, 9½ in. in width and 9½ in. front to back. The lower half of the front opens downward and forms a convenient flap for writing on; the top half is provided with a small door carrying the aerial ammeter and opening to allow of tuning on the jigger secondary coils; the top, which carries a heavily insulated leading-in bush and socket, is hinged to open as a lid to allow of adjustment of the jigger primary. Sockets are provided on either side for connecting the power leads from the alternator. The apparatus contained in the cabinet comprises low-frequency iron-cored inductance transformer, designed for an input of 250 W, two air-core protecting chokes, discharger and with cylindrical zinc electrodes and adjustable spark gap; condensers having a total capacity of 0·016 mfd. (made up in two halves each having a capacity of 0·008 mfd., one half being spare), or of such other capacity as may be necessary in special cases; jigger with variable coupling, the primary being in the form of a flat spiral with ebonite frame and carried on an insulated pivot rod with ebonite handles projecting from the side of the cabinet for varying the angle between the primary and secondary coils and provided with an insulated locking ring for securing it in the required position. The inductance of the primary can be varied by means of plug and socket connections with a flexible lead. The secondary is a rectangular helix of stout copper rod or strip also provided with an adjustable clip and flexible lead for varying the inductance. Provision is made for wave-lengths of 300, 450, 600, and 800 metres for large vessels, or 220, 300, 450, and 600 metres for small vessels. Other combinations can readily be obtained. The manipulating key is made to fold back when the cabinet is closed. A hot-wire ammeter reading 4 A is fitted on the door of the cabinet. A send-and-receive switch is provided for changing over the aerial from the transmitter to the receiver and for starting and stopping the motor alternator if this forms part of the complete set. The simple receiver usually supplied with this set, where only a short range of wave-lengths is required, consists of a tuner with variable inductance and variable condenser tunable over a range between 250 and 800 metres, and is provided with two separate crystal detectors, and a pair of high-resistance head gear telephones, the whole being contained in a polished mahogany box measuring 8½ in. by 8½ in. by 8 in. deep and provided with suitable terminals for the aerial and earth leads and with a high note buzzer for testing the receiver circuits and crystals.

The illustration shows the complete equipment, including the motor alternator and main switch, and the whole can be accommodated on a small table as shown. A full diagram of connections is given in Fig. 5. The transmitter and receiver can be fastened on a bulkhead if necessary, and take scarcely any more room than the usual wall-type telephone. In view of its efficiency this set, and the larger types also, must be regarded as remarkable achievements in design.

The Reason Why:

We Must Standardise Manufacture.

By W. J. HISCOX.

To produce cheaply, standardisation of manufacture is essential, and this fact must not be lost sight of by the operator when he is tempted to deplore the changes in manufacturing methods which are gradually eliminating the "skilled" job in favour of the specialised operation. Every man is out for what he can get, and the higher his wages, the better pleased is he. Yet it is only when the output is commensurate that these high wages can be paid, for it has been proved that a limited output is not remunerative, from the operator's standpoint.

The Elimination of Unnecessary Costs.

It is well known that, in order to meet competition, the manufacturer must place upon the market a saleable commodity at a reasonable price, and that to achieve this all unnecessary costs must be eliminated. The old method was the rough and ready one of cutting wages to the lowest possible level, buying material in the cheapest market, and waging ceaseless war on the so-called "non-producers."

To-day we are wiser, and although costs must still be reduced, they are reduced scientifically. The indiscriminate cutting of wages is known to be a bad policy, and has been abandoned by most progressive firms. Instead, higher wages are paid, but an adequate return is insisted upon. It being known that the increased output cannot be obtained by the unaided efforts of the operator, the aim of those who "plan" is in the direction of standardisation of manufacture.

Standardisation means bigger production and lower working costs per piece. It enables the goods to be placed upon the market at a saleable price, and creates the demand for more. It increases the productive capacity of the factory, of the department, of the operator, and it increases the earning capacity.

The Fitting Shop—Then and Now.

Let us take the case of the fitting shop—10 or 15 years ago. It was a comparatively small department, and output was extremely limited. The workmen were *fitters*, and every part which came into the department *had* to be fitted. The unit had to be built up, and although there were several units of ostensibly the same type and size, the parts comprising these were not interchangeable. Even in those unenlightened days the workmen complained of the amount of "fitting" necessary, blaming the machining departments for the inaccuracies which should have been non-existent. The customer too, was by no means satisfied, for he had to pay a high price for the commodity, and when a small part needed replacing he was compelled either to return the unit to the factory for repair, or to engage a mechanic to put the job right, simply because the part sent as a replacement was not interchangeable with the worn-out or broken piece on the unit.

Standardisation in the General Interest.

It is in the interests of all concerned—the customer, the firm, and the operator—that the unit be standardised as much as possible. Where the firm specialises to the individual customer's requirements, standardisation is, of course, out of the question, but so far as general engineering is concerned, it is not only desirable, but essential. The machining operator benefits by increased quantities. He probably does not get as much per piece as formerly, but his work is easier by reason of the facilities offered him, and his weekly earnings are higher. Despite what has been said of the limited scope of specialisation, in reality the operator has a wider range, for he can handle work which in the past, owing to lack of facilities, was denied him.

This conduces to continuity of employment, for if there is a shortage in one direction, it is possible for this to be counteracted by plentitude in another. It is really the result of bad management which makes the scope of the specialist limited, for if adequate facilities are available, the range can obviously be extended.

The Passing of the Fitting Shop.

In the fitting shop, standardisation has brought about a revolution, for, indeed, in many factories, the fitting shop has ceased to exist, being replaced by an assembling department. It is in this connection that the operator is somewhat apprehensive, for he sees "skill," as he understands it, replaced by labour trained to handle a definite part of the work. Yet a comparison between the fitting shop of yesterday and the assembling department of to-day will reveal many important facts, the chief of these being the vastly-increased amount of employment. The old fitting shop, with its 15 or 20 workers, has been considerably extended, and 50, 60, or may be 70 men are busily engaged, each one earning considerably more (even taking into consideration the higher cost of living) than the "skilled" man of years ago.

Further than this, orders are rolling in. True, at the time of writing, we are going through a period of adversity, but this is due to abnormal conditions which, it is hoped, will quickly right themselves. The firm is able to place the goods on the market at a competitive price, and customers are as a consequence more numerous. Those who in the past could afford but one unit can now afford three or four, and this enables *them* to develop *their* businesses; whilst those who could not afford to buy at all are in a position to take advantage of the opportunity, due to the lower price, made possible by standardisation.

Skill Still Necessary.

And although standardisation must of necessity favour the specialist rather than the "all rounder," it does not follow that "skill" is eliminated. There must always be skill in manufacture, despite the ingenious aids which are being devised. The operator must be in evidence, for the machine, or the tool, must be under control. The device may be wonderful, but its capabilities are determined by the skill of the operator.

The tool room enjoys prosperity when standardisation is favoured, and the manufacture of the tools and jigs calls for skill of the highest degree. From an obscure section the tool room has developed into a most important department, upon which the prosperity of the factory depends. Interchangeability is made possible by the provision of jigs, which also make production rapid and economical, by eliminating the lengthy process of "working out." True, this means also the ousting of a skilled worker, but this only so far as the process is concerned, for this individual is wanted in the tool room, where more scope is found for his talents.

Standardisation then means quicker production, lower costs, more orders, and consequently more employment.

In order to meet the views of manufacturers the Leeds electricity department has agreed to give a supply of current for power purposes on four days per week (including Friday) instead of three. When work was restricted to three days the workers were entitled to unemployment pay, and when the four days' work was instituted last week, some of them objected to work on the fourth day for about the same as they had been receiving in unemployment dole. For example, at one clothing factory, the girls, by working on the fourth day, would have earned about 7s., whereas in the previous weeks they had been getting three days' wages and 8s. unemployment pay. Rather than work a day for 7s., they preferred "to play" and get 8s. This provides a good illustration of the abuse of the unemployment dole which prevails in some quarters.

Reviews.

Bau Grosser Elektrizitatswerke. Vol. III. By Dr. G. Klingenberg. (Berlin: Julius Springer). Pp. 106.

The first and second volumes of this book were published in 1913 and 1914, and are now well-known. In them were developed the rules for designing large power stations from every point of view, and two examples were given in full, the Märkische station near Berlin and the Victoria Falls and Transvaal Power Company in South Africa. The third volume deals with the super-station at Golpa, not far from Berlin. We learn from the preface that a new edition of the first and second volumes has become necessary, and the author has taken the opportunity of adding this third volume in order to bring the work up-to-date.

The cultivation of land in Germany is carried out to a very great extent by means of artificial manures, so that before the war the imports of nitrates into that country were very large, although her production was comparatively small. At the beginning of the war, the blockade stopped all imports, and an embargo was placed on the home-production for the sake of the manufacture of explosives, with the result that the agriculturist was in a very bad way. The existing works for the production of nitrates and like substances were enlarged, but as these were still not sufficient for the demand, it was decided to build a complete new station. The speed with which this work was carried out stands out as one of the wonders of the war. The station consisted of four turbo-alternators, each 23 000 kVA, with condensers, &c., 42 boilers, seven chimneys, eight cooling-towers, two cooling-ponds, a high-tension station with four transformers, each 23 000 kVA, with switchgear, buildings for the machines and boilers, a coal-transporting plant and a transmission line for 60 000 kW at 82 000 V for a distance of 25 km. In addition to this, the situation was away from any towns or railways, so that it was necessary to construct a line 2½ km long to transport all the material to the site, and the necessary dwellings, &c., had to be built for the workmen. All this work was completed in nine months, from February to November, 1915.

There is no need to enter in detail into the contents of the book. The power-station and everything connected with it are described with the same meticulous care which characterises the other volumes. The addition of this third volume has considerably enhanced the value of the whole work, by adding such a complete description of a more modern super-station. R. G. J.

Operation and Care of Vehicle Type Batteries. Circular No. 92 of the Bureau of Standards. (Washington: Government Printing Office.) Pp. 94. Price 30c.

This excellent publication reminds one forcibly of the difference in outlook between our own Army authorities and that of the American Army. Here we have an example of the forward mindedness of a nation justly renowned for its eager anxiety to apply scientific method and highly developed technical apparatus to *every* department of its activities—hence this very complete manual on the electric vehicle accumulator, prepared under the guidance of engineers and physicists, and made available to the public generally. One wonders how many of our own Army engineers have even heard of the existence of electric vehicles, also why it did not occur to them during the war that electric ambulances might have saved many lives. Commencing with a clear definition of terminology the two main types, lead-acid, and nickel-alkaline, of traction cells are expounded, mechanically, chemically, and electrically, and in lucid detail. Many "performance" graphs are included of both types, bringing out clearly their respective characteristics under working conditions. Section VII. discusses simply but fully the relations between internal and external resistance and limiting effects on external work output. Other sections follow dealing with electrolyte, testing, routine of charging, repairs, cleaning and storage. Finally an admirable series of standard record forms is included, the more extended use of which would double the life of many vehicle batteries. Raymond J. Mitchell.

Shorter Notices.

The Year-Book of Wireless Telegraphy and Telephony, 1921. (London: The Wireless Press.) Pp. lxxiv. + 1,355.

The Year-Book of Wireless Telegraphy and Telephony differs from other publications of this kind by including in its pages a number of specially-written articles on subjects which are agitating those working in this twin field of science and industry. This year these articles include one on "Radio-communication and Meteorology," by Lieut.-Col. E. Gold, D.S.O., F.R.S., on "Wireless and Time," by Mr. A. R. Hinks, F.R.S., on "Historical Landmarks in Wireless Invention," by Prof. G. W. O. Howe; "Some Outstanding Problems on Radio-Reception Interference," by Mr. P. R. Coursey; and on "The Radio Compass," by Mr. Stuart Ballantine. The last is of special interest, seeing the rapid strides that have been made of late in the development of direction finding on ships by wireless means. In order that the full benefit of this may be felt it is necessary that the accurate geographical position of all wireless coast stations should be available to ship masters. The co-operation of the Governments concerned has enabled the publishers of the Year-Book to give the geographical positions of the land stations in a very accurate manner, and this in itself must add considerably to the valuable work whose utility is already well known in wireless circles.

Kempe's Engineer's Year-Book for 1921. (London: Crosby, Lockwood & Son.) 28th edition. Pp. ciii. + 2,697. 30s.

To give a critical review of a book which has reached its 28th edition is not only difficult, but almost unnecessary. It is obvious, that, to use a well-worn journalistic *cliche*, it fills a long-felt want, and that any criticism can only be directed to matters of detail. This applies particularly to that well-known publication "Kempe's Engineer's Year-book for 1921," which shows a still further enlargement over its former bulky size. To become trite again, it is a book which no electrical engineer can afford to be without, and we have no doubt that in reality very few are without it. This year new sections have been introduced or old sections have been re-written on Electric Traction, Steam Turbines, Pulverised Coal and Electric Welding. The purely electrical section covers rather over 100 pages, and deals shortly with most matters which are agitating electrical engineers at the present time. A useful feature is that the authority for the statements given are quoted, though in some cases an improvement could be made by sub-editing a certain amount of what is not only biased but somewhat contradictory information. A disproportionate amount of space is given to electrical instruments, and the paragraphs devoted to the copious quotation of rules might well be employed for other purposes.

Practical Electrician's Pocket-Book, 1921. (London: S. Rentell & Sons.) Pp. lxxv. + 522. 3s. net.

Practical Engineer Pocket-Book and Diary, 1921. (London: The Technical Publishing Company.) Pp. cxlii. + 610. 2s.

Mechanical World Electrical Pocket-Book, 1921. (Manchester: Emmott & Company.) Pp. 376. 2s.

The pocket books which appear under the above headings are well-established publications, and in general get up and information are worthy of attention by those to whom reference to such works is a necessary part of their daily toil. The first of them has reached its 23rd issue, and a useful feature of it is the numerous references given to text-books where fuller information can be obtained. This feature might be extended by including each year a reference to articles which have appeared in technical journals during the preceding twelve months.

In the second pocket-book the wireless telegraphy section has been modified in accordance with recent knowledge of the thermionic valve. This pocket book has the further distinction of sticking to the traditional pocket-book arrangement. We notice that in the Acts of Parliament section, there is no reference to the Electricity (Supply) Act of 1919, or to later pending legislation. From the general arrangement of this section we are not quite certain what the object of its publication is, and it would be a good thing if the whole were re-written in the light of what has happened during the past two or three years. Some of the diagrams are needlessly small.

In the third pocket-book the section on motor starters and controllers has been re-written, as have also the sections on wiring systems and electric cooking and heating. The information given is well edited and up-to-date, but the book in general suffers from there being no reference to other text-books or to current literature.

Hilfsbuch fur die Elektrotechnik. By Karl Strecker. (Berlin: Julius Springer.) Pp. ix + 662. M.70.

This is the first edition of this well known work that has appeared since 1912. It is interesting to see that the publishers have taken heroic measures to deal with increasing cost of printing and other charges by cutting down rather than increasing its scope. The pruning knife has been rigorously applied to a good deal of the "weak-current" matter, and also to the information given about electro-chemistry. As regards the latter especially this is a pity, as what has been done in this field of chemistry is worthy of more publicity than it usually receives. The treatment of the information is more mathematical than is usual in English text-books, but a pleasing feature is the full references that are given to sources from which the information is drawn. The book generally gives a good review of Continental electrical practice, but though it covers no less than 650 pages, there is no index. A fairly detailed Contents does not make up for this.

Correspondence.

QUALIFICATIONS OF TEACHERS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: One notes with interest in the current number of The Electrician the suggestion put forward to the Burnham Committee by the Institution that corporate membership of that Institution should rank as equivalent to an Honours Degree as a qualification for teaching in a technical school. Surely this suggestion was not put forward seriously! Let us compare the two qualifications. For the A.M.I.E.E. examination, we have two parts. Part I. embraces English Essay *or* a translation from one foreign language, together with applied mechanics, and *either* physics or chemistry. Surely this part is barely equivalent to London matriculation. Part II. consists of two three-hour Papers on one electrical subject chosen out of a list of eleven branches of electrical science. Compare this with the average B.Sc. Engineering honours degree in electrical work, *i.e.* :—

(1) Theory of machines and machine design—one written and one drawing paper.

(2) Strength and elasticity of materials—two papers.

(3) Electrical technology—two papers.

(4) Theory of heat engines—two papers.

(5) Design of electrical machinery and apparatus—two written and one drawing papers.

(6) Generation, transmission and distribution of electrical energy—two papers.

I.e., eleven written papers of three hours each, and two drawing papers of four hours each. Who can possibly advocate putting these two examinations on an equal footing? When, further, one realises the number of associate members admitted to the Institution during the war period without examination at all, the suggestion becomes preposterous.

Then, again, why is it that the last thing that appears to be looked for in the technical teacher is the aptitude for teaching? I doubt if 1 per cent. of the teachers in technical institutions are trained teachers at all. However, the matter of the training and the qualifications that should be possessed by such teachers is a wide subject that need not be discussed here.

May I suggest two reforms that would be beneficial in many directions. Firstly, the A.M.I.E.E. examination should be considerably harder than it is, or that another class be created —say, "fellowship" admission to which can only be obtained by examination analogous to the B.Sc. engineering examination. This, of course, premises that the Institution desires to figure as an educational body. Personally, I think the Institution would do well to devote its activities to the practical side of the subject, and not trespass on the domain of the university, for strictly speaking there is no equivalent to a university degree.

Secondly, I would urge a revision of the regulations for the London University degree in Engineering. Surely the enormous advances in electrical science in recent years justify more than three papers on this subject. To bunch generation, transmission and distribution into one subject is like attempting the impossible. One has the striking contrast that a candidate for mechanical engineering can obtain his degree without touching electricity, whereas the electrical candidate has to take three mechanical subjects besides his own. This does not appear to do justice to electrical engineering, and the choice of subjects should be extended by subdividing the electrical subjects and all candidates should be compelled to include at least one subject from the other side.

At the time of writing the Burnham Report is not published, but I doubt if the Institution's suggestion above will find a place in that report when it is at last published.—Yours, &c.,

Devonport, June 6. S. Gordon Monk.

THE ENGLISH ELECTRICAL INDUSTRY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I have read the account of a lecture on the English Electrical Industry delivered by Dr. Rosenberg in Vienna and your Editorial in the current Electrician with considerable interest. Whilst Dr. Rosenberg states much that is true of the past he provides ample evidence that he has been out of touch with our industry for a considerable time. Apparently Dr. Rosenberg ascribes most of the troubles of the manufacturer in the early days to our Free Trade system. I have no desire to enter into a political discussion on this thorny question, but I doubt very much if half the trouble could be assigned properly to that cause. Wrong headed legislation in other directions is probably nearer the root of the matter.

In ascribing the present somewhat happier conditions to the War I think Dr. Rosenberg is wrong. Undoubtedly some manufacturers benefitted by the war, but whether or not development would have been on sounder lines without the War is a debatable question. Dr. Rosenberg's castigation of the consulting engineers was perhaps deserved in the days when he had to wrestle with weird specifications in Manchester, but a change for the better has been made in that respect, and to-day the manufacturer seldom has to deal with a "cranky" specification. If all consulting engineers would copy the example of the recognised leaders of their profession and hold the scales equally between the buyer and the manufacturer, the latter's lot would be a still happier one.

One statement by the lecturer cannot be allowed to pass unchallenged. In speaking of the evolution of higher frequency converters Dr. Rosenberg is reported to have said:

> "The motor-converter, which had proved technically sound, formed merely an episode before the general adoption of the 50 cycle rotary converter."

With the first part of the statement I cordially agree, and I am pleased to learn that Dr. Rosenberg has changed his opinion on the soundness of the motor converter since May, 1909, when he took part in a discussion at the I.E.E. on Mr. Hallo's paper—The Theory and Application of Motor Converters. As to the motor-converter being merely an episode —well "facts are chiels which winna ding," and the fact is that my Company has received orders for motor converters since the day of the Armistice, having an aggregate output of more than 120 000 kW; whilst at that date the total output of the motor converters in commission or on order amounted to more than 250 000 kW. A contribution of nearly 400 000 kW to the world's sub-stations is evidence that the "episode" has developed into a considerable part of the main narrative, whilst the volume of orders received during the past two years and its proportion to the total of 50 period converting plant ordered in Great Britain during the same period is evidence of the confidence of the purchasers in its technical soundness and commercial efficiency.—I am, &c.,

Bruce Peebles & Co., Limited.
Edinburgh, *per* S. E. Bastow.
June 4. Managing Director.

Heating and Cooking Notes.

It would be interesting to have precise figures as to the effect of the coal stoppage upon the sale and use of electrical appliances. The total consumption of electricity has probably decreased, owing to Governmental restrictions and to the various appeals for fuel economy that have been made. Such restrictions and appeals, however, are chiefly applicable to industrial and commercial users, and it seems likely that the domestic consumption of current has risen in those districts where the gas supply has either ceased altogether or has become unusably feeble.

One manufacturer of electric irons, fires and cooking apparatus has been almost overwhelmed with orders from certain towns during the last week or so. This fact, which is no doubt true of many other firms—especially of those who have made publicity capital out of the miners' recalcitrance—is highly significant in view of the time of year and the general tendency of trade. People may be installing electric irons, boiling-plates, &c., at the moment for emergency use, but who can doubt that not only will these devices continue in regular employment when the strike is no more than an evil memory, but that they constitute the insidiously thin edge of the electric wedge which will, in time, completely separate the householder from the dirt and drudgery of discredited methods? Of course, the supply of electricity would fail if the coal stoppage continued indefinitely, but the point that people are beginning to appreciate is that while the supply lasts it is at least constant in quality. The hours of use may be severely curtailed, but even the most restricted consumer will be able to say with the inimitable George, "What there was was good."

New Carron Fires.

The Carron Company have achieved an enviable reputation in the electrical world for the substantiality and excellent workmanship of their appliances. No matter what the apparatus may be, if it is of Carron make it is distinguished, or, at any rate, characterised, by the strength and simplicity of its design. The chattering flimsiness, which is an all too common quality in electrical devices, is totally and refreshingly absent from Carron products.

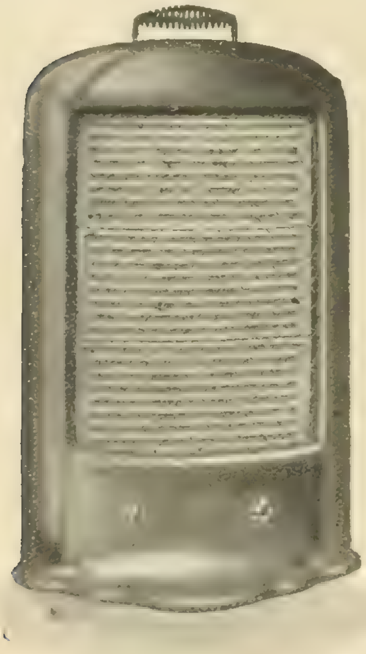


Fig. 1. New Carron Fire. 3 000 W Loading.

These reflections are induced by the perusal of a new Carron pamphlet, illustrating 10 electric fires which have just been developed. The majority of these fires are made of cast iron. Some of them are fitted with cast-iron, porcelain-enamelled element frames, and porcelain formers wound with nichrome wire. The elements are of pleasing appearance, are interchangeable and are loaded to 1 000 W. Another range of cast-iron fires is equipped with special brick elements having grooves for the reception of the nichrome-wire coils. This arrangement, which seems to be entirely satisfactory, is considerably less expensive than the standard form of element, and has enabled the Company to meet the demand for an electric fire of substantial construction, good appearance and low price. The bodies of two of these fires, one of which is illustrated in Fig. 1, are made without sharp edges and are intended to be finished with enamel.

Other fires in the new Carron list have front frames made of sheet brass or copper decorated with repoussé work. These fires have porcelain-enamelled, cast-iron element frames, and are sufficiently light to be easily carried from room to room.

Up-to-date Genii.

There is a great deal to be said, from the points of view of both economy and effect, for the hot-water radiator principle of room warming, providing the heat of the radiator surface is kept below, say, 180°F. If the temperature exceeds this value, the atmosphere tends to become dry and uncomfortable, and possibly unhealthy. The secret of successful heating by this method lies in the maintenance of a large heating area at a relatively low temperature. For this and other reasons the electrically operated hot-water radiator has become deservedly popular. A radiator fitted with an immersion heater can be guaranteed to reach a certain temperature in a given period, and not perceptibly to exceed that temperature, no matter how long it may be left running. In any case, it is a simple matter to control the heat by means of a three-heat switch, or even to fit thermostatic regulation.

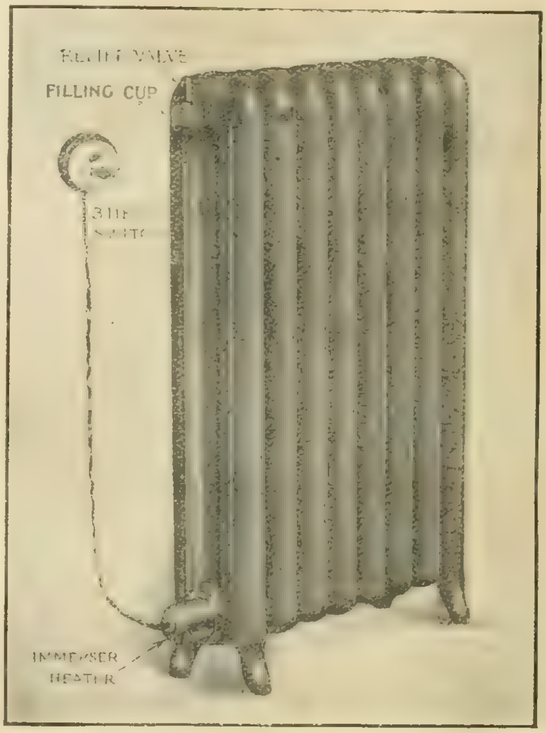


Fig. 2. -The Genii Hot-water Radiator.

The Genii electric hot-water radiator, manufactured by Messrs. George Nobbs, of Cleveland-street, London, W.1, is an excellent example of modern design. An immersion heater is fitted at the bottom of the radiator casing, which is of standard pattern. At the top there is an air-relief valve and a filling-cup through which the radiator may be replenished with water when necessary. A three-heat control switch is also provided. The great merit claimed for the Genii radiator is that it cannot overheat, the temperature being maintained between 120°F. and 180°F. Five sizes of radiators are supplied, ranging from 21 in. to 39 in. in width and from 1 000 W (full heat) to 3 000 W (full heat) in loading. A large radiating area relative to the loading prevents over heating. The full dimensions of the smallest radiator are 21 in. wide, 5½ in. deep and 32 in. high, which represent a generous ratio of heating surface to loading.

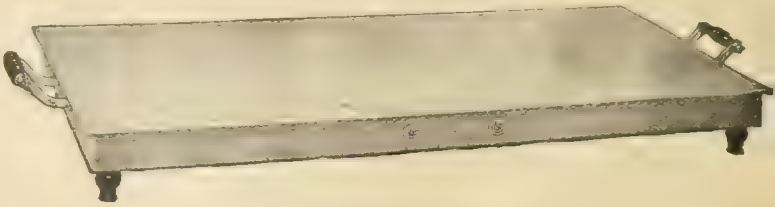


Fig. 3.—Electroyl Warming Plate.

Messrs. George Nobbs, Ltd., also manufacture a range of warming-plates, which possess certain noteworthy features. First of all, they are genuine warming-plates and do not cook or scorch the food placed upon them. Considering their dimensions, they are very lightly loaded, the smallest, 18 in. by 12 in., taking only 200 W, and the largest, 36 in. by 18 in., 600 W. These warming-plates are made throughout of rustless metal. The top table is of solid aluminium, with dull finish, and the casing below of sherardised steel. Heat-insulating handles and feet are fitted in their appropriate positions. The heating elements are disposed in such a manner as to heat the table surface uniformly and are solidly connected to the service terminals. Mica insulation is used, and the elements can be easily replaced when necessary.

Association of Consulting Engineers.

The annual general meeting of this association was held at Caxton Hall, Westminster, on the 30th ult., Mr. E. L. Mansergh presiding. In moving the adoption of the report of the committee for the past year, the chairman remarked that it contained little of interest. Speaking generally, during the last nine months business had been very slack, which naturally reflected on the activities of consulting engineers and on the number of questions coming before the committee. There had, however, been a large amount of routine work, and consideration had been given to the question of conditions of contract and model clauses. When he was appointed chairman of the Association he set to work to increase the number of members. When he took office there were about 64 members, four of whom had since been lost through death or resignation. At present the membership totalled 76 names, in addition to which there were three or four applications for admission. It had been his ambition to achieve a century, and he hoped members would do their best to induce all those eligible, but who had not yet joined, to do so.

Contract Conditions and Arbitration.

The Association had made good progress, as was evidenced by the recognition of Government departments, local authorities and other public bodies. Among the members they had representatives of every branch of engineering. The chairman referred to the negotiations with the Federation of Civil Engineering Contractors and with the B.E.A.M.A. on the qiuestion of standard conditions of contract. They were represented through their honorary secretary on the sub-committee appointed by the I.E.E. to consider model general conditions of contract for electrical work. As the result there had been a meeting between representatives of the B.E.A.M.A. and members of the committee of the Association, from which it was hoped that agreement would be reached. Although he was breaking a sixty years' tradition of his firm, he thought that the time had come when there should be an outside arbitrator for every contract, the leading principle governing the reference to arbitration being that the engineer responsible for the work was entitled to have it carried out in accordance with his plans and wishes, and that if any request of his appeared to the contractor to entail a greater cost to him than was fairly implied under the specification and contract he could claim to refer the matter to an arbitrator who should decide what additional payment, if any, he was entitled to. He hoped that the decision of the committee to postpone the annual dinner till the autumn would be generally approved.

Mr. J. M. **Kennedy** raised some points in connection with the model general conditions for electrical work, which were replied to by the chairman and the honorary secretary.

Mr. G. **Midgley Taylor** remarked that when the question first came up some years ago between the Association and the B.E.A.M.A., he, being then chairman of the committee, collected a number of conditions of contract issued by independent consulting engineers, both civil and electrical, and after comparing them clause by clause, he found that there was such a general measure of agreement that it was possible to form a digest which did not differ very largely from any one of them. The principal difference disclosed between the conditions now suggested and those in use in his father's time was in the appointment of an independent arbitrator, and he thought that on the lines laid down the introduction of an independent arbitrator would be of assistance to the engineers.

The report was then unanimously adopted.

The hon. treasurer presented the accounts, which were also approved.

The names of the new members of the committee in place of those retiring were then announced as follows :—

London Members: W. J. E. Binnie (Sir Alex. Binnie, Son & Deacon), S. B. Donkin (Kennedy & Donkin), S. Cooke Lewis (Douglass, Lewis & Douglass), and G. Midgley Taylor (John Taylor & Sons).

Country Members : B. Hall Blyth (Blyth & Blyth, Edinburgh) and Arthur Ellis (Arthur Ellis & Partners, Cardiff).

Votes of thanks to the Chairman and honorary officials of the Association terminated the proceedings.

The Engineers' Club, London.

At a largely attended meeting at the Hotel Cecil (London) on the 2nd inst., presided over by Mr. C. H. Wordingham, C.B.E., it was decided to constitute an Engineers' Club, London, forthwith and to form a company under the Companies Act to carry out its organisation, each member being liable to contribute £5 in the event of the Club not being able to meet its liabilities, in addition to his annual subscription—10 guineas for town, 5 guineas for country and 2 guineas for overseas and foreign members. Mr. E. Manville was elected as president, and it was also decided that the first general committee should consist of the present Executive Committee, which is composed of :—

Messrs. A. H. Allen, E. L. Cash, C. T. Colpitts, H. W. Couzens, A. R. Fenn, Howard Foulds, Dr. W. Hewison, and Messrs. E. L. Hill (also appointed hon. secretary), R. W. Hughman, J. Snow, Huddleston G. Layton, P. C. Pope, W. Prescott, T. C. Pulman, H. Scholey, H. T. Wilkin and David Wilson.

A resolution was proposed that permanent membership should be confined to British subjects, and this was carried, with the addition that "the General Committee shall provide for an additional class of members, who, although not British, shall be eligible for membership provided they are not late enemy aliens." This resulted from expressions of opinion by several members that there were eminent engineers in other countries, France and America being especially mentioned, whom the Club would feel it an honour to admit as members.

Mr. Hill read the Committee's report, which stated that in a little less than four months the applications for membership had risen from 1 197 to 1 665, and it was estimated that they would reach 5 000 by the end of this year. He also gave particulars of negotiations, now in progress, for the acquisition of the premises of the Road Club, in Coventry-street, £85 000 being required for a seven years' lease. He stated that this sum could be provided by a yearly payment of £14 000. He commended the premises, which well suited their purpose as a temporary home, amongst the advantages offered being 76 bedrooms and dining rooms to accommodate 225 persons.

Appjications and inquiries should be sent to Mr. Hill at 39, St. James' Street, S.W.1.

Progress of Electrical Research.

The quarterly Progress Report of the British Electrical and Allied Industries Research Association (E.R.A.) states that the Council is carrying out a comprehensive programme of research at the National Physical Laboratory. Of its sectional activities it is reported that tests are being made upon cotton fabrics dressed and undressed of various weights and treated with varying thickness of varnish. A collection is being made of samples of treated fibrous insulating materials with a view to classification before proceeding with these tests. A complete series of purchasing tests is to be made on samples of untreated papers used for various electrical purposes, such investigation including the testing for impurities such as metallic inclusions and carbon obtained from soot in the atmosphere, as well as porosity conditions. A large number of samples of treated papers have been collected. The numerous other materials in use have been classified, with the exception of vulcanised fibres, and a preliminary schedule of acceptance tests for purchasing purposes has been prepared. In the section dealing with composite insulating materials, on completion of experimental work general clauses for mechanical and electrical tests will be prepared. Fire resisting materials have to be dealt with. Proposed clauses for tooling tests on ebonite are being prepared. In connection with porcelain insulators a valuable report has been received from Messrs. Langton and Harris on preliminary researches on electric and mechanical strength temperature effects, hardness, specific gravity, thermal conductivity and moisture absorption. Programmes of research are being dealt with in regard to insulation resistance, surface improvement, dielectric strength and uniformity of vitrification.

Mica and Transformer Oils.

n the section dealing with mica and micanite the views of users of these materials for commutators are not supported by sufficient evidence to enable decisions to be made at present. Information on commutation troubles not directly connected with mica and micanite is being forwarded to the B.E.A.M.A. for the benefit of manufacturers. The committee is considering research on abrasive hardness, and on the manufacture of micanite. Troubles met with in the manufacture of condensers are being tabulated for consideration. The final draft of the preliminary purchasing specification for insulating oils for transformers, oil switches and breakers, is to be submitted to the Engineering Standards Association. The National Physical Laboratory has undertaken researches on vapour pressures, thermal transference coefficients and thermal conductivity. Research is proceeding on specific heats, latent heats, boiling points, effect of numerous catalysers on sludging, such as metals in contact with paint metals, the effect of the electric arc on the oil, the carbon deposit and sludge produced in transformers and switches.

Conductors, Switchgear, &c.

In the conductor section, conclusions of wide application may be drawn from investigations of the thermal and moisture conditions of the soil. The mathematical formulæ developed in three-core cable work are being checked over a wide range and experimental work is progressing on methods of measuring dielectric losses and the effects of grouping and spacing cables. In regard to electric control apparatus a report is being issued in sections on the phenomena of switching and arcing based on information collected from power station engineers and others. Co-operation with the Home Office is being continued in testing mining switchgear. A report is in preparation on the design and operation of heavy duty fusible cut-outs and incidental matters. Information is being collected on the rupturing capacity of direct-current circuit breakers with a view to the improvement of purchasing specifications. A committee has been formed to consider a programme of research on conditions arising from the use of larger plant in respect of the conductivity of bolted, clamped and screwed joints.

A substantial contribution has been made by this Association to the funds required for research in regard to the corrosion of condenser tubes, which is being conducted by the Institute of Metals.

Electric Fans at the New Madras Council Chamber.

As is well known, the General Electric Company have always been associated with the supply of electric fans of the highest quality suited to all conditions of service. The Witton "Swan" Patent Fan is a special design of self-lubricating fan for use in tropical climates. These fans have a large sale in India, and it is therefore not surprising that a large number of these have been installed in the new Council Chamber at Madras. The accompanying illustration shows the inaugural ceremony of this chamber by H.R.H. the Duke of Connaught and the "Swan" Fans are seen at work.

"Swan Fans at Madras."

The Shanghai Electricity Undertaking.

According to the annual report of Mr. T. Hill Aldridge, engineer and manager of the Shanghai Municipal Electricity Department, for the year 1920, the power-house had to operate under very adverse conditions during the year owing to plant shortage and to delay in the delivery of water pipes, &c. The installed operative capacity of the two power-stations at Dec. 31 last was the same as a year previously, viz., 38 600 kW. During March No. 3 set (a 5 000-kW A.E.G. machine) broke down, and No. 4, of the same size and make, broke down in April. No. 3 was repaired, but broke down again in September, and both units were scrapped. The loss of these two machines prevented the overhaul of the General Electric 10 000-kW turbine set. In consequence of the failure of the two German machines and the delay in commissioning the first of the two 18 000-kW turbines there was no material reduction in the cost of production and the supply to the newer power consumers was restricted to the extent of some 4 000 kW. The 10 000-kW Parsons turbine put into service in April last has run extremely well. The 70-tons-per-hour coal transporter ordered in 1916 was only delivered in November last. The additional plant which will be available for use during the current year will be two 18 000-kW turbo-generators and a 10 000-kW turbo-generator, also condensers for the 18 000-kW sets. The condensers of the two scrapped A.E.G. turbines will be utilised with the new 10 000-kW machine, thus effecting a saving of £20 000. Two B. & W. and two Stirling boilers, each of 80 000 lb. per hour evaporative capacity, were ordered in 1919, and though two of these boilers were promised for July last year, the premises were not fulfilled. There will be ample turbine plant to take care of this year's demand, but insufficient boilers.

The highest simultaneous maximum load at the Riverside and Fearon-road stations in 1920 was 36 742 kW (compared with 28 365 kW in 1919) and the load factor improved from 42·39 to 46·7. The units generated were 179 619 458 and sold 144 539 632, an increase of 41·24 per cent. over the sales in 1919. The power units sold were 116 839 147 (increase, 37 216 599), and for heating and cooking, 1 240 136 (increase, 287 322). The additional premises connected were 2 739, making the total 30 642, and the new connections represented 11 672 kW. 17·28 miles of 22 000-V underground mains were laid during the year, and 9·22 miles 6 600-V underground mains, extensions and enlargements of h.p and e.h.p. overhead feeders amounted to 36·44 miles, and of l.p. overhead mains 108·39 miles, in addition to smaller extensions of l.p. underground mains, pilot cable, telephone cable and public and private road-lighting mains. The public street lamps, all gasfilled, represent 347 700 c.p., besides 71 440 c.p. in private streets. There are 182 transformers in substations = 65 776 kVA. The aggregate of motors connected is 45 305 h.p., increase 12 243 h.p. = 37 per cent.

Engineer's Report.

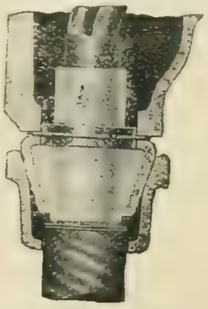
Mr. Aldridge says the plan of extensions as outlined in his report of Dec. 22, 1919, is now in progress. A few modifications have been made, such as selecting 20 000kW, instead of 18 000 kW turbines, two 300 kW house turbines instead of two of 5 000 kW each, and three 750 kW rotary converters for direct-current supply to the boiler house, instead of two of 1 000 kW each. His recent visit to the U.S.A. and toEngland expedited the issue of specifications, and the receipt and selection of tenders. In July last he settled in the United States contracts for switchgear amounting to $240 000. From 1901 to the present day, during which period the generating plant has grown from 550 kW to 120 000 kW, the preparation of schemes, plans, &c., has been entirely undertaken by the department. The contracts placed in Great Britain recently amounted to £504 026, and those placed in the U.S.A. to G$676 792. The British orders included a 20 000 kW Parsons turbine for £125 715 (including £35 715 for Hick, Hargreaves condenser), a 20 000 kW Metropolitan Vickers turbine, £122 050; three 750 kW Metropolitan-Vickers rotary converters, £13 543; and two Metropolitan-Vickers 300 kW turbines, £30 144; B.T.H. switchgear, £69 548; and Mitchell Conveyor & Transporter Company, coal handling plant, £56 000.

Annual Accounts.

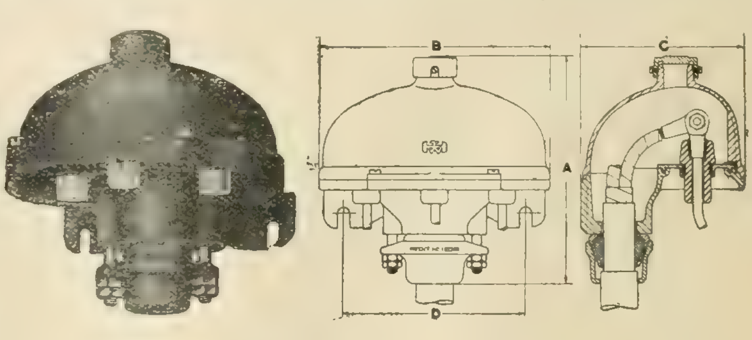
The past year's revenue was 5 210 760 Taels, and the balance carried to net revenue account 1 290 121 Taels, to which were added profit on installation, &c., 8 265 Taels; dividend and bonus on shares in Union Insurance Society, 99 Taels; and superanuation refunded 1 183 Taels. After providing for special charges, depreciation of stores, &c., the balance to appropriation account was 781 537 Taels, to which is added a balance of 386 780 Taels from previous year. 309 000 Taels were contributed to general funds, 77 400 to general funds equalisation account, and 781 917 carried forward.

Henley Outdoor Terminal Boxes.

In the list recently issued by Messrs. W. T. Henley's Telegraph Company, Ltd., particulars are given of a new range of outdoor type of l.t., h.t. and e.h.t. terminal boxes. With the extension of electricity supply in rural areas which will ensue upon the reorganisation of the supply industry there will be an increasing demand for terminal boxes of this type. All the boxes set out in the pamphlet have the well-known Henley features; the overall dimensions are given and may be relied on for fixing purposes. The weight of insulating compound is also given.


Section Showing Bonding of Cable.

The low-tension boxes are fitted with the new Henley patent armour grip, which has been designed by the company for use with all types of lead-covered and armoured cables. It is claimed that whilst a perfect mechanical grip and electrical bond are obtained, it is impossible to damage the cable, as, after sufficient pressure has been obtained for bonding the lead, further pressure cannot be exerted, owing to the faces of the two halves of the malleable iron cone coming into contact with one another. This overcomes a source of trouble to a supply service, and no doubt mains and distribution engineers will be interested in the new armour grip. The particulars given include full jointing instructions for the inverted outdoor type of terminal boxes. Further particulars can be obtained from the Company, Blomfield-street, London Wall, E.C. 2.



Inverted Outdoor Terminal Box.

Sheffield Charges for Electricity.

The question of the proper tariff to be adopted for electricity will be again considered by the SHEFFIELD Corporation this week. It will be remembered that in July, 1920, a special committee was appointed to deal with the matter in consequence of a motion by Councillor Graves to make the same charge for lighting and power supply.

The report states: "It would appear that the ideal basis for charging for electric current would be a fixed price per kilovolt ampere of maximum demand plus a charge for current registered by meter, with provision for a sliding scale covering fluctuations in the cost of coal and labour, and it is thought likely that a recommendation for some such ideal basis will be made by the Electricity Commissioners in their forthcoming report. A reference to the charts exhibited in the Council Chamber shows very clearly that the great increase in current supplied for power has resulted in (*a*) a very material reduction in the cost per unit; (*b*) a very material increase in the number of units supplied per ton of coal consumed. It must be borne in mind that the great increase of units sold has made possible the maintenance of the low price per unit for lighting. In addition to this the introduction of the metallic filament lamps in 1909 reduced the consumption of current used by 70 per cent., and the later introduction of the gasfilled lamps in 1919 further reduced the consumption 15 per cent.

It is stated: "Having given the whole matter very full consideration, your committee recommends that the present percentage increases, which are 50 on all units over 2d., 75 on all units for tramways, 150 on all units under 2d., be varied so far as the 150 per cent. scale is concerned by reducing it from 150 to 125 after the June quarter of this year, and your committee regrets to find that the figures do not justify a reduction in either of the other two classes of users, but further recommends that when costs are somewhat more stabilised the basis prices be revised, unless in the meantime the recommendations of the Electricity Commissioners have rendered this unnecessary."

The report was only adopted by six votes to three.

Country House Plant.

The Willys Overland Crossleys, Ltd., of Heaton Chapel, Stockport, have placed upon the market an interesting lighting and power plant for country houses, farms, &c. We learn that the Willys light and power plants are used extensively in America, and it is claimed that they are compact, simple and absolutely self-contained. The engine is an air-cooled 3 H.P. "Knight" sleeve-valve engine. The engine speed (1 350 revs. per min.) is high enough to give an absolutely steady light when driving direct from the generator and yet assure long life, quietness and economy. The engine burns kerosene; there is no carburetter, and the fuel tank in the base holds 2 gallons, sufficient to operate the engine for nearly eight hours. The oil consumption is very slight, and there is only place to oil the complete plant.

The engine is direct coupled to an Auto-Lite 1½ kW generator, of which it is said there are more than 2 000 000 in daily use. The armature is the only moving part, and it is keyed to the crankshaft as is the flywheel. The generator is shunt wound, has four poles and two positive and two negative brushes to collect current from the commutator. The generator is cooled by forced air and will not overheat.

The battery, which is big enough to absorb the full charge rate of the generator, can be fully charged from dead in five hours. The ampere-hour capacity is 225; it consists of 16 cells of the sealed glass type, and it can run a ½ H.P. motor without the aid of the generator. The control system is simple and eliminates the usual switchboard with its fuses, exposed terminals and complicated wiring; it includes a master switch, overlaid circuit breaker, battery gauge, a charge and discharge indication. It is claimed that the Willys is a real light and power plant; it will supply electricity for more than 100 lights (63 from the generator alone); it will pump water, churn, run a vacuum cleaner, heat water, and perform many other useful operations.

The company state that more than 400 000 home owners and farmers have already purchased these plants. Contractors can see the plant in operation, either at the Manchester factory or London showroom.

Electricians' Wages.

We are pleased to announce that, in accordance with the National Wages Agreement made on Aug. 7, 1920, between the Electrical Trades Union and the National Federated Association, the parties have now further agreed as under:—

To vary the wages of all grades in accordance with the recommendation of the National Conference, held at York, on April 20, 1921, which read as follows: "It was agreed to mutually recommend a reduction of 10 per cent. in the present rate of wages in two instalments, namely, 5 per cent. to come into force on the first pay day following May 9 for the pay period covered by that pay day, and a further 5 per cent. to come into effect on the first pay day following July 9 for the pay period covered by that pay day."

This recommendation is without prejudice to the revision of wages due in July provided by the National Standardised Wages Agreement. Under the present agreement, which is dated the 31st ult., there is to be no victimisation by either side. Complaints under this head are to be investigated by joint committee or existing machinery, and no stoppage of work is to take place pending such investigation.

Parliamentary Intelligence.

SAFEGUARDING OF INDUSTRIES BILL.

In the House of Commons last week the financial resolutions in connection with the safeguarding of industries passed the Report stage, and Mr. Baldwin then brought in his Bill for safeguarding industries. On the first resolution, relating to key industries, various amendments were moved and defeated. These amendments were to reduce the period during which the resolution would have effect from five years to three, to reduce the duty from 33⅓ per cent. to 10 per cent., to omit optical glass and arc-lamp carbons, and to substitute Parliament for the Board of Trade and its Advisory Committee as the ultimate authority to determine the specific articles to be taxed. On the resolution dealing with dumping, Sir A. Mond said there was no doubt that the collapsed exchanges had enabled foreign countries to export to the world markets at a very great advantage. The abnormal circumstances of the time had driven him reluctantly to the conclusion that the course proposed was the right one to pursue.

The Bill was read a second time on Tuesday by a large majority.

GRIMSBY CORPORATION BILL.

This Bill, which had previously been passed by the House of Lords, was considered on Tuesday by Section A of the Local Legislation Committee of the House of Commons, presided over by Sir William Middlebrook. The Bill sought authority for the Corporation to construct and work tramways and trackless trolley routes, to purchase tramways outside the borough and also further powers in regard to electricity supply, markets, &c.

Mr. W. J. JEEVES, K.C. (for the promoters), explained the objects of the Bill, and made it clear that it was not intended to borrow money for both tramways and trackless trolly routes.

Mr. J. B. HAMILTON gave evidence in regard to the estimates of the cost of the proposed works and of the value of portions of the Great Grimsby Street Tramways Company's system affected by the proposed tramway purchase powers, and Mr. H. L. WHITE, general manager of the company, gave evidence on behalf of the company, and ultimately the Committee passed the preamble of the Bill, the clauses relating to tramways and trolley vehicles being then adjusted.

COAL FOR ELECTRICITY UNDERTAKINGS.

In the House of Commons last week Mr. W. THORNE asked the Secretary for Mines if he was aware that just before the stoppage of work in the coal mines the engineer and manager of the West Ham electricity department purchased 1 500 tons of coal at 38s. 6d. per ton, which the Government held up, but in consequence of the supplies running short the Government allowed a further quantity for which the dealers were charging 68s. 6d. per ton; whether that extra 30s. would mean an additional cost of £2 250 to the Corporation, who were already losing over £200 per week through the restrictions of coal supply; and, seeing that the cost of those demurrage charges should fall on the nation and not on Corporations, whether the Government intended taking any action in the matter.

In reply, Mr. BALDWIN said the Mines Department had been in communication with West Ham Corporation regarding the case. The principle followed, was, on the outbreak of emergency, to hold up all coal afloat in British ships as a mobile reserve to meet requirements necessary for the existence of the community wherever they might arise. It was a mere chance that when the need for further supplies for West Ham Electricity Department arose, the coal released was part of a supply originally consigned to them. When coal was held in that way charges such as demurrage, &c., necessarily accumulated, and the principle was followed that the consumer receiving the emergency supply must pay the costs of that supply. No other course was practicable, and the principle was obviously fair and just. He could not agree that such extra costs arising out of the emergency should fall upon the Exchequer.

In order to add to the troubles of the country a SERIOUS CRISIS in the ENGINEERING AND ALLIED INDUSTRIES appears to be developing on the question of wages. The Engineering and National Employers' Federation have posted notices of reduction in wages which are to take place in three stages. The employers contend that they cannot get orders until they bring down the high cost of production, which is attributed to the present high level of wages, and therefore it is announced that from June 16 a reduction of 3s. per week will be made in the case of time workers and 7½ per cent. for piece workers. A similar reduction will take place on July 16, and from September the war bonus of 12½ per cent. and 7½ per cent. for time and piece workers respectively will be cancelled. Naturally, the organisations of the workers contend that these reductions are too drastic, and unless some means of bringing the parties together is discovered the engineers throughout the country will, it is feared, leave work at the end of next week. However, attempts are being made to induce the Minister of Labour (Dr. Macnamara) to institute an inquiry under the Industrial Courts Act, but further efforts are to be made to induce the two parties to come to an agreement before the Minister will give a decision upon the demand for an investigation.

Commercial Topics.

Mineral Samples from Chile.

Samples of large sheet mica and molybdenite have been received in the Department of Overseas Trade, 35, Old Queen-street, S.W.1, from Chile through the Commercial Secretary to H.M. Legation at Santiago, and may be inspected by British firms on application to the Department.

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Standardised Contracts.

The movement for drawing up a standardised form of contract for Government and municipal work is proceeding slowly. As might be expected, the question is proving somewhat complicated, and the Committee of the Federation of British Industries, which is dealing with it, has decided first of all to establish the fundamental principles which should govern all contracts, and then to consider the specific conditions which should be attached to particular types of contract. Of course, the general aim, and a very laudable one, is to remove or modify clauses of an oppressive or onerous kind.

* * * *

Extension of Export Credit Scheme.

The House of Commons has passed a resolution declaring it expedient to extend the Export Credits Act to the giving of guarantees in connection with export transactions, and to amend it as regards the countries to which the scheme applies. The amounts outstanding at any time in respect of credits and guarantees will not exceed the amount now authorised—viz., £26 000 000. Sir P. Lloyd-Greame stated that the scheme is to be extended to the British Empire, but will not at present be extended to India and to British possessions in the Far East. Mr. A. M. Samuel, who supported the resolution, quoted the case of Australia, to which country the export of thousands of pounds' worth of goods is blocked on account of the state of the exchange. Speaking for exporters and for the Association of British Chambers of Commerce, he thought the scheme a first-class measure, and likely to benefit workpeople and manufacturers at no great cost to the Government.

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Italian Tariff Policy.

It is reported that the Director-General of Commerce has reported to the Superior Trade Council on the urgent needs of Italian commercial policy and pointing out the insufficiency of the provisions contained in the treaties of peace to re-establish Italian foreign trade. The Director-General urges that special economic agreements should be concluded with ex-enemy States, for supplementing the provisions of the Treaties of St. Germain and Versailles. These agreements should be for very short periods, and should aim, besides settling disputes with regard to trade at breaking down, or at least minimising, the Customs barriers with regard to exports and imports, thereby enabling Italy to obtain goods she needs and to dispose of merchandise which she cannot place on other markets. Italian economic policy should tend : (1) With regard to Allies, to obtain the abandonment of those measures of excessive protection and high cost of raw materials which are causing serious harm to Italian industry ; and (2) with respect to ex-enemy countries, and the new countries arisen since the war, to re-establish such conditions as are essential to trade, and to conclude reciprocal agreements for removing import prohibitions.

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Swedish Imports.

It is pleasant to read that the share of the United Kingdom in Swedish imports in 1920 was well maintained and was valued at £39 332 000. American competition, which was very marked in 1919 and the first few months of 1920, seems to be losing ground, although in motor vehicles and agricultural machinery the United States has maintained a firm hold, due mainly to well-developed selling organisations. Although imports from Germany fell far short of the pre-war figure, there are indications that this country is making a determined bid to regain the Swedish market. Manufactured and semi-manufactured metal goods, glass and pottery, formed some of the principal items of import from Germany in 1920. With regard to machinery, Germany supplies about two-thirds and the United Kingdom one-sixth of Swedish requirements from abroad.

Imports of heavy chemicals from the United Kingdom have increased and appear to be steadily growing. Large quantities of glassware are imported from Germany, the United States, Czecho-Slovakia and Belgium. Electrical insulators and china for electrical purposes were imported to the extent of 1 327 tons, mainly from Germany. Of the hot rolled iron imported (66 551 tons), 37 779 tons came from Germany, the United Kingdom supplying only 3 747 tons. Of the pig iron, the United Kingdom supplied 17 000 tons, Germany 8 600 tons and the United States 8 000 out of a total of 35 000 tons. The consumption of rails stands at the same figure as the average before 1915, with a total of 59 000 tons, of which Germany previously supplied 80 per cent. ; but the figures for 1920 were : Germany, 29 390 tons, United Kingdom 15 150 and the United States 11 331 tons.

A breakdown in the electricity supply of BELFAST occurred shortly before midnight on the 5th inst., and consumers were cut off for over two hours. It was ascertained that a breakdown had taken place in a main near the centre of the city. A good deal of inconvenience was caused in the newspaper offices, Post Office, Telephone Exchange, &c. Concurrently with the above incident, an attempt was made to isolate Belfast by cutting the telegraph and telephone wires at various points, so that the failure of the electric current is attributed to the action of Sinn Feiners.

Electricity Supply.

WEST BROMWICH Corporation has received sanction to a loan of £29 040, for electricity supply purposes.

On the past year's working of the EXETER electricity undertaking there was a gross profit of £11 918 and a net profit of £2 486

The Minister of Transport has revoked the BIDDULPH ELECTRIC LIGHTING ORDER, 1912, as to the whole area of supply as from May 31.

The Electricity Commissioners have authorised ABERDEEN Corporation to put in a 10 000 kW turbo-alternator and two water-tube boilers at the electricity works.

The chairman and vice-chairman of BLACKBURN Electricity Committee have been empowered to acquire a plot of land at Lower Darwen for the erection of a sub-station.

WATFORD Urban Council have received sanction from the Electricity Commissioners to borrow £23 000, part of a £45 000 scheme for extending the electricity supply undertaking.

The Electricity Commissioners have given permission to WATFORD Urban Council to supply electricity to houses on the Grove Estate, Radlett, which is in St. Albans rural area.

STEPNEY (London) Council is recommended by the Finance Committee to take up a loan of £10 000 at 7 per cent. per annum, repayable within 20 years, for the electricity department.

BURTON Corporation has received sanction from the Electricity Commissioners to raise a loan of £15 000 for extensions of the electricity undertaking, but other extensions estimated to cost £18 000 have been deferred.

Last week SALFORD Corporation approved a recommendation of the Electricity Committee to purchase for £1 570 a plot of land of about 16 acres adjoining the land recently acquired for the new power station at Agecroft.

At a meeting of the leading ratepayers of THRAPSTON held last week in order to consider the question of introducing electricity supply into the district, a committee was appointed to make inquiries and report to a subsequent meeting. A sub-committee was also instructed to visit electricity works in the neighbourhood.

Owing to coal shortage the NOTTINGHAM Tramways Committee has decided to run the tramcars between 7 and 9 a.m., and between 12.30 and 6.30 p.m. Electric current for power is cut off at 4 p.m., but in order to relieve the situation the Emergency Committee has decided to convert eleven boilers for oil fuel.

Good progress is being made with the erection of the additional plant at the OLDHAM Electricity Works, including the second turbo-generator of 6 000 kW, two Babcock & Wilcox boilers, green economisers, switchgear, &c. The consulting engineer, Mr. R. Blakemore, has been instructed to proceed as soon as possible with the preparations of the scheme for a new generating station.

The NEWCASTLE & DISTRICT Electric Lighting Company has notified its consumers that, owing to the coal dispute it has become necessary to use oil fuel to maintain the supply of electricity. In consequence of the additional cost of production it has, however, become necessary to increase the charges for electrical energy supplied for power as from the June monthly meter readings. The Company states that the present cost of a ton of oil is equivalent to a ton of coal at 70s., and on this basis the charges are to be advanced under the coal clause in the contracts.

Last week LIVERPOOL Corporation endorsed an arrangement between the Housing and the Tramways and Electric Power and Lighting Committees for the laying of supply mains to the various housing areas. The Housing Committee will pay annually a sum equivalent to the amount of interest and sinking fund on the capital expenditure. The wiring of the houses has already been put in, and the Housing Committee will make a charge to the tenants to cover the wiring and other expenditure as well as the current supplied.

The STAFFORDSHIRE, WOLVERHAMPTON & DUDLEY Joint Committee for Tuberculosis has provisionally adopted a scheme and accepted tenders for electric lighting and heating of Prestwood House. It is proposed to use water power for the generation of current, and the following tenders have been accepted, subject to the approval of the Ministry of Health : Warburton & Company, amounting to £4 324 10s., including generator and switchboard of Rees Roturbo type ; Couzens & Akers, for electric wiring and fittings, £2 650.

The accounts of the CANTERBURY electricity department for the year ended March 31 show a total capital expenditure of £82 695, an increase of £4 760 during the past year. The income was £20 679, an increase of £4 213 over 1919-20. The expenditure was £15 160, against £11 451, coal accounting for £1 820 and salaries and wages for £872 of the increase. The gross profit is £5 519, an increase of £505. Sinking fund, interest and income tax amounted to £4 475, leaving a net profit of £1 043. 1 021 883 units were sold, against 870 058.

BIRMINGHAM Electric Supply Department proposes to acquire land, known as the Whitacre Meadows, for a connection with the railway. On Tuesday the Committee reported that there were some hundreds of applications for electricity services on the books, and others were coming in daily. The expenditure on this normal development called for about £30 000 per annum. Since the Committee last reported on the question of plant extensions the position had considerably altered. Owing to the present trade depression there is a margin of generating plant available for new business, and it has been found possible to connect up a large number of premises for lighting supplies. Further, when the first portion of the Nechells permanent station plant is in operation a considerable number of applications for power supplies can also be dealt with, provided funds are available for the connections. The new business which it is desirable to deal with expeditiously would call for a further sum of £50 000 in the near future, some of which was required immediately. In order, therefore, to carry on the work of the undertaking and to deal with its ordinary development, the Committee asks that they be authorised to expend £50 000 further on account of the provision of £146 400 included in the Nechells scheme, and subject also to their making suitable arrangements with the Finance Committee for raising the money and to obtaining the necessary sanction of the Electricity Commissioners. The Committee also asked for authority to carry out alterations at the Chester-street station, making it a sub-station, the steam generating plant being retained for emergencies. An expenditure of £15 000 would be necessary, but a net saving of £1 450 per annum was estimated.

The ELLESMERE PORT Urban Council has been in communication with the Electricity Commissioners in connection with the question of a supply of electricity for the district. The chairman of the Council (Councillor W. Stockton), who recently visited London, where, in company with representatives of the Mersey Power Company, he saw Sir John Snell, said his view was that the Council had no prospect of a supply for several years except from the Mersey Company. The chairman stated at the last meeting of the Council that it was, therefore, a question of transferring the Council's electric lighting order to the company or having the order revoked. The transfer would be made upon terms which would secure to the Council the reimbursement of the costs in getting it, and a clause could be inserted in the agreement providing for the acquisition of the undertaking by the Council at the end of 42 years at the then capital value, excluding goodwill.

In the course of the discussion, Mr. T. PERCIVAL said they were apparently going to be at the mercy of a private company. What was to stop the Mersey Power Company supplying electricity to householders at a cheaper price than the Council's gas? He hoped the Council would fight the matter. He moved that the Council fight it out and refuse to transfer the order without an explanation as to why they were being so treated.

Ultimately it was decided to inform the Commissioners that the Council were unable to make their decision yet and to ask for full particulars of the reason why they should be called upon to surrender their order to the Mersey Company.

Electric Traction.

The first railless trolly vehicle in use at ROTHERHAM was put into service last week.

A scheme for the construction of a light railway between AMBLESIDE and KESWICK has been referred by the Westmorland County Council to the Main Roads Committee for consideration.

The BURNLEY Tramways Committee has decided in view of the losses incurred during the financial years ended 1920 and 1921 to appeal against the assessment of the tramways undertaking.

A serious FIRE which occurred at the TORQUAY TRAMWAY DEPOT on Friday and caused the destruction of a number of tramcars, motor-omnibuses, charabancs, &c., was due to the explosion of a barrel of petrol. The damage is estimated at £20 000.

The EXETER City Council has instructed the Tramways Committee to revise the wages of the staff and to obtain a reduction in the charge for electric current, and failing a reasonable concession being made, the expediency of closing the undertaking is to be considered.

The income of the BLACKPOOL Corporation Tramways for the year ended March 31 amounted to £279 661, compared with £186 475 in 1919-20, or £9 600 more than estimated. The expenditure, estimated to be £203 000, was actually £235 338, and the gross profit was only £44 323. After meeting interest and other charges, the disposable balance is only £144. The gross capital outlay is £662 442, but the net indebtedness is only £436 900.

The accounts of the GLASGOW TRAMWAYS DEPARTMENT for the year ended May 31 show traffic revenue of £2 388 444. Passengers carried were 447 601 811, compared with 509 339 886, in the previous year, and car-miles run, 26 902 874 (increase, 443 859). On June 1 last fares were increased so that the minimum fare was ¾d. (paid by means of a coupon) compared with the previous minimum of ½d., the result being a decrease of 61 728 075 in passengers and an increase of £671 954 in receipts. Traffic receipts per car-mile were 21·307d. (increase 5·737d.).

The Highways Committee of the LONDON COUNTY COUNCIL has negotiated an agreement with LEYTON Urban Council for working the Leyton tramways for 10 years. It is estimated that the annual car mileage should reach 2 000 000, and on this basis, and taking receipts and expenses at the average of the Council's system, it is estimated that the gross annual revenue from the Leyton tramways would be £184 405, and the expenditure would be £176 515, leaving a balance of £7 890. Under the suggested arrangement for the division of the estimated surplus on the working of the combined London and Leyton systems, the District Council would receive £10 119 as their proportion, and the Council would thus lose approximately £2 000. It is asserted, however, that this deficiency would be more than counterbalanced by improvements and economies rendered possible by the agreement.

The agreement was approved at the meeting of the Council on Tuesday, when the chairman of the Highways Committee (Mr. SQUIRES) stated that the matter of OIL FUEL at the power station at Greenwich had been under consideration some time before the coal stoppage. Two of the largest boilers had been converted for oil fuel and were now under full steam. Two others were in process of conversion, and the work would be completed within a few days.

Institution Notes.

The report of the STUDENTS' SECTION of the SOUTH MIDLAND CENTRE OF THE INSTITUTION OF ELECTRICAL ENGINEERS shows the past session to have been entirely successful. There has been a large increase in the number of student members in the section and the membership has now reached a total of 210.

The following nominations have been made for the vacancies which will occur upon the Committee of the WESTERN CENTRE OF THE INSTITUTION OF ELECTRICAL ENGINEERS at the end of the present session. *Chairman*, Mr. A. C. MacWhirter; *First Vice-Chairman*, Mr. F. Tremain; *Second Vice-Chairman*, Mr. C. T. Allan. The seven following nominations are put forward to fill five vacancies on the Committee: Prof. F. Bacon, Messrs. W. A. Chamen, F. S. Carter, A. H. Dowson, W. Hardy, W. G. Heath and Prof. D. Robertson. Members may submit other nominations, which must be proposed and seconded, and accompanied by a letter from the nominee signifying his willingness to serve, and such nominations should reach Mr. A. J. Ostler, The Exchange, Corn-st., Bristol, by June 14.

At the recent annual general meeting of the Sydney Division of the INSTITUTION OF ENGINEERS OF AUSTRALIA, the result of the ballot for the election of the N.S.W. division officers and committee for 1921 was announced:—Mr. D. F. J. Harricks is chairman, Mr. C. E. Wright of Elder, Smith & Company, hon. secretary, and Mr. A. Morrison, hon. treasurer. The new committee consists of Messrs. R. J. Boyd, J. E Donoghue, A. D. J. Forster, R. Vine Hall, T. H. Houghton, T. H. Kirkpatrick, J. H. McTaggart, Wm. Poole, Walter Reeks, Wm. Sinclair, T. P. Strickland, J. P. Tivy, J. Vicars and F. V. Wikner. It will be remembered that the Institution was recently formed by the affiliation of the Engineering Association of N.S.W., the Electrical Association of Australia (N.S.W. Section), the Sydney University Engineering Society and the Institute of Local Government Engineers of Australia.

The BRITISH ASSOCIATION has issued its preliminary programme for the 89th annual meeting which will be held at Edinburgh from Sept. 7 to 14 next. The president (Sir Edwin Thorpe) will give an address on Aspects and Problems of Post-War Science, Pure and Applied, and among the addresses of presidents of sections, which will initiate debates are the following: Prof. O. W. Richardson on "Problems of Physics"; Mr. W. L. Hichens on "Principles by which Wages are Determined"; and Prof. A. H. Gibson on "Water Power." The Council summoned all Sectional Committees to consider a common action, and out of the various suggestions made some topics were selected to be debated by appropriate groups of sections at joint meetings. These topics include the structure of molecules, the age of the earth, and bio-chemistry. Prof. A. S. Eddington will give a popular exposition on the theory of relativity and public lectures will also be given. The speakers will include Sir Oliver Lodge, who will deal with speech through the ether.

At its meeting last week the SOUTH WALES INSTITUTE OF ENGINEERS resumed the discussion on the case for powdered fuel, as put in a Paper by Mr. Robert James, Wh.Sc., who gave an analysis of the pulverising costs of a plant dealing with fifty tons a day. After allowing for interest and depreciation, the total cost, including drying, &c., would be 7s. 6d. per ton. He referred to the plant for firing a Stirling boiler with powdered coal on the Holbeck system, which is approaching completion at the Hammersmith electricity works, and he also stated that the application of coal dust firing to locomotives was under test by the Great Central Railway. The chief mechanical engineer of the Company (Mr. J. G. Robinson) was said to be favourably impressed with the experimental results obtained. The advantages claimed for coal-dust fired locomotives include sustained boiler power, automatic firing, reduction of heat losses, easy fuelling and ability to use inferior coal.

In the discussion Prof. Bacon, M.I.Mech.E., M.I.E.E., of Swansea University College, remarked that the first thing to look for would be a very substantial saving in the matter of running expenses; and Mr. Geo. Roblignes, of Ponthenry Colliery, said that any experiments should be carried out at the expense of the whole of the anthracite owners, as all would reap any benefits that might accrue.

Business Items, &c.

Walter Stanley Bass and Reg. Alick Jones (trading as BASS & COMPANY), electrical engineers, 402, Essex-road, London, N., have dissolved partnership. Debts by Mr. Jones, who continues the business under the existing name.

Considerable extensions have been made recently to the works of the LANCASHIRE DYNAMO & MOTOR COMPANY, LTD., at Trafford Park. Two large bays have been added, making the area covered by the company's works 17 000 sq. yds., and at present there are nearly 1 000 persons employed. In connection with the company's welfare scheme, a new canteen is being equipped for about 500 persons, while a recreation ground has been provided for cricket and outdoor sports.

Messrs. Sanders, Rehders & Co., Ltd., have transferred to the SARCO ENGINEERING AND TRADING COMPANY, LTD., King's House, 36 and 38, Kingsway, W.C. 2, the London and Manchester business of their two engineering departments (the "Sarco" and the "Machinery") for the purpose of their greater development. The Sarco Department has been specialising for more than 30 years in fuel saving and furnace control apparatus, while the Machinery Department has been engaged in buying and shipping all kinds of machinery, plant, rolling stock, &c. The stock of Sarco apparatus and goods, with the department books and accounts, have been transferred to the new company, whose telegraphic address is Sarcosian London; telephone No. Holborn 5821. The Sarco Company has opened a workshop and warehouse at 124, Long Acre, W.C. 2.

Imperial and Foreign Notes.

The Demerara Electric Company has now started to build its own tramcars in the Colony, native wood being used for the purpose.

Lithgow (N.S.W.) Council has applied for Government sanction to a loan of £5 000 for carrying out the first portion of its electric supply scheme.

Kyneton (Victoria) Council have asked Messrs. Christie & Gardner to prepare a report on the advisability of establishing electricity works

The Portland Electric Supply Company, Portland, N.S.W., is being formed with a capital of £3 000. The Company is to take current in bulk from the Commonwealth Portland Cement Company.

Port Kembla (N.S.W.) Council is borrowing money for establishing electricity works. The Port Kembla Amusements Company, which has hitherto supplied current in the township, complains of being ousted.

The Government of India propose to pass legislation in order to compel practically all classes of ships to install wireless telegraph apparatus. Public opinion seems to favour wireless on all ships, but it is probable that sailing ships and small coastal steamers will be excluded from the ambit of the proposed legislation.

Recent delays in cablegrams to India and the Far East are explained by the temporary interruption necessitated by large renewal work carried out on the Eastern Telegraph Company's Red Sea cables. The work is being undertaken in order to increase the carrying capacity of the cables, and when it is completed, in a few weeks, the service with India and the Far East will be vastly improved. Unfortunately one of the cables in the Pacific became interrupted while the Red Sea operations were being carried out, and the whole of the traffic between the United States and the Far East was thrown on the Eastern Company's system.

A wireless station is being erected at Maracaibo (Venezuela), which will have a radius of 1 500 miles by day and 500 miles at night.

The French journal, "Vie Financière," of the 14th ult., announced that the Cie Générale de T.S.F., has concluded a contract for 30 years with the Government of Ecuador for the working of the telephones, telegraphs and wireless service in that State. The Government will pay the company an annual subsidy of 430 000 sucres (about 1 200 000 francs) which will be increased in the event of extensions of the system. The company will deduct from the gross receipts the sums necessary for working the lines, paying interest on the capital and for sinking fund, but the State will have a share in the net profits. The telephonic apparatus will be automatic and constructed on a system perfected by French experts; the telegraphic and wireless apparatus will also be on French models.

Miscellaneous.

The Local Legislation Committee of the House of Commons struck out the motor omnibus clauses of the Burnley Corporation General Powers Bill.

The death is announced of Mr. E. L. Lalonde, who was for many years general manager in Mauritius of the Oriental Telephone and Electric Company.

The Apex Steel Company has recently installed a new Greaves-Etchells Electric Furnace at its Sheffield works. A furnace of the same type has also been installed at a foundry in South Wales for producing steel castings.

Francis Forbes and Fredk. Wm. Collett have applied for the Restoration of a Patent, No. 108 392 (13 798 of 1916), for "Improvements in or relating to Therapeutic Arc Lamps," which expired on Sept. 28, 1920, owing to non-payment of renewal fee.

The death took place on May 30, at the Cumberland Infirmary, of Mr. William S. Hetherington, a member of the electrical staff of Hetherington Bros., of Penrith. Deceased was 27 years of age, and during the war served with the motor transport.

In the June number of "Garden Cities and Town Planning," issued by the Garden Cities and Town Planning Association, 3, Gray's Inn-place, London, W.C.1, there is an interesting article giving the reader an insight into the skilled operatives' point of view of the housing question, and another article describing the activities of the Building Guilds and their aims and objects.

In the House of Commons last week the Postmaster-General, replying to a question, stated that any agreement which might be made between the Government and Marconi's wireless telegraph company with regard to the combined land and wireless service between London and Paris would be laid before Parliament. As no charge will be thrown upon public funds, confirmation by a resolution of the House of Commons was not required, but if there was a general desire for discussion he would consult the Leader of the House as to the possibility of meeting it.

At Bow-street (London) Police Court last week the summons against Frederick Newington, branch secretary of the Electrical Trades Union at Wandsworth for committing an act likely to cause disaffection in the army was withdrawn. A man named Freeman, whilst with the Defence Force, received a letter asking him why he had joined the force at such a critical time, and adding that one member had been expelled for similar action. Freeman did not reply, and was expelled by resolution of the branch. It was stated that Freeman and the other man would be reinstated, and the resolution expelling Freeman had been rescinded.

Personal and Appointments.

Sir Isambard Owen, Vice-Chancellor of Bristol University, will retire at the end of the present session under the age limit.

In consequence of the postponement of the sailing of the "Celtic," Prof. Einstein's Lecture (in German) on "Relativity" will not be delivered at King's College, London, until Monday, June 13.

Owing to ill-health Mr. J. G. Griffin has resigned his position as general manager of the Delhi Electric Tramways and Lighting Company, Ltd., as from Dec. 30, but his services have been retained as consulting engineer for the Company in London. Lieut.-Col. C. Barber, A.M.I.C.E., succeeds Mr. Griffin as general manager in Delhi.

Mr. John Bunting, who has been associated for over 20 years with Messrs. Bruce Peebles & Company Ltd., of Edinburgh, is severing his connection with that firm to join the Ateliers de Constructions Electriques de Charleroi, for whom he is opening a branch at 56, Victoria-street, London, S.W. 1.

The King's birthday honours list contains few names connected with engineering and science, although the following may be mentioned:

Baronet.—Joseph Wm. Isherwood (the well-known naval architect and inventor of the Isherwood system of longitudinal construction of ships).

Knights.—Henry Hollingdrake (of Henry Hollingdrake & Sons, Ltd., Stockport); Walter R. Preston (M.P. for Stepney and a director of J. Stone & Co.); Dr. Sydney Russell Wells, B.Sc. (Vice-Chancellor of the University of London).

C.B.—Wm. Chas. Fletcher (Chief Inspector of Secondary Education under the Board of Education); and Llewellyn S. Lloyd (Assistant Secretary to the Department of Scientific and Industrial Research).

Mr. Alexander Moir, O.B.E., superintending engineer of the London District of the Post Office, is about to retire after nearly 47 years' service. Mr. Moir started his official career in his native town, Aberdeen, and subsequently served in Edinburgh, Bradford, Leeds, Newcastle, Dublin and London. In 1903 he was attached to the staff of the Engineer-in-Chief as head of the construction section, in which capacity he was responsible for the methods to be adopted in the construction of overhead and underground plant, and for laying the main trunk underground routes. Prior to 1912 the London engineering work was in charge of three and subsequently of two superintending engineers, each of whom was also responsible for a provincial area. On the transfer of the National Telephone Company's business to the State the present London Engineering District was formed and placed under Mr. Moir's control. The District contains (*inter alia*) 56 telephone exchanges and the largest telegraph office in the world. The outdoor plant includes 1¼ million miles of wire and the telephones in use in the District at present number 303,000. Mr. Moir controls a staff of nearly 6 000, a large proportion of which is at present engaged in overtaking the arrears of construction due to the war. About 50 per cent. of the staff joined the forces; the remainder, in addition to keeping the telegraph and telephone services running smoothly and providing some thousands of special circuits for war purposes, built up the extensive system of communication in connection with the London Air Defences. For these services Mr. Moir was made an Officer of the British Empire. He is Chairman of the Committee of P.O. Superintending Engineers and was a member of the War Office Committee responsible for the introduction of the scheme of army signalling.

An interesting ceremony took place on the 31st ultimo when Sir William Noble, the Engineer-in-Chief, presented Mr. Moir, on behalf of the staff of the District, with a grandfather clock and Mrs. Moir with a diamond brooch.

Bankruptcies and Liquidations.

Mr. Cyril Rhodes, Carlisle-chambers, Goole, has been appointed trustee in the bankruptcy of Horace Edgar Carr, electrical engineer and contractor, Carlisle-street, Goole.

A first and final dividend of 3s. is payable at 26, Baldwin-street, Bristol, to creditors of Jas. S. Denley (trading as Denley & Company), electrician and cycle dealer, 69, Regent-street, Cheltenham.

A meeting to receive an account of the winding up of Electro-Chemical Developments, Ltd. (in voluntary liquidation), will take place on July 4 at Waye, near Ashburton, Devon.

Claims against the Ampere Electrical Engineering & Plating Company, Ltd. (in voluntary liquidation), are to be sent by July 1 to Mr. T. L. Hammond, North-Eastern Bank Chambers, South Shields.

Stoneycroft Electrical Works, Ltd., 20, St. Anne's-street, Liverpool, is being wound up voluntarily, and appointed as liquidator Mr. E. Chetter, 26, North John-street, Liverpool, at which address a meeting of creditors will be held on June 17.

Lacy-Hulbert & Company, Ltd., is in voluntary liquidation for the purpose of reconstruction. The claims of all creditors will be paid in full. A notice referring to the registration of the new company, Lacy-Hulbert & Company (1921), Ltd., appeared in our last issue.

The adjudication in bankruptcy of Wm. Henry Pease, electrical engineer, lately trading at Royal Hotel Shops, Scarborough, and 19 and 20, Baxter-gate, Doncaster, has been annulled, the debts proved in the bankruptcy having been paid in full.

The first meeting of creditors of Reg. Percival Baker and Fredk. Clarence Stubbs, trading as the Sheffield Electric Construction Company, 124, Pond-street, Sheffield, will take place on June 14 at the Official Receiver's office, Figtree-lane, and the public examination on July 7 at the County Court Hall, Bank-street, Sheffield.

Catalogues, Price Lists, &c.

Messrs. Higgs Bros., of Sandpits, Birmingham, have issued their June stock list of a.c. and d.c. motors and dynamos, the prices given being subject to a discount of 27½ per cent.

A leaflet (No. F.2451) on Semi-Indirect Pendants for use with Osram Gasfilled Lamps is being circulated by the General Electric Company, Ltd., Magnet House, Kingsway, W.C.2. Illustrated particulars of a number of artistic designs (with prices, &c.) are given in the leaflet, which is of particular interest at present, especially as regards the company's catalogue numbers F.C.1172 and 1173 units, which are very suitable for use with the new smaller size of Osram gasfilled lamps.

The Mirrlees-Watson Company have issued a pamphlet describing the surface-condensing plant supplied by them for the Dalmarnock power station of Glasgow Corporation. A plan is given of arrangement of the plant, fitted with rotary and multi-ejector air pumps. The plant is designed to deal with the exhaust steam from a turbo-alternator with a rating of 15 000 kW and overload capacity of 18 750 kW, the steam duty at overload being 210 000 lbs. per hour.

Messrs. Alfred Herbert, Ltd., of Coventry, who are sole agents for the Norton grinding and polishing machines and co-agents for the Norton grinding wheels, are circulating a beautifully illustrated pamphlet on "grinding practice and manufacturing progress," which gives particulars of various applications of grinding machinery to modern engineering industries. The examples given include the manufacture of motor cars and trucks, phonographs, small tools, tractors, oil engines, rolling stock, &c., and the whole forms an attractive and interesting form of publicity.

The General Electric Company, Ltd., Magnet House, Kingsway, W.C.2, have inaugurated an intensive campaign in co-operation with the trade for the purpose of stimulating the demand for their well-known Freezor Fans. A new price list (V 2 532), giving particulars and prices of their fans, has been issued recently, and, in addition, the Company are now issuing striking posters, a folder price list (V 2 543) and a large poster which is printed in colours and measures 19½ × 14½ in. Quantities of the folders, overprinted with retailer's name and address, can be supplied, together with adhesive advertisement stamps, with a good illustration of the fan for the purpose of attaching to correspondence, envelopes, &c. The publicity department of the Company also offer to co-operate in other ways with retailers for the purpose of popularising the fans.

There is probably no firm which has a longer and more successful experience in the manufacture of primary cells and batteries than Messrs. Siemens Bros & Company, Ltd., of Caxton House, Westminster, S.W.1, and Woolwich, and therefore the trade will welcome the publication by the firm of a series of four post-war editions of their catalogues of these products. The first (No. 600) is their main catalogue of primary cells and batteries. Nicely printed and well illustrated, it contains 88 pages of the latest and most complete particulars relating to the principal dry and fluid primary cells and batteries manufactured by the Company at Woolwich. This publication is really an enlarged and comprehensive edition of their pre-war catalogue, and it will prove a useful and instructive guide, more particularly to those who employ primary cells in considerable numbers. Two other lists (531A and 537) are to some extent made up of extracts from the principal catalogue, and relate respectively to Leclanché cells and batteries and to dry cells and batteries. The fourth catalogue (No. 531D), relating to fluid and dry cells and batteries, has been prepared in order to meet the requirements of dealers in and users of these cells, and who are sometimes less acquainted with the technical side of the subject, being mainly interested in the types of cells generally employed. The Company's technical staff at Woolwich has denoted a close and unrelaxed attention for over 50 years to this branch of the electrical industry, with the result that the firm retain their leading position in the manufacture of primary batteries. The various catalogues contain full technical details of the various cells and batteries, and also a large amount of information which should be useful to dealers, users and all interested in primary cells.

The British Insulated and Helsby Cables, Ltd., of Prescot, Lancs., have issued a pamphlet giving particulars of their Helsby "Ozone-proof" Cables for high voltages. Experience has shown that even the best rubber-insulated cables, when used on high-voltage circuits, are liable to break down in a mysterious way. The pamphlet states that exhaustive research has convinced the engineers of the firm that the action of ozone which is freely developed on the suface and at the ends of cables subjected to high voltage is responsible for many of these failures. Vulcanised india rubber deteriorates slowly by oxidation when exposed to the air, and this deterioration is more rapid when the rubber is exposed to the action of ozone. The Helsby "ozone-proof" in a cable is specially designed to meet this difficulty. The internal and external surface of the vulcanised rubber is protected by a layer of special dielectric, which is insensitive to the action of ozone, air or copper salts, all of which affect rubber in greater or less degree. The special dielectric does not reduce the flexibility of the cables. Particulars are included of single, concentric, and three-core cables manufactured by the firm and designed for voltages from 2 200 to 11 000.

The firm have also issued a pamphlet containing information about their Prescot Insulating Varnishes. These varnishes are described and particulars are given of the method of application, stoving temperatures and consistency, with the results of recent tests. The varnishes referred to contain as a base an extremely elastic rubber-like gum which is manufactured only at the company's Prescot works, and the advantages claimed include freedom from corrosive acidity, great flexibility, brilliant gloss and resistance to water, acid fumes and fatty and hydrocarbon oils.

Tenders Invited and Accepted.

West Ham Guardians want tenders by June 16 for three months supply of electrical fittings, engineers' oils, &c. Forms of tender from the Clerk, Union-road, Leytonstone, E. 11.

Nottingham Electricity Committee want tenders by June 16 for the supply of general stores for 12 months. Forms of tender, &c., from the Electrical Engineer, Talbot-street, Nottingham.

Manchester Electricity Committee require tenders by June 28 for six months' cable requirements, and by June 21 for six months' supply of marine stores. Specificatuons, &c., from Mr. F. E. Hughes.

Manchester Electricity Committee want tenders by June 17 for 12 months' supply and erection of static transformers. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Edinburgh Corporation requires tenders by June 22 for the wiring of houses comprised in the Gorgie housing scheme (southern section). Specifications from the Engineer, Dewar-place, Edinburgh.

Tenders are invited up to July 11 for the supply to the Postmaster-General's Department, State of Tasmania, of switchboard material (Schedule T.317). Specifications from the Office of the High Commissioner for Australia, Room E.5, Australia House, Strand, W.C.2.

The Borough Council of King William's Town (S. Africa) invites tenders for steam-driven electrical generating machinery, boilers, switchgear and cable. Specifications from Messrs. Dyer & Dyer, 17, Aldermanbury, London, E.C.2, to whom tenders by June 25.

London County Council invite tenders for the supply, delivery and erection of one 8 000 kW steam turbo-alternator and exciter, condensing plant, &c., and seven 1 000 kW rotary converters, static transformers and accessories. Specifications from the Clerk of the Council, County Hall, Spring Gardens, S.W., to whom tenders should be delivered by 4 p.m., July 11.

The Victorian Government Railways Commissioner, Melbourne, requires tenders by Aug. 10 for 250 impedance bonds for power signalling (Contract 34 130) and 56 miles of insulated copper wire (Contract 34 131), and by Aug. 17 for renewals for 3 000 sets of caustic soda primary cells (Contract 34 145). Specifications can be seen at the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1.

Llandaff & Dinas Powis Rural District Council invite tenders for the supply and laying of e.-h.-t. feeder, with switchgear, sub-station equipment, complete system of feeders and distributing cables, with services, for about 800 houses. Specifications from the engineer, Mr. R. Howard Fletcher, B.A., M.I.E.E., 20-22, Queen-street, Cardiff, and tenders to the clerk, Mr. M. Warren, Park House, Cardiff, by June 22.

The Wairoa (N.Z.) Electric Power Board invite tenders for the supply of material for an 11 000/3 300 V 600 kW outdoor sub-station, including four 200 kVA transformers (11 000/1 900V), insulators, air-break switches, fuses, lightning arresters and choke coils, accessories, &c. Tenders (by July 31) to Messrs. Hay & Vickerman, Wellington, N.Z.

The Victorian Government Railway Commissioners invite tenders (by July 27) for the supply and delivery of 24 000 metal filament lamps for electric car lighting (46-W, 116-V) and 4 000 carbon filament lamps (32-W, 140-V), and (by Aug. 3) for a 5-h.p. electric motor, controller and resistances, &c. Tenders to the Commissioners, Spencer-street, Melbourne.

The New Zealand Public Works Department invite tenders for the supply and delivery at Lyttelton of two 50-kVA, two 100-kVA and two 200-kVA condensers, in connection with the Lake Coleridge electric power supply scheme (Section 116); and also for 10 single-phase oil transformers for the Waikato power scheme for converting three-phase current at 50 cycles, the voltage ratio being 50 000/11 000. Tenders by June 28 to the Secretary of Public Works, Tenders Board, Wellington.

New Zealand Public Works Department also invite tenders for suspension type porcelain insulators to carry 110 000 V 50-cycle transmission lines in connection with the Waikato power scheme. Tenders by August 9 to the Secretary, Public Works Tenders Board, Wellington. Specifications may be seen at the Department of Overseas Trade.

Worksop Urban Council has accepted the following tenders: W. T. Glover & Company, cables, £13 042; Metropolitan-Vickers Electrical Company, switchgear, £3 763 15s.; transformers, £2 328, and rotary converter, £4 381 10s.

Four tenders were received for the reconstruction of the Belfast tramway track, and the Tramways Committee recommend the acceptance of the tender of the Consolidated Construction Company, at £200 643 14s. 3d.

St. Pancras (London) Borough Council recently received 14 tenders for the supply of l.t. cable, varying from £9 739 to £12 316, and the lowest (that of the Hackbridge Cable Company) has been accepted. For h.t. cable 14 tenders were also sent in, varying from £2 461 to £4 015, and that of the Western Electric Company (at £2 429) was accepted.

In response to Messrs. Merz & McLellan's invitation of tenders in England for two turbo-generators for the Newport power-house of the Victorian Electricity Commissioners, six tenders (all from British manufacturers) were received, and the Commissioners have decided to accept that of C. A. Parsons & Company for the manufacture and delivery of two 15 000-kW turbo-generators at £100 000. This was the lowest tender for the type of generator considered suitable. The plant is to be delivered and erected within 18 months. Messrs. Parsons manufactured all the existing plant in the Newport power house of the Railways department. The Commissioners expect to have the new power-house in operation before the middle of 1923.

Patent Record.

SPECIFICATIONS PUBLISHED

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

12 157/14 Lederer. Electric gas-filled glow discharge lamps. (19/5/13.)
126 635 Soc. Anon. Dite "Calor." Electrically-heated soldering irons. (6/5/18.)
13[illegible] 954 Trembour. Electric furnaces. (24/3/16.)
135 212 Schrodder. Electric seam-welding machines. (8/6/18.) (Addition to 133 700.)
135 482 Schrodder. Electrical seam-welding machines. (12/6/18.)
135 485 Pintsch Akt.-Ges. Electric gas lamp with glow discharge. (27/10/17.)

Relates to an electric lamp operating with a luminous discharge in a rarefied atmosphere of neon or other rare gas, wherein the pressure of the gas is so selected and the electrodes, the nature and area of the surfaces are so chosen, according to the nature and voltage of the commercial supply, are arranged at such a distance from one another that the lamp will start on voltages of commercial supplies without any special starting device and substantially the whole of the light emitted will be confined to the surface of the cathode.

137 856 Bosch (Firm of). Electrical condensers. (15/3/15.)
140 753 Ogden. Methods of constructing electric resistance girds. (21/3/19.)
142 795 Bosch Akt.-Ges. Electric motors for starting internal-combustion engines. (5/5/19.)
142 851 Western Electric Co. Telephone exchange systems. (17/8/16.)
143 220 Western Electric Co. Electrical connectors. (16/8/18.)
143 865 Pilon. Electrical systems containing X-ray or like apparatus. (19/8/19.)
144 997 Grimaud. Dynamos for use with lighting and starting devices upon motor-vehicles. (13/6/19.)
145 467 Siemens-Schuckertwerke Ges. Commutators for dynamo-electric machines (27/6/14.)
145 777 Siemens & Halske Akt.-Ges. Electric amplifying device such as thermionic valves.

Comprises an arrangement for the prevention of disturbing coupling reactions (self-excitation, speech distortion),in amplifying devices having one or more amplifiers in which all the elements of the arrangement (conductors, transformers, amplifiers, &c.) through the mutual capacities of which parts of the amplified current can return to the receiving end thereof, or of a preceding amplifier, are surrounded by metallic cases of any kind, which are electrically connected together, and with a pole of each battery, or of the common battery (in the case of valve amplifiers, heating battery).

146 184 Pechkranz. Electrolysers. (27/6/19.)
146 921 Tournayre. Magnetos. (28/6/19. Patent of Addition not granted.)
147 089 Munz. Brush holders of electric dynamos. (5/4/19.)
147 786 Apple. Armature cores for dynamo-electric machines. (8/3/19.)
148 450 Optische Ansalt C. P. Goerz Akt.-Ges. Electrodes for electric searchlights (24/9/18.)
149 289 Akt.-Ges. Brown, Boverie et Cie. Electric induction regulators cooled by forced draught. (15/7/19.)
149 940 Alkan. Snap-action switches for electric lighting circuits. (19/7/19.)
152 686 Smalley. Electric furnaces. (21/10/19.)
153 562 Fabriques des Montres Zenith. Magnetos having rotating armatures. (6/11/19.)
160 191 Hewson. Electric ovens. (20/1/20.)
160 195 Berry. Electric fuses, heating elements and the like. (1/9/19.)
160 196 Trichard. Electric wave form indicators or oscillographs. (5/9/19.)

Comprises the use of a thermionic valve having three electrodes disposed in series with the test piece whose tension is to be analysed and with a condenser connected to a voltmeter, forming a principal circuit comprising the filament and the plate of the valve; the whole in combination with a secondary stopping circuit comprising the filament, the grid, a constant tension generator, and an alternating tension obtained from the analysed tension through a variable phase-transforming device, the voltmeter recording at each phase difference a corresponding ordinate of the wave.

160 201 Lane, and Indicators, Ltd. Electrical-testing apparatus. (9/10/19.)
160 204 Parsons & Ball. Electric Clocks. (17/10/19.)
160 209 Electromotors, Ltd., Longbottom & Greenhalgh. Electric driving and controlling gear for planing-machines. (6/11/19.)
160 211 Smith & Healey. Ammeters, voltmeters and other recording and indicating instruments. (8/11/19.)
160 218 British Electric Transformer Co., Ltd., & Sims. Electric connections. (14/11/19.)
160 231 Newall. Electric furnaces for calcining magnesia and for similar purposes. (9/12/19.)
160 243 Murray and Telephone Mfg. Co., Ltd. Telephones. (13/12/19.)
160 244 Bulle, Favre, & Lavet. Diaphragm and like vibrators operated by alternating electric current. (13/12/19.)
160 246 Imeson & Hunter Electrical-signalling apparatus for use in mines and other places. (13/12/19.)
160 250 Murray, Erskine-Robinson & Crowther. Radio-navigational apparatus and the like. (15/12/19.)
160 251 Murray, Erskine-Robinson & Crowther. Radio-navigational apparatus and the like. (15/12/19.)
160 255 Le Tall (Westinghouse Electric & Mfg. Co.). Electrically-driven sewing machines. (15/12/19.)
160 257 Withers (Renault). Electric lighting systems for automobiles and other vehicles. (15/12/19.)
160 260 King. Mounting of rotary shafts for electric motors, dynamos and rotary converters. (16/12/19.)
160 261 Railing & Connaught. Electric-signalling apparatus. (16/12/19. Addition to 139 994.)
160 283 Villiers Engineering Co., Ltd., Farrer and Boutney. Contact-Breakers for ignition magnetos and the like. (19/12/19.)
60 302 Morris, Ltd., and Weston. Alternating current electric control mechanism for cranes or other hoisting gear. (31/12/19.)
160 307 B.T.-H. Co. Ltd., Taylor, Hutt and Clough. Dynamo-electric machines (2/1/20.)
160 317 Allison. (Narabayashi). Filling for storage batteries. (8/1/20.)
160 330 Bolton. Apparatus for grinding electric commutators or distributors. (22/1/20.)
160 348 Joseph. Electrical heating-apparatus. (10/2/20.)
160 354 Midland Electric Mfg. Co., Ltd., & Sutherland. Electrical fuses, switches. and the like. (19/2/20.)
160 375 Williams. Terminal electrical connections suitable for sparking plugs of internal combustion engines. (10/12/19. Divided Application on 151 349.)
160 383 Austin. Electric fuses. (31/5/20.)
160 388 Roe. Electric contact makers and circuits connected therewith for railways and the like. (21/6/20. Patent of addition not granted.)

Complete Specifications.

160 475 Round. Wireless direction finders. (19/8/19.)
160 478 Bishop & Chadwick. Pulleys for use with trolley poles of electric tramcars and for other purposes. (9/9/19.) (Cognate Application 9 303/20.)
160 486 Berry. Electric heat radiators. (22/10/19.)
160 497 Westney & British Ever Ready Co., Ltd. Electric switches. (21/11/19.)
160 502 Chandler. Wireless receiving apparatus. (24/11/19.) (Cognate Application 14 683/20.)

Comprises a corrector circuit consisting of a condenser and an inductance coupled to a disturbing source and connected in parallel with the primary of an intervalve transformer in which the influence of the disturbing source is neutralized by the action of the condenser and inductance.

160 518 Kenyon. Electric welding. (17/12/19.)

APPLICATIONS FOR PATENTS.

Dec. 14, 1920.

35 192 Elwell & Mamlok. Control of high-frequency electrical oscillations.
35 195 Metropolitan-Vickers Electrical Co. Motor starting systems. (3/6 0, U.S.)
35 199 Peters. Electric geysers.
35 213 Henley's Telegraph Works Co. & Judge. Jointing submarine cables.
35 225 Sykes. Thermionic valves.

December 15, 1920.

35 250 Hubbard. Magnet brakes.
35 297 B. T.-H. Co. (G. E. Co.) Reactors, &c.
35 303 West. Liquid electric motors controller, &c.
35 308 Sorelli. Feeding traction lines with direct current. (15/12/19, Italy.)
35 316 Western Electric Co. Telephone exchange systems.
35 319 Ges. fur Teerverwertung. Electrodes of large cross-section. (27/11/19, Germany.)
35 336 Round. Wireless transmitting stations.
35 337 Franklin. Aerial systems for wireless telegraphy and telephony.
35 338 Soc. Francaise Radio-Electrique. Duplex telegraphy and telephony. (16/1/20, France.)
35 340 Smith. Electric coupling devices.
35 352 Kirk & Milliken. Cord grips for electrical apparatus.
35 360 Lyto, Ltd., & Forbes. Galvanic battery containers.

December 16, 1920.

35 362 Murray. Detent for printing telegraphs, &c.
35 378 Hallowell. Dynamos for motor cycles, &c.
35 380 Automatic Telephone Mfg. Co., Electrical Improvements, Ltd., & Hudd. Indicating position of apparatus or conditions of circuits at a distance.
35 391 Joyner & Butler. Electric heaters.
35 392 May & Padmore. Electric heaters.
35 408 Swinton. Thermionic tubes or valves.
35 418 Fabriques des Montres Zenith Succ. de G. Favre-Jacot et Cie. Electric meters. (5/8/15, Switzerland.)
35 420 Reyrolle & Mirrey. Plug and socket connections for cables.
35 436 Lectner. Accumulators.
35 438 Garrett (R.) & Sons & Serve. Safety controlling gear for electric vehicles.
35 445 Craig. Electrically wound clock.
35 446 Bock. Electric burglar and fire alarms.
35 458 Fontana & di Pietro. Electric stoppage, &c., indicators.
35 464 Preston, Golding & Hodgson. Thermionic valves.

December 17, 1920.

35 469 Taylor. Superposing currents of different frequencies upon alternating-current systems.
35 486 Crossley. Machines for popping barley by electrical methods.
35 498 Gabriel. Electric lamps.
35 510 Beaver & Claremont. Insulation of cables.
35 528 Cracoanu. Fuses. (17/12/19, Germany.)

December 18, 1920.

35 578 Corrall. Electric, &c,. furnaces for treatment of metals.
35 620 B. T.-H. Co. (G. E. Co.) Resistance material.
35 626 & 35 627 Royce. (Bernard.) Protective devices for transmission systems.

December 20, 1920.

35 675 Wild. Electric gas-lighting devices.
35 694 Beckton. Clip for regulating height of electric lamps.
35 710 Callender's Cable & Construction Co. & McCrudden. Junction boxes for cables.
35 715 Bacon & Bolton. Circuit beakers, &c.
35 730 Metropolitan-Vickers Electrical Co. Treatment of steam to prevent corrosion of apparatus.
35 731 Metropolitan-Vickers Electrical Co. Preventing corrosion of turbine blading.
35 734 Scharpenberg. Electrical cable sockets or lugs. (2/1/20, Germany.)
35 749 Sullivan. Electrical condensers.
35 751 Soc. Anon. Aclastite. Connecting metal parts by insulating material. (16/5/19, Italy.)
35 755 Davis. Calling devices operated by wireless signals.

December 21, 1920.

35 775 Taylor. Superposing currents of different frequencies upon alternating-current systems.
35 825 Metropolitan-Vickers Electrical Co. & Fletcher. Induction-motors.
35 826 Arden-Pye. Reflector for electric bulbs.
35 845 Automatic Telephone Mfg. Co. Telephone systems.
35 861 Ferry. Telephone conversation meter.

December 22, 1920.

35 889 Royston. Electric horns for automobiles.
35 891 Lawrance. Trollies for overhead system tramways.
35 912 Marelli. Magnetos.
35 915 Methuen. Electric lamp locking ring.
35 919 Bailey. Motor starter.
35 922 Field. Electric instruments.
35 931 Haddan (Regan). Detecting damaged ramps in train electrical control systems
35 932 Yeo. Device for use with telephones.
35 938 Western Electric Co. Selector switches for automatic telephone systems.
35 950 Masseroni. Thermo-electrical apparatus for heating flowing liquids. (24/5/20, Italy).
35 953 Thorpe & Willing. Storage battery and recharging system.
35 976 Inrig. Electro-chemical treatment of petrol cans to prevent corrosion, &c.
35 992 Connas. Electrical treatment of ores.

December 23, 1920.

36 019 Groise. Electric control mechanism of race games.
36 054 Haddow & Rutherford. Electric lamp holders.
36 077 Taylor. Transmission cables.
36 082 Frampton. Switches.
36 084 Pintsch (J.), Akt.-Ges. Electric lamps with luminous discharge.
36 086 Soc. Anon. pour l'Exploitation des Procedes M. Leblanc-Vickers. Electric valves. (23/12/19, France).
36 112 Landau. X-ray plates.
36 116 Hazeltine. Converting d.c. into a.c. by electrostatically controlled installations (28/11/19, U.S.)
36 127 Telephone Mfg. Co. Diaphragm mountings for telephones, &c.
36 131 & 36 132 Dessauer & Veifa-Werke Vereinigte Elek. Inst. Frankfurt-Aschoffenburg. High-tension transformers. (29/9/15 and 7/10/15, Germany.)
36 133 Reiniger, Gebbert & Schall Akt.-Ges. Transformers. (16/5/18, Germany.)
36 134 Dessauer. High-tension transformers. (23/6/20, Germany.)
36 135 Norballe. Petrol, electric, &c., generating apparatus.

December 24, 1920.

36 142 Powell. Electric controllers, starters, switches, &c.
36 144 Jones & Rice. Electrical cooking indicator.
36 165 Automatic Telephone Mfg. Co. Telephone systems. (27/12/19, U.S.)
36 170 Plauson & Vielle. Electrodes and electrolysis. (6/7/18, Germany.)
36 233 Marconi's Wireless Telegraph Co. (Davis). Wireless transmitting apparatus.
36 251 Morris, Airey, Shearing & Preston. Valve transmitters for wireless telegraphy, &c.
36 252 Hodgson & Mullard & Preston. Supports for filaments in thermionic valves, &c.

Companies' Reports, &c.

The directors of the **British Electric Traction Company** recommend a dividend of 4 per cent. on the ordinary stock for the year ended March.

The directors of the **Western Telegraph Company, Ltd.**, have declared the third quarterly interim dividend of 5s. per share (tax free) for the year ending June 30, 1921, being at the rate of 10 per cent. per annum. The transfer books will be closed from June 9 to 16 inclusive, and the dividend will be payable on the 24th inst.

The revenue of the **Lewes & District Electric Supply Company, Ltd.**, for the year 1920 was £7 779, and working expenses were £5 361, leaving £2 418. After providing £440 for debenture interest and adding interest, £54, and £837 brought forward, there remains £2 869. The directors recommend placing £1 750 to renewals fund and carrying forward £1 119.

The capital expended by the **Merthyr Electric Traction & Lighting Company, Ltd.**, during 1920 amounted to £10 016, making the total on the traction undertaking £75 454 and on electricity supply £92 124. The total revenue was £52 105, and after deducting all expenses, including £3 523 for debenture and other interest, and providing £5 000 for renewals the balance is £5 948, plus £581 brought forward, or an available total of £6 529. The directors propose to place to reserve £1 200, to pay a dividend at the rate of 6 per cent. per annum on the ordinary shares, carrying forward £1 429.

The directors' report of the **Electric Construction Company, Ltd.**, for the year ended March 31 last states that, after providing £6 140 for debenture interest and £10 000 for depreciation, the profit was £83 110, and with the amount brought forward (£15 148 net), the balance is £107 743. The directors recommend a final dividend at the rate of 9 per cent. per annum on ordinary shares (making 7½ per cent.), and a bonus of 2½ per cent. on the ordinary shares (all less tax), the transfer to general reserve (making it £120 000) of £19 851, carrying forward, subject to excess profits duty, £53 498. The turnover has been greater than in any previous period. Recently, however, orders have been difficult to obtain in consequence of unsettled industrial conditions.

The total revenue of the **Guildford Electricity Company, Ltd.**, for the year 1920 was £22 538, compared with £16 783 for 1919, an increase of £5 755. The total costs were £16 663 (against £12 677) and the balance on the revenue account is £5 874, compared with £2 105 (after crediting the depreciation fund with £2 000). After meeting debenture interest and interest on temporary loans, the balance is £4 053, and the directors recommend that this be carried forward. The number of connections is 1 695, compared with 1 528 in 1919. The directors entered into an agreement on December 6, 1920, with the Corporation of Guildford for the sale of the undertaking, but the date of taking over by the Corporation has not yet been fixed.

The gross receipts of the **Delhi Electric Tramways and Lighting Company, Ltd.**, for the year 1920 were £16 642 from the tramway and £4 048 from the electric supply undertaking. Both branches were affected by labour troubles during the latter part of the year. The combined undertakings show a net revenue of £22 267, compared with £20 430 in 1919. The profit for the year (including profit on exchange), after charging general expenditure in London and Delhi and debenture interest, amounted to £31 325. After adding £1 362 brought forward and appropriating £10 000 for depreciation of plant and equipment, £7 500 for renewals reserve, and reserving £4 000 for British and Indian taxation, the balance is £11 188, out of which it is recommended to pay (less tax) the following dividends :—8 per cent. per annum upon the preferred and participating shares (£8 000) and 1s. 6d. per share upon the ordinary shares, requiring £2 205, and leaving £982 to be carried forward.

The directors of the **United River Plate Telephone Company, Ltd.**, report that the gross earnings for the year 1920 amounted to £1 096 373, whilst the gross maintenance and other charges in Argentina and London were £855 606, leaving a profit of £240 767. Deducting interest on debenture stock and dividend on the preference shares to Dec. 31, 1920, and the interim dividend on the ordinary shares (£72 100), and adding amount brought forward (£35 700), the available balance is £204 367. The directors recommend payment of a final dividend of 5 per cent. on the ordinary shares, making, with the interim dividend already paid, a total of 8 per cent. for the year, tax free (£81 000), placing £50 000 to reserve and £35 000 to exchange suspense account, leaving to be carried forward £38 367. The Company's business continues to progress satisfactorily, the applications for telephone service exceeding by many thousands the capacity of the present switchboard plant. A certain amount of new equipment has been shipped since the accounts were closed, and much more will be dispatched during the next few months, including the automatic plant for the City of Buenos Aires. To provide further capital, the directors have decided to issue to the ordinary shareholders 108 000 new ordinary shares of £5 each at par.

In presenting the report and accounts of the **Shanghai Electric Construction Company, Ltd.**, at the annual meeting last week, the chairman (Sir Alfred Dent, K.C.M.G.) said that the traffic receipts and profits were substantially larger than ever before. The profits had also been greatly augmented by the favourable silver exchange. With the balance brought forward the amount available was £178 415. They had transferred £10 000 to reserve for renewals, £50 000 to reserve for taxation and £45 000 to general reserve and, having paid two interim dividends of 6 per cent. each, the directors recommended a final dividend of 8 per cent., carrying forward £9 415. The appropriation to general reserve raised that account to £80 000, which, with the sanction of extraordinary general meetings, had been applied in paying up 8 000 new shares at £10 each, and had been distributed as a bonus in the ratio of one new share for every four shares held. That had necessitated the increasing of the capital to £400 000. The traffics and net receipts for the current year were the largest in the history of the company, a circumstance which was due in part to the fact that they were constantly adding to their rolling stock in order to cope with the increasing traffic. The management was in negotiation with the Municipal Council for increased powers with a view to the extension of the company's railless traction system.

The report of the directors of the **Direct United States Cable Company, Ltd.**, for the year ended 31st March, 1921, states that the sale of the Company's cable and properties to the Government has been completed, the purchase consideration of £570 000 being satisfied by the payment of £70 086 in cash, and the handing over of £506 700 5 per cent. National War Bonds, maturing for payment on the 1st April, 1923, at £102 per cent. Provision is made in the accounts for all known liabilities of the Company, and the investments have been written down to their market quotations. A settlement of all claims under the Company's pension scheme has been effected for a smaller amount than was estimated. The directors are therefore satisfied they will be in a position to pay a dividend out of the Company's income at the rate of 4 per cent. per annum until the War Bonds are redeemed in 1923, when the shareholders may confidently look for a return of £6 per share. A total income of £56 530 was received during the year and after providing for administration expenses and the cost of repairing the balance was £38 263, out of which the directors have paid a dividend of 4 per cent., carrying forward £4 265. The Board report with regret the death of Sir James Pender, Bart., a director of the Company for 29 years and chairman since 1913. Two other directors—Mr. John Varley and Mr. H. C. B. Underdown—have resigned, and it is not proposed to fill the three vacancies thus created. The remaining directors have agreed to accept £1 000 per annum as directors' fees in place of £2 [illegible] per annum provided by the Articles of Association.

The gross earnings of the **Oriental Telephone & Electric Company, Ltd.**, for the year 1920, including dividends and interest from subsidiary companies, &c., amounted to £168 182, and with £11 013 from 1919 the total is £179 194. Deducting working expenses, &c. (£109 878) and interim dividends, debenture interest and redemption charges (£22 172), there remains £47 144. The directors recommend payment of a final dividend of 3 per cent. (less tax) for the year on the preference shares (£1 500) and a final dividend of 6 per cent. (tax free) on the ordinary shares, making 10 per cent. for the year (£17 364), and a bonus of 2 per cent. on the ordinary shares (£5 788) ; also to transfer £10 000 to depreciation and general reserve and £2 000 to staff-pension fund, leaving to carry forward £10 492.

The revenue at the various branches of the Company and the associated companies shows a substantial increase. The new switchboard equipment at Singapore was brought into operation in June last. The following dividends have been declared by the Indian local companies—viz., 16 per cent. by the Bombay Telephone Company, against 18 per cent. for 1919, and 10 per cent. by the Bengal Telephone Company, against 8 per cent. At the end of the year the Oriental Company had a total of 9 017 stations in operation, an increase of 897 ; the Bombay Company had 9 709 exchange and private lines in operation, a net addition of 1 829 ; and the Bengal Company 6 838 stations, an increase of 275. The latter company is in communication with the Government of India in order to ascertain whether they intend to purchase the undertaking in 1923 under the terms of the Company's licence. Similar negotiations have also been in progress during the year with regard to the future of the Bombay Company, as well as of this company's branches in India. It would now appear that the views of the Indian Government incline rather towards an extension of the existing licences than to the acquisition of the undertakings. The gross revenue of the China & Japan Telephone & Electric Company shows a further increase, but the net result is considerably less favourable than that of 1919, and that company has been unable to declare a dividend. There are in Hongkong and Kowloon 6 112 stations in operation, an increase of 519.

The revenue of the **Cork Electric Tramways & Lighting Company, Ltd.**, for the year 1920 amounted to £111 880, and the expenses were £94 966. Adding balance from 1919 (£2 512) and deducting income tax (£2 624) and interest on debentures (£4 600), the balance is £12 203. Of this amount, £6 500 has been added to reserve for depreciacion and renewals, and the directors recommend that the balance of £5 703 be carried forward. The revenue for the year amounted to £111 880, an increase of £21 019 compared with 1919 ; the tramways account shows an increase of £4 092, lighting and power £16 090, and the other revenue items £837. The expenses amounted to £94 966, an increase of £24 232, of which increase £6 920 was in respect of maintaining and operating the tramways, £15 453 for generating, £836 for lighting and power maintenance, and £1 023 for general and administrative expenses. The gross profit shows a reduction of £3 213, and is mainly due to the further rise in salaries and wages of the staff and employees, to the further large increase in the cost of coal and other materials, and also to the restrictions imposed upon the Company by the curfew, and the effect of the state of the country on the public and business generally. The Patrick-street fire, which occurred in December last, involved the Company in the loss of a number of house services and revenue from the consumers whose premises were destroyed or damaged by the fire. One of the tramcars was also destroyed. A claim was made against the Cork Corporation and £3 394 for loss of property was awarded to the Company. A demand for an additional £1 per week and other concessions by the tramway and certain other employees was made in November last, which the directors were unable to meet, as the tramways were being operated at a loss. A strike followed in February and extended 7½ weeks, involving a complete stoppage of the tramway service and greatly restricting the supply of current for lighting and power, before the men returned to work. In view of the reduction in gross profit and the loss involved in the strike the directors are unable to recommend payment of the preference share dividend for the past year. The lighting and power tariff has been revised, owing to the increased cost of generating, and application has also been made to the Ministry of Transport for powers to increase the tramway fares. The installation of additional plant for the power station is being proceeded with, and the new 2 000 kW Curtis turbine will be in operation for the ensuing winter load.

New Companies.

The following list is compiled from information supplied by Messrs. Jordan & Sons, Ltd., company registration agents, Chancery-lane, London, W.C.2 :—

F. DARTON & COMPANY, LTD. (174 909.)—Reg. May 27, capital £1 000 in £1 shares, to carry on business of manufacturing opticians and scientific instrument makers. Directors, F. A. Darton and O. Darton. Reg. office, 142, St. John-street, Clerkenwell, E.C. 1. Private company.

HENLEY ENGINEERING COMPANY, LTD. (174 833).—Reg. May 23, capital £3 000 in £1 shares, to carry on business of engineers, stampers, &c. Reg. office : 114, Spring-hill, Birmingham. Private company.

LANCASHIRE INDUSTRIES, LTD. (174 761).—Reg. May 18. Capital £1 000 in 900 £1 and 200 10s. ordinary shares, to carry on business of electrical engineers, dealers and factors in all kinds of electrical and and mechanical applicances. Directors : F. W. Roberts, E. Tracey and H. D. Barker. Reg. office : 63, Cannon-street, Manchester. Private company.

LIFT & ENGINEERING, LTD. (174 800).—Reg. May 20, capital £5 000 in £1 shares, to carry on business of manufacturers of and dealers in lifting and hoisting machinery. Reg. office : 4, Tokenhouse-bdgs., King's Arms Yard, E.C. 3. Private company.

M.A.F., LTD. (174 710).—Reg. May 13.—Capital £100 in £1 shares, to carry on business of engineers. Directors : W. Dunn. Reg. office : 165, Above Bar, Southampton. Private company.

RICHARD MACARTNEY & COMPANY, LTD. (174 981.)—Reg. May 31 capital £100 in £1 shares, to carry on business of consulting engineers, &c. Subscribers, R. J. Macartney and W. C. Hopwood. Reg. office, 22, Preeson's-row, Liverpool. Private company.

STOCKDALE BOILER FURNACES, LTD. (174 856).—Reg. May 24, capital £500 in £1 shares, to acquire interests in any patents in relation to improvements in steam generators and furnaces. Subscribers : G. Stockdale (White Hart Hotel, Daybrook, Notts.) and F. Parkin. Private company.

TIDD, SIDAY & COMPANY, LTD. (174 902).—Reg. May 26, capital £2 000 in £1 shares, to carry on business of electricians and mechanical engineers. Directors : J. T. Tidd, W. E. Siday, H. S. Grimston and H. Buss. Reg. office : 180, Drury-lane, W.C. Private company.

WIGHTON & PARTNERS, LTD. (174 789).—Reg. May 19, capital £1 015 in 100 £10 ordinary and 300 1s. founders' shares, to carry on business of engineers and manufacturers, representatives and agents. Directors : L. G. Wylde and J. E. Elliott. Reg. office : East Block, Caxton House, Tothill-street, S.W. 1. Private company.

Forty Years Ago.

(THE ELECTRICIAN, JUNE 11, 1881.)

INSTITUTION OF CIVIL ENGINEERS.—The annual conversazione of this institution was held at South Kensington last week. The rooms were pleasantly illuminated by the electric light. The night being a hot one, offered a good opportunity for showing off the advantages offered by the electric light as a non-heater of the atmosphere, at all events to any appreciable extent.

POST OFFICE TELEGRAPHS.—We are glad to be able to announce that, upon the recommendation of the Postmaster-General, the Lords Commissioners of Her Majesty's Treasury have sanctioned the payment of a gratuity of £20 to Mr. Barnett, a telegraphist at Aldershot, who has devised an ingenious arrangement whereby an ordinary single-needle instrument can be converted into an acoustic instrument at a small cost.

PRICES.—The prices as quoted this week are : For gutta-percha, genuine, 4d. to 3s. 3d. per lb. ; reboiled, 3d. to 1s. 3d. For india-rubber, per lb., fine Para, 3s. 7d. ; negrohead, 2s. 4d. ; Central American, 1s. 11d. to 2s. 6d. ; Assum and Pegu, 1s. 2d. to 1s. 11d. ; other East Indian, 1s. 9d. to 2s. 2d. ; Madagascar and Mozambique, 1s. 6d. to 2s. 4d.

THE TELEPHONE IN EGYPT.—There are two companies at work erecting telephone lines, the Compagnie Telephonique, represented by M. Edwin le Leon, which has been established some little time, and the more recent Messrs. Hubidos, Dargon & Company. The latter offer to erect telephones at the undermentioned charges : 875 francs per annum for consuls, bankers, &c. ; 750 francs for stockbrokers and large firms ; 650 francs for merchants and members of the liberal professions. The above subscriptions to be payable in advance. The company will erect and keep in order the necessary apparatus, &c., as soon as sixty or more subscriptions have been received.

Arrangements for the Week.

FRIDAY, June 10th (to-day).

ROYAL SOCIETY OF ARTS.—INDIAN SECTION.

4.30 p.m. At John-street, London, W.C. Paper on "The Development of Bombay," by Sir George Curtis, K.C.S.I.

PHYSICAL SOCIETY.

5.0 p.m. At the Imperial College of Science, S. Kensington, London, S.W. Lecture on "The Stability of Atoms," by Sir Ernest Rutherford, F.R.S.

ROYAL INSTITUTION.

9.0 p.m. At Albemarle street, London, W. Discourse on "Absolute Measurements of Sound," by Dr. A. G. Webster, LL.D.

FRIDAY, June 17th.

9 p.m. At Albemarle-street, London, W. Discourse on "Chemical Combination and the Structure of the Molecule," by Sir J. J. Thomson, O.M., F.R.S.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics" :—"The Ultimate Aero-Engine," by Col. J. G. Vincent ; "The Loads and Stresses in Aeroplanes," by John Case ; and "Aeronautical Maps."

"The Cabinet Maker" :—"Cabinet Making at the Central School of Arts and Crafts" ; "Measured Drawings of Museum Pieces," and "Furnishers' Window Displays in the North of England."

"The Chemical Age" :—"Development of an Oil By-Product Industry," by Eric K. Rideal ; and "Progress of Key Industries Bill."

"Farm & Home" :—Special "Bath and West" Show Number : Illustrations of Winners ; "Successful Farming Courses" ; and "Agricultural Council and Land Reclamation."

"The Fruit-Grower" :—"Fungicide Trials at East Malling" ; Taxation of Market Growers' Motor Vehicles" ; and "National Retailers' Federation at Birmingham."

"Gardening Illustrated" :—New Feature : Pages for Beginners in Garden Work.

"The Gas World" :—Reparation Coal from Cornwall ; "Proposed Concentration of Gas Manufacture in the Potteries" ; and Analyses of Gas Accounts.

"Hardware Trade Journal" :—"Arms and Ammunition Number" ; "Trade Travellers and Truth," by F. B. Shuffrey ; and "The Working of Sheet Aluminium."

Prices of Metals, Chemicals, &c.

TUESDAY, June 7.

		Price.	Inc.	Dec.
Copper—				
Best selected............	per ton	£74 0 0	—	—
Electro Wirebars ...	,,	£78 0 0	£1 0 0	—
H.C. wire, basis	per lb.	0s. 11⅞d.	⅛d.	—
Sheet	,,	1s. 0½d.	—	—
Phosphor Bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. 3⅞d.	⅛d.	—
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1¼d.	—	—
Wire, basis	,,	1s. 1¼d.	—	—
Pig Iron—				
Cleveland Warrants .	per ton	£6 10 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£27 0 0	—	—
Lead Pig—				
English	,,	£23 10 0	—	£0 10 0
Foreign or Colonial ...	,,	£22 5 0	—	£0 5 0
Tin—				
Ingot	,,	£168 10 0	—	£5 5 0
Wire, basis	per lb.	2s. 4d.	—	⅝d.

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £15.

,, (Roll-Brimstone).—Per ton £14 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £31.

Boric Acid (Crystals).—Per ton £69.

Sodium Bichromate.—Per lb. 7½d.

Sodium Chlorate.—Per lb. 4¼d.

Rubber.—Para fine, 11d.; plantation 1st latex, 8½d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd.

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Notes.

The London Electricity Supply Problem.

THE Electricity Commissioners are at present engaged in investigating one of their most difficult, and at the same time most important, problems—the reorganisation of the electricity supply systems in the London and Home Counties Electricity District. This question has been discussed at various times during the last twenty years and on one or two occasions we have been within sight of settlement, but political and municipal issues have always intervened and so a solution has been postponed. As time goes on the problem becomes more difficult and more urgent, and considerable skill and tact will be required to discover a scheme that will command the confidence of the various interests involved. Difficult though the problem is, we are confident that the Commissioners will be equal to the task and that they will be able to devise a plan which will give the London area that abundant supply of electricity for which it has waited so long.

The Various Schemes.

OF the six schemes submitted, three contemplate the formation of Joint Electricity Authorities for the whole of the district, and Poplar proposes a Joint Authority for the East London and suburban portion of the district, while the Great Eastern and London, Brighton & South Coast Railway Companies submit some suggestions as to their probable requirements for electric traction purposes. Unfortunately, the powers and functions of any Joint Authority that may be decided upon will depend upon the fate of the Electricity Supply Bill and if this should fail to become law considerable delay may be caused. However, the inquiry, which began with an investigation of the London County Council scheme, will not have been in vain. It would have had to take place in any event, and the information gained will probably assist the Commissioners in finding a solution of a complex problem.

Einstein on Relativity.

IT has often been the hard lot of protagonists of new ideas to suffer neglect, criticism and general disregard of their teachings, this attitude being the more noticeable the greater the benefit to be derived from attention to their doctrines. On this score, at any rate, Prof. EINSTEIN has no grounds for complaint. His theory of relativity has attracted sympathetic attention not only among scientists and metaphysicians but, extraordinary to relate, among the general public as well. His visit to this country to expound his ideas has been received with great interest and made an occasion of publicity of the kind accorded usually to crowned heads, boxers and cinematograph artists. We are not surprised therefore that a crowded audience assembled at King's College on Monday last to hear from his own lips what he had to say about his theory. The lecture was rather a fresh exposition of what is generally known about his ideas than a putting forward of anything new. His principal arguments will be found summed up on another page of this issue and form a useful landmark in determining how far we must change our ideas on matters which had been considered fundamental not only in electro-magnetic theory, but in physical science generally. To describe Prof. EINSTEIN's work as a landmark is correct in so far as other pioneers are already pressing forward farther than even he has done and it may be necessary as a result of their work once again to revise our conceptions on these matters. At the moment it is a little difficult to see how these theories will affect practical electrical engineers. As has often been pointed out the relation between theory and practice in electrical work has often been surprisingly close. On the other hand, the paradoxical character of much of Prof. EINSTEIN's work has somewhat naturally attracted the metaphysician and with metaphysics electrical practice has fortunately little or nothing to do. It would be interesting to see whether the movement in that direction increases, in which case it will cease to have interest for us, or whether we may derive from it some assistance in solving the problems which are more truly of an engineering character.

The Johnsen-Rahbek Effect.

CORRESPONDENCE, which has recently taken place in a number of scientific and technical journals as to the original date of the discovery of the phenomena described by Messrs. ALFRED JOHNSEN and KNUD RAHBEK in their recent lecture before the Institution of Electrical Engineers, indicates that the differences between the work of these engineers and that of earlier experimenters are much wider than at first appeared. The official abstract of the lecture, which was issued by the Institution, begins by saying that the lecturers discovered in 1917 that strong adhesive forces were developed when an electric P.D. was applied between a solid body, consisting of certain badly conducting materials, and a conductor resting on that solid body. In this sentence the keyword is presumably "strong" and this supposition is confirmed by a letter from Messrs. JOHNSEN and RAHBEK themselves in "The Times" of Monday last. The whole basis of their discovery, they point out, is that an abnormally strong attraction occurs when certain substances are used and that upon the use of these substances and upon the phenomena to which this use gives rise the whole possibility of obtaining interesting practical applications of which certain examples were given in their lecture depends. That their contention is the correct one is confirmed by a reference to their patent specification in which they refer to the retentive force as a hitherto *disregarded* electrical phenomena, *i.e.*, they do not describe it as a new discovery. If, as we hope, our present knowledge of these phenomena is a preliminary to wide and useful practical applications, it is rather on the lines suggested by Messrs. JOHNSEN and RAHBEK than on those foreshadowed by the earlier workers that advances may be expected. The whole value of their work in fact resides in the application and not in the effect itself.

A Thermal-efficiency Exhibition.

A FEATURE which might be more widely adopted is to form part of a two-day conference organised by the Institution of Mechanical Engineers to discuss means of increased thermal efficiency and heat power plant. This will consist of an exhibition of all kinds of appliances connected with boiler-room economy and with the efficient use of steam and internal combustion engines. The exhibits will include feed-water heaters, superheaters, economisers, mechanical stokers, feed-water regulators, combustion recorders, coal-consumption recorders, waste-heat boilers, carburettors, steam and gas engine indicators, means for the prevention and measurement of smoke, and so on. With the passing criticism that if full advantage is taken of the invitation to send exhibits we fear no lecture hall or institution building in London would be sufficient to contain them, we may wonder whether something of the kind could not also be done by the Institution of Electrical Engineers. We are led to this thought by remembering that on the occasion when Mr. WATSON's paper was read we noticed a large number of magnetos on view, but there seemed no one to demonstrate their peculiarities to visitors and no direct reference was made to them by the reader of the Paper or by any of the speakers in the discussion. There are often occasions when models or actual electrical apparatus could be exhibited at the Institution with advantage, and we hope that now we have returned to our own building such opportunities will not be lost.

Solutions for Industrial Unrest.

DURING the past few days two solutions for the present state of industrial unrest have been suggested, one by the National Alliance of Employers and Employed, and the other by Dean INGE at the annual general meeting of the British Science Guild. Dean INGE is a gentleman who, partly by natural talent and partly as a result of a newspaper campaign, has been elevated from the position of a church dignitary to that of a prophet. We are, therefore, rather disappointed to find that his solution for those troubles, whose gravity we should be the last to minimise, is summed up in the phrase "science and religion." Apart from this he has little use for labour organisations, whose activities he described as revolutionary, anti-social and obstructive. It is true that during the past few years many of the deeds of organised labour have been so foolish as to be almost insane, but then so have some of the deeds of Parliamentary Government. Yet few there are who would blot the latter out. The cause, we think, is the same in both cases, the criminal indifference of that large and stable body of moderate members to the way in which their affairs are managed. But this in itself is no argument for a war against Trades Unionism, but rather a sign that it is time the activities of these bodies were turned in more sensible directions. This can be achieved by leading rather than bullying.

Co-operation the Solution.

THIS we are glad to see is clearly recognised by the National Alliance of Employers and Employed, who, like Dean INGE, see no good in Government interference in these matters, at which we do not much wonder with the miners' dispute still before us. They rightly emphasise the fact that means must be found to prevent the suicidal quarrels which are gradually ruining the trade of the country and they point out that the way in which this can best be done is by arranging for the principal parties in an industry to be continually in consultation on matters relating to that industry. The formation of Whitley Councils is an obvious way of doing this. Unfortunately, the good which these bodies can both actually and potentially achieve has been stultified by Parliamentary indifference, combined, as shown in an answer by Mr. CHAMBERLAIN to Lord ROBERT CECIL, with the difficulty of making the Council fully representative at once. At present this should not be an unsurmountable obstacle, and we agree with the National Alliance that the Industrial Council should be called together in the most representative form possible, and that the Government should give guarantees that the decisions come to by that Council shall be laid before the House without delay. We feel sure that this is the right policy. For only by a frank discussion of all the differences, many of them quite small, which now exist between interested parties and by a genuine desire to settle these differences, not for the benefit of either party but for the good of the industry as a whole, can we expect to achieve that peace which is necessary if we are to maintain and develop our trade along the lines which is essential for the well being of the Empire.

The Utilisation of Low-Grade Fuels.

ONE of the arguments that the miners have put forward in support of their case is that though a reduction in the cost of production is necessary this reduction should not be achieved solely at their expense. This point was made in rather a different way by Sir RICHARD REDMAYNE in an address recently delivered before the British Science Guild. He pointed out the necessity for research into our methods of using fuel not only to discover whether these methods could not be improved but to find out whether new fuels could not be economically employed. This applies particularly to the utilisation of low-grade fuels, as at present there are vast quantities of coal which it does not pay to work. In this direction the use of so-called colloidal fuel requires examination. The recovery of the coal and its more perfect cleaning by the "froth flotation" process and the possibilities of employing low temperature carbonisation are also matters which need consideration. This is the more necessary as our present oil resources will probably be exhausted in about 50 years, and to economise them we must consider such problems as the distillation of oil-bearing minerals, the desulphurisation of oils and the reduction of the losses which at present occur in refining. Connected with this question are possible improvements in the methods of reduction of low-grade iron ores, in the utilisation of the iron and potash dust in blast furnace gases and in the recovery of vanadium from the ashes of carbonaceous substances. This is an ambitious programme and one both difficult and expensive to carry out, but nevertheless it will be worth doing.

Trade Unions and Profit Sharing.

The attitude of some trade unions towards co-partnership and profit-sharing schemes is strange and wonderful, though at first sight it would appear that any scheme which ensured, not only the full trade union rate of wages, but also gave a share in the profits of an undertaking to meritorious workmen, was both innocuous and desirable. Nevertheless, most unions are hostile to the idea, and some have gone so far as to provide for the expulsion of members who participate in such schemes. The legality of such action was recently argued at some length before the Court of Appeal, and the result is a considered judgment of some general interest. It appears that a member of the Amalgamated Society of Carpenters and a member of the General Union of Operative Carpenters and Joiners sought injunctions to restrain their unions from excluding them from membership because they had participated in a profit-sharing scheme of Messrs. Lever Brothers. In the Court below Mr. Justice Eve found that he was bound by Sec. 4 (1) of the Trade Union Act of 1871, and held that he had no jurisdiction to entertain the actions, as they arose out of agreements relating to the conditions of employment of members of trade unions. From this decision the plaintiffs appealed. We are glad to notice that the appeals were unanimously allowed.

A Just Decision.

In the first case the Court held that the defendants had never made any agreement, but the unions made it a condition of membership that the plaintiffs would not commit any breach of their rules. The latter had not committed such a breach by participating in the profit-sharing scheme of Messrs. Lever Brothers. After a careful analysis of the decided cases, the Master of the Rolls found that the plaintiffs had done nothing in contravention of the rules of the union, and in this the Lords Justices agreed, Lord Justice Younger stating that "expulsion from a union was a sentence of industrial death." The result is eminently satisfactory, and we hope that it will lead the unions to reconsider their attitude towards schemes of profit-sharing.

London Traffic Conditions.

It has long been recognised that the traffic arrangements in London are in a chaotic condition and though various proposals, including the formation of a Traffic Board, have been put forward for co-ordinating and improving the services, little or no progress has so far been made. We had hoped that with the advent of the much-lauded Ministry of Transport this difficult, but important matter, would somehow have been dealt with, but so far neither our hopes nor anyone else's have been realised. We are therefore glad to see that the London County Council, which appointed a special committee of inquiry into this question some time ago, is now pressing the Government to make provision for the unified operation of local passenger transport undertakings, and to set up a municipal control authority, pending the reorganisation of local government in Greater London. It will be agreed that the reform is long overdue, but any effective steps to bring about an improvement are hampered by the multiplicity of authorities and by the conflicting interests involved. What can one expect, for instance, when there are 122 road authorities exercising various powers of control over the seventeen systems of tramways, a number of omnibus undertakings and the various railways operating in the area? Though it may be doubted whether the precise form of traffic control suggested by the London County Council is the best, yet almost any change would be an improvement on the existing chaotic condition of things. At any rate, only one master would have to be served instead of several. We note that as the Minister of Transport will retire in August the County Council hope he will start the work of reorganisation before he returns to private life, but we are afraid that in view of the long and complicated Railway Bill which has recently seen light, even Hercules has enough labour to keep him busy for the rest of his official existence. It will, therefore, be left for other hands to deal with a chaos which gradually grows worse, not only because it is not tackled in an enlightened spirit, but because it is not tackled at all.

A Postal Concession.

We are glad to be able to record that the proposal to increase the postal rates on printed papers sent abroad has been dropped by the Postmaster-General owing to the pressure brought to bear upon him by all sections of the community. The other increases, however, stand, and though their effect is not likely to be quite so serious in its effect on trade as would that which has been remitted, the harm caused by cutting down any communication facilities is such as to warrant the closest consideration of all alternative methods. We hope the new Post Office Council will make this their first task. The disabilities which result from a lack of free intercommunication bear particularly hardly on scientific publications. This is emphasised in the report of the Conjoint Board of Scientific Societies. That Board has been definitely prevented from developing their good work by the high postal rates which are charged on scientific publications, as these do not, as a rule, enjoy newspaper rates. It does not seem to be realised by our rulers that expenditure of this kind is really educational expenditure, and educational expenditure is always a good investment. That such work should flourish and extend is of international importance and therefore deserves every possible encouragement.

A Policy that may do Good.

Though we must, under the circumstances, be grateful for the small concession made in regard to printed matter for abroad the other changes made by the Post Office are highly detrimental to the best interests of the community. The abolition of the Sunday collection especially will have a serious effect upon that prompt dispatch and delivery of correspondence which are so essential for business purposes. The only interesting point in the Postmaster-General's speech was, in fact, his reference to the New Advisory Committee which has been set up to consider questions of administration. This is a new and welcome departure in Government methods, and though the personnel of the Committee is excellent, we are afraid that very little authority will be wielded by it. But unless the Committee possesses fairly wide powers to make recommendations and to see that they are carried out, little good can be effected.

The Exchange of Scientific Publications.

The need of easy exchange is obvious when we consider the facilities that exist for the introduction into this country of the proceedings of foreign scientific societies and foreign technical journals, especially those published in Germany. In this case it is not a question of postal rates alone, but of the operation of the Reparation Act in addition. The effect of this Act is, in fact, peculiarly harmful and is also particularly unnecessary, for the one German thing which cannot be made in this country is obviously a German book, and their free importation cannot, therefore, affect our trade. The result of the Reparation Act in this case is therefore simply that English engineers or scientists requiring German textbooks have to pay for them at double their published price. The same applies equally to technical and scientific journals, though Mr. Hugh Richardson, writing in "Nature," points out that this disability can to some extent be got over by exchange. He suggests that readers of the "Elektrotechnische Zeitschrift" and of The Electrician in the countries of their publication should adopt some system of mutual self-help by passing their journals over when they have done with them. There are, however, two difficulties which prevent the easy operation of this idea. One is the question of postage, which would mount up to a considerable amount, and the other is the fact that subscribers to both the journals cited may desire to bind their copies. To do this would mean either double postage in each case, and the exercise of more than usual care in preserving the copies in a clean and untorn state, or the purchase of duplicate copies, a course to which we should not have the least objection. The real remedy for a very serious check on knowledge is to bring pressure on the Governments in both countries to remove artificial obstacles of this kind from the easy exchange of information.

Electricity on the Farm.

The decision of the Government to discontinue the subsidy to the agricultural industry may lead farmers to consider, as other people are doing, ways and means of introducing more economical working into their various operations. In this connection, they cannot do better than weigh carefully the claims of the electric drive. As has been justly pointed out in a pamphlet issued by the British Electrical Development Association, the use of electricity on the farm means more profit for the farmers, and if further confirmation is required of that statement, we cannot do better than to refer to conditions in the Hereford district, where, as is well known, a system of rural supply has been most enterprisingly worked up with entire satisfaction, not only to the supply authorities, but to the farmers themselves. The question is, however, not one for the farmer alone, and it behoves electricity supply engineers in charge of undertakings adjacent to rural districts to consider all possible methods of developing what should be before long a most profitable source of revenue. There is no time like the present for doing this.

Trams as Others See Them.

The interest which is being taken by the daily Press in Prof. Einstein's work is surprising as it is unwise. It cannot be supposed that the general newspaper reader is interested in such an abstruse subject, nor that the columns of the daily Press are the proper place for its exposition if he were. The result can only be that an entirely wrong idea is gained of a fundamental conception and that harm instead of good will be the certain result. If therefore the daily Press wish to deal with scientific and electrical questions they might well confine themselves to the more practical matters, and at any rate take the trouble to see that what they publish contains at least the germs of accuracy. As an example of the way such matters are now dealt with, we may instance a short article which recently appeared in a well-known daily paper. This article purported to explain how the electric tram is operated. After some introductory remarks on systems of supply, which, to say the least of it, are open to question, the writer continues :

> "In small towns where the tram service is limited, one station is sufficient to do all the work of manufacture and supply of current. . . . This 'juice' is known as direct current and *would be quite useless to rotate the motors on tramcars.* It is conveyed to various local sources of supply known as sub-stations. In these sub-stations it is employed to drive other dynamos *capable of developing anything up to* 700 *h.p.* Here the engineer is able to tell exactly what is going on on every street track, although he cannot see them and controls according to necessity, feeding his car as an infant is fed with a spoon."

The author of this article has missed his vocation. He should be writing romances to compete with those of the late-lamented Jules Verne or the earlier works of Mr. H. G. Wells. In those it would not be quite so necessary for fact to correspond with theory, so long as the principal characters finished up by living happily ever afterwards. The italics, it is perhaps needless to add, are ours.

When is a Unit Not a Unit?

Webster's definition of a unit is "Any determined amount or quantity adopted as a standard of measurement for other amounts or quantities of the same kind." On this line of reasoning a Board of Trade unit should perhaps be a measurement of the Board of Trade, an operation which would be difficult, and perhaps even dangerous, to perform. For as we pointed out a week or two ago, this term, although hallowed by association, was always an anomaly and is now actually incorrect. Further, as Mr. Cooper rightly said at a discussion at the Institution a short time ago, this example of British nomenclature is very confusing to foreigners, who know little about the actions and organisation of the Board of Trade and care less. We feel, therefore, that the time has now come when an official pronouncement should be made in favour of the general use of the term kilowatt-hours, until such time as the International Electrotechnical Commission are in a position or feel inclined to give to this unit the name of some eminent worker in electrical engineering. The name of Kelvin has, of course, been suggested for this purpose and no better could be found. It might well receive official sanction.

The Protection of Key Industries.

The large number of amendments, the hostile criticism and the energetic propaganda, visible and invisible, to which the financial resolutions that formed the preliminary to the Safeguarding of Industries Bill were recently subjected, led to the hope that this measure would be dropped, and that the industries of the country would be allowed to wax or wane without Government interference. That hope has not been realised. Indeed the Government are using all their powers to force the Bill through the House of Commons, and the closure is to be vigorously applied so that the measure can be placed on the Statute Book this session.

The framework of the Bill being unsound, it is a pity that so many of the amendments and so much of the criticism has been directed to secure the elimination of certain articles from the measure rather than against the wisdom of the broad principles on which it is based. To work in this way is human, and especially Parliamentary human, nature. For everyone regards such a measure from a personal point of view, and his opinion of its goodness or badness is determined by how it affects his particular occupation and the probable effect of a tariff on his means of livelihood. In the widest sense, however, the opposition is justified for the Bill is unlikely in practice to do what it is supposed to do and its futility will be increased by reason of the machinery it is proposed to set up to operate it. This is, in fact, so fundamental that everything should have given way to it. The failure of similar machinery to collect the German indemnity is sufficient indication of the rightness of this argument.

A Sliding, Not a Fixed, Scale Wanted.

For instance, the British Empire Producers' Organisation in a memoranda submitted to the Chancellor of the Exchequer pointed out that fixing the customs duty at 33⅓ per cent. is good in theory, but must fail in practice. If a tariff is employed at all, it must be on a sliding scale, so that some articles may be absolutely prohibited from importation, though for others an amount of much less than 33⅓ per cent. will suffice for protection. It is therefore recommended that instead of the Board of Trade deciding what articles are or are not to be protected, a Commission should be set up to schedule these articles and the amount of duty to be imposed upon them. Apart from any other advantages this arrangement would certainly have the desirable feature of freeing the industry from a most undesirable form of bureaucratic control.

In addition the Association point out the need for preferential treatment of materials and articles coming from our Colonies. The Government are, however, asking for no powers of discrimination between articles of the same kind which come from foreign countries, and from other parts of the Empire. Such arguments as these coming from a body whose sole object is to develop British Trade should have been given more weight than they have received.

Carbons and Electric Lamps.

On the other hand, there is the type of opposition which assumes that all tariffs are in themselves both wrong and harmful to the industries they are intended to protect. It is interesting to see that electrical apparatus has been used as an illustration of this fact in more than one quarter. We are told, for instance, that the British electric lamp industry is practically in the hands of the Electric Lamp Manufacturers' Association, less than 10 per cent. of the lamps sold in this country being imported, and that there is therefore no reason why this industry should be protected from dumping. Indeed it is pointed out that foreign competition, if it does exist (though here the argument seems a little inconsistent) has great uses in keeping down the prices to their present level. It would be interesting to know what explanation this propagandist would give for the recent reduction in the price of lamps sold by the Association. The chief objection we see to the foreign made lamp, as we knew it before the war, was that it was only superficially cheap and, being perfectly definitely nasty as well, was actually expensive, so that if the imposition of a tariff on this article will help to keep up the quality of the lamps in general use it will be an advantage worth paying for. But the matter is not so simple as it looks at first sight, and whether a tariff be imposed or not, the question of the importation of lamps cannot be settled in this easy fashion.

The Arc Lamp Carbon Trust.

We are surprised to find that the other electrical article which it is argued needs no protection from a tariff, is the arc lamp carbon, the reason being apparently that only one firm makes arc lamp carbons in this country and this firm "during the war laid down a special factory for the production of these goods." This firm has, the argument continues, grown into a gigantic trust which, if foreign carbons are protected, will impose its evil will not only upon private consumers but on municipalities and Governments as well. This is the more deplorable as (of course !) foreign made carbons are of a much better quality than English carbons, owing no doubt to the usual backwardness of the British manufacturer. We need hardly point out to readers of The Electrician the distortion of facts which such an argument represents. The history and enterprise of the General Electric Company in regard to carbon manufacture in spite of Government neglect and opposition amounting almost to *sabotage* on the part of foreign interests, is worthy of the highest praise. For military reasons it is essential that these articles should be manufactured in this country in sufficient quantities to supply our demands, as conditions at the opening of the late war amply showed. If therefore there is one electrical article in the electrical industry which requires protection more than another we should have thought it was the arc lamp carbon. The argument to which we have referred discloses a chain of reasoning which is not unusual, but is not the less surprising for that. Protection is bad for the consumer and the trade. But if a tariff is to be imposed do not put it on any article made by a trust, as it will render that trust still more powerful.

The Broad Question.

These, however, are relatively minor matters compared with the broad question as to the advisability of Government interference with trade. This point is well argued in an appeal from the bankers of the United Kingdom which was recently issued. In this it is pointed out that the system of Government regulation of trade by licences, controls and departmental orders has admittedly, however well intended, had in many cases unfortunate results. The essential truth of this no one can deny. It is further pointed out that the policy of trying to exclude the productions of other countries with the view of encouraging our own cannot increase the volume of commerce, or the total volume of employment here. And it may well compel consumers who form the bulk of our population to submit to privation in the quality or quantity of the goods they buy. We must be in a position to export our products, but as trade is essentially exchange, Continental nations must be encouraged to export to us. This seems to us to contain the germ of the whole matter, and we feel sure that British trade would be much sooner and more strongly placed on her former basis by the co-operation and work of all parties concerned in its development, so as to obtain cheap production and low prices, rather than by the easy road of Government assistance. Whatever arguments there may be in normal times for the imposition of a tariff on imported articles these do not hold at the moment.

But as recently pointed out by Capt. Wedgwood Benn, there is an even graver constitutional question involved in this matter. The Bill in fact hands over to a Government Department the jealously guarded right of Parliament to define and impose taxation. The maintenance of this right against royal power has led to some of not the least stirring episodes in our history. To relinquish that right would be a grave mistake—a point with which we feel sure both those who desire and those who are against a tariff will agree. We hope that the Government will see the force of the argument so ably put forward by Capt. Benn and, whether tariffs are to be imposed or not, ensure that they are collected by constitutional methods.

The Wagner "Earth Connection" in Practice.

By G. E. MOORE.

The purpose of Wagner's "earth connection" is to ensure that a test-bridge is at earth potential, this being of particular importance when precision measurements of small capacities (of the order of micro-microfarads) are being carried out. It is quite possible for the electrostatic capacity of a bridge to earth to cause perceptible errors, and these may be magnified by the inductive effects of a telephonic detector; by placing the bridge at earth potential such errors are nullified.

Unless the principle of the "earth connection" is understood, it will, at first sight, appear somewhat complicated; in some technical books the authors do not go further than presenting a diagrammatic explanation, this by no means being as clear as it might be. In Fig. 1 a simple De Sauty bridge arrangement is shown by the full lines, such bridge when balanced giving the value of the unknown capacity C_1 as $\frac{R_2C_2}{R_1}$. Silence or a minimum of sound will now obtain in the telephone.

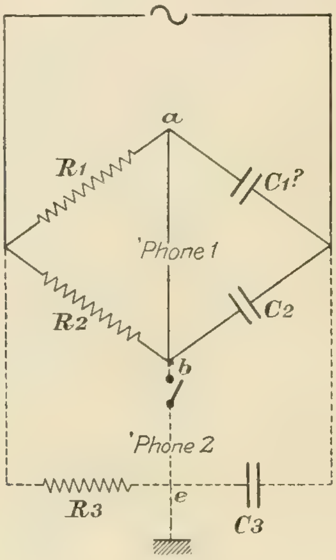

FIG. 1.

THE OBJECT OF THE DEVICE.

The object of the Wagner device is to bring the telephone points *a* and *b* to earth potential. With a balanced bridge, point *a* is at the same potential as point *b*; if, therefore, one of these points is brought to earth potential this is equivalent (provided the bridge remains balanced) to bringing both telephone points *a* and *b* to earth potential.

The actual "earth connection" by which this is done is shown by the dotted lines in Fig. 1. It consists of a second bridge arrangement, the sides *cb* and *bd* of the original test-bridge being common to both. A switch and second telephone are connected as shown, the point *e* being earthed. If, now, the switch is closed and the new bridge arrangement balanced, point *b* (and also point *a*) will be brought to the same potential as point *e*—*i.e.*, to earth potential—and on opening the switch a final adjustment of the test-bridge can be made.

In practice the operation of the two bridges is not absolutely straightforward, and in this connection a few details will not be out of place. It should be pointed out here that the "earth connection" can be applied to other more accurate bridge arrangements for measurement of capacity; one such will be detailed later. And, of course, one need not be restricted to the use of high-frequency alternating-current and telephonic detection (as indicated in figures); these and the usual routine arrangements and precautions do not require treatment here.

NEED FOR CAREFUL INSULATION.

But it is necessary to point out that the apparatus should be well insulated and all wires carefully disposed. The operator must also ensure that the terminals and leads of his telephone headgear (if this is used) do not make contact *via* other conducting parts with his head; and if, when reaching final balance, he presses a receiver on his ear, he must keep his hand away from metallic parts. The switch should be placed where shown rather than on the earth side of the second telephone. The use of two telephones is somewhat of a nuisance, because several change-overs may be necessary before final balance is obtained. *One* telephone, which can be suitably switched over from one bridge to the other, is not satisfactory; a better alternative is to use headgear with two receivers disconnected from each other, one acting as telephone 1 and the other as telephone 2.

DETAILS OF THE TEST BRIDGE.

The test-bridge itself should be so arranged with the extra bridge that the known capacity is in the side *bd*, as shown; this will help in choosing R_3 and C_3 of suitable values. Both R_3 and C_3 can be variable, but conditions will naturally depend upon available apparatus and the resistance and reactance values of the main bridgearms referred to. A resistance may be used in series with C_3.

As regards actual operation, it will be found that both bridges may require several readjustments in turn, particularly if there is no clue whatever as to the value of the unknown capacity. Two or three change-overs can, however, be obviated by the adjustment of the extra bridge (*with the telephone switch open*) from the test-bridge itself, the amount of sound in telephone 1 affording a rough indication regarding the mutual effect of the two bridges as well as to the comparative balance of the test-bridge. The switch, be it noted, is on occasion apt to be left on when reverting to telephone 1; erratic results may then confidently be expected!

THE ANDERSON BRIDGE.

It has been pointed out that the simple De Sauty comparison bridge is not the only one to which the "earth connection" can be applied; as a matter of fact, conditions are seldom favourable to this type of bridge in any event. The Anderson bridge is one which may raise difficulties; the writer has not actually experimented with this form of bridge, but it would seem that *if* the "earth connection" is at all feasible it would require arms equal, or in due proportion,

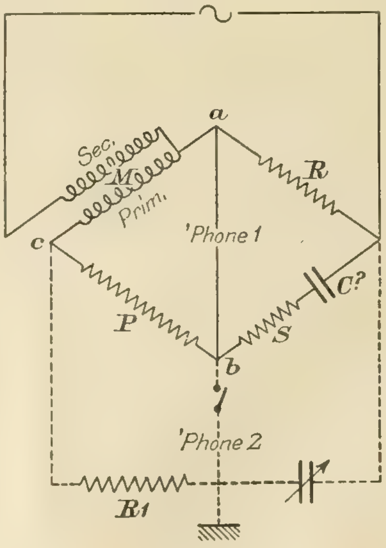

FIG. 2.

to the respective resistance and impedance values of the main-bridge arms.

THE CAREY-FOSTER ARRANGEMENT.

In another test arrangement the Carey-Foster—capacity is measured in terms of mutual inductance; it is an important, precise and adaptable method, and in the measurement of very small condensers by its means the writer has successfully utilised the "earth connection." The Carey-Foster method is generally shown diagrammatically as a bridge (Fig. 2), although in a sense this is hardly correct, and certainly it is difficult to understand. As originally set forth the bridge arrangement was not emphasised; a make-and-break was used with the battery current and the unknown capacity had no series resistance. The capacity (in farads)

$$=\frac{\text{Micro-henries}}{R\times(P+\text{Res. of Prim.})}.$$

Obviously the point *d* gives the one common current point for the Wagner bridge and point *b* that for the second telephone. But although *a* is the other current point it can hardly be used as a "common." However, point *c* can be used and the "earth connection" may accordingly be arranged.

When using the Carey-Foster method with this modification, it is necessary in the first place to apply the earthing-bridge whilst determining true zero; a possible error of several per cent magnitude may thus be avoided.

THE CAMPBELL VARIABLE MUTUAL INDUCTANCE.

That widely useful and accurate apparatus, the Campbell Variable Mutual Inductance can be employed in the Carey-Foster capacity test, the makers (The Cambridge and Paul Instrument Company, Ltd.), supplying a suitable auxiliary box, whereby the bridge arrangement shown in Fig. 2 is conveniently obtained. The connections are schematically given in Fig. 3—identical lettering being used in both figures. The "earth connection" is connected to one "Source" terminal, one "Primary" terminal and one "Galvo" terminal of the auxiliary box as shown.

Working with equal bridge arms, R_1 must be of fairly high value—in the region of 10 000 ω, as this is the value of *p* for very small capacities. The condenser should be variable, as this facilitates adjustment, and should eventually approximate to the value of the unknown capacity if $R_1=P$. Unless the unknown capacity is a very leaky condenser and the source of imperfect wave form, the working conditions are very satisfactory. The bridge precautions indicated previously, in addition to the usual routine lay-out, &c., also apply in this case.

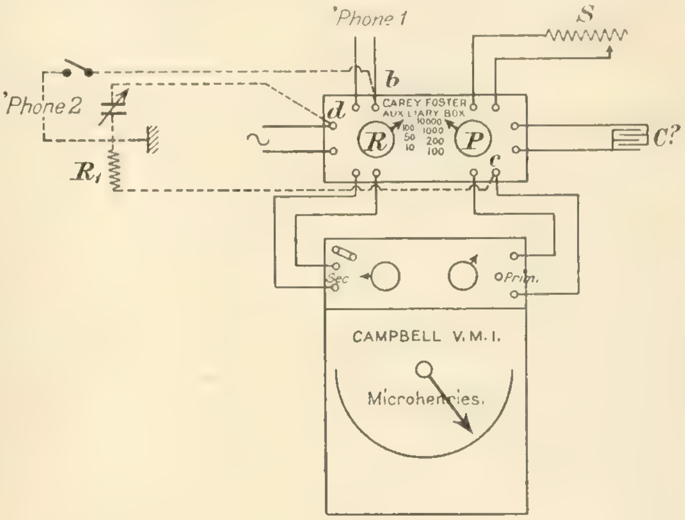

FIG. 3.

Some Recent Wireless Literature.*

By E. H. SHAUGHNESSY, O.B.E., M.I.E.E.

Dr. Van der Bijl's book fills a distinct gap in the literature of telephone repeaters and wireless telegraphy. During recent years there have been many valuable Papers published by various workers on the subject of the thermionic valve, but a book collecting and co-ordinating all recent researches on the subject has been lacking, and for this reason the present volume will be welcome. The writer goes very thoroughly into his subject, and devotes the opening chapters to the properties of electrons and their dislodgement from matter. The main portion of the book can be roughly divided into four sections, the two electrode valve and its use as a rectifier, the three electrode valve as an amplifier, as an oscillation generator, and finally as a modulator and detector. A final chapter deals with miscellaneous applications. The author as Research Physicist to the American Telegraph and Telephone Company, and Western Electric Company, is well qualified for the task he has undertaken.

VARIOUS TYPES OF VALVES.

The type of valve which the writer deals with more particularly, that of the Western Electric Company, has coated filaments in contradistinction to the tungsten filaments which are now in almost universal use. The coated filament which was used on some of the earlier valves made by the Marconi Company has the advantage of greater emission, but it has the disadvantage of being less able to withstand overheating while it is difficult to give the heavy and fragile filament adequate support. On the other hand the coated filament valve appears to have given satisfaction, and is stated to be sufficiently constant in its behaviour to meet the very rigid requirements called for in long distance telephone lines.

The author lays particular emphasis on the necessity for regarding the plate current as a quadratic function of the plate and grid voltages, rather than the linear function assumed by Latour and Vallauri or the 3/2 power relation assumed by Langmuir. In this connection it is interesting to note that the characteristic curves given appear to be much less linear than those usually obtained with the French type of valve.

SOME ERRORS.

A few errors of a minor character were noticed, but they are for the most part obvious. For example, in formula (15) on p. 165 the first term inside the bracket is inverted. On p. 223, Fig. 114, the microphone does not appear to be in circuit. There are also one or two points in nomenclature which might well be revised in a later edition, the Greek ε being used in one place as the base of Naperian logarithms, and in other places as a potential.

The book is well printed, and the diagrams and illustrations are clearly reproduced. It is confidently recommended to th notice of all dealing with the subject.

A BOOK ON THE QUENCHED SPARK SYSTEM.

The quenched spark system has hitherto never received adequate treatment commensurable with its importance in any work published in the English language, and in order to obtain detailed particulars it was necessary to refer to

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* "The Thermionic Vacuum Tube and its Applications," by H. J. Van der Bijl, M.A., Ph.D. (London: The Hill Publishing Company.) Pp. x+391. 30s.

"Wireless Telegraphy with Special Reference to the Quenched Spark System," by Bernard Leggett, A.M.I.E.E. (London: Chapman & Hall, Ltd.) Pp. xv.+485. 30s. net.

"Radiotelegraphisches Praktikum," by Dr.-Ing. H. Rein and Dr. K. Wirtz. (Berlin: Julius Springer.) Pp. xviii.+557. 120 M.

German publications. For the foregoing reason Mr. Leggett's book is welcome.

It is mainly descriptive, and for the most part deals with quenched spark apparatus as manufactured by Messrs. Siemens Bros., of Woolwich. This part of the volume is well carried out, and clearly illustrated by numerous excellent photographic plates, which show to full benefit the neat design of this apparatus. One regrets that such a work as this was not published earlier. In passing, it should be pointed out that the effect of increasing the value of a capacity in series with an aerial is to increase its wave length not to decrease it as stated on p. 90.

In dealing with branches of telegraphy other than the quenched spark system, the author does not appear to be on such safe ground, and at times makes statements which suggest lack of intimate knowledge of his subject. On p. 166 it is stated that in comparison with the spark transmitter the Poulsen Arc is relatively unimportant. The Imperial Wireless Telegraphy Committee, 1919-1920, reported that the Poulsen Arc was "pre-eminent at the present moment among methods of long-range wireless transmission." The author seems unaware that arcs of 1 000 kW rating are giving satisfactory service. On p. 377 a statement appears that the recent Parliamentary Committee recommended the adoption of Poulsen Arc transmitters for the British Imperial Scheme. The Committee actually recommended valve stations. On p.376 we learn that the hydrocarbon atmosphere is to prevent oxidation of the arc electrodes while the author appears to be unaware that the hydrocarbon is usually supplied in liquid form, as elsewhere it is stated that the use of an arc at a tropical station would be prohibitive (presumably in cost), because a cheap source of gas is not available.

Again, in the description of the Telefunken Compass it is stated that readings can be taken with the apparatus correctly to within 2 to 3 deg. As the compass has only 32 aerials the angle between each will be $11\frac{1}{4}$ deg., so that a station lying in a direction midway between two aerials of the compass could not have its direction determined within $5\frac{1}{2}$ deg. As far as our own experience goes with trained operators taking stop-watch readings, the average of dozens of readings could not be guaranteed to within 10 deg., compared with limit of accuracy of 1 deg., obtained by means of Bellini-Tosi apparatus. Another error occurs in the description of the Goldschmidt alternator, where a rotating magnetic field is stated to be capable of resolution into two component forces at right-angles, rotating in opposite directions.

An excellent feature of the book is the bibliography at the end of many of the chapters. A useful chapter is devoted to maintenance and operation of plant. As a description of the quenched spark system, the work is excellent, and one regrets that it was not limited to this subject.

THIRD EDITION OF A USEFUL BOOK.

The third edition of Dr. Rein's work revised and augmented by Dr. Wirtz, is an excellently produced book. The first 330 pages are devoted to descriptions of apparatus, its measurement and calibration. In this section is to be found a good deal of practical information on the various methods of measurement of capacity, inductance, mutual-inductance and decrement. A comparatively small portion of the book is devoted to transmitting apparatus, including valve transmitters; the remainder of the work being devoted to receiving apparatus. With the exception of the valve transmitters there seems to be little or no advance recorded since pre-war days. The valve transmitters described are only of low power. An interesting section is that devoted to wave-meters in which several types of direct-reading wavemeters are illustrated and their principles of action described. Useful sections are devoted to the measurement of the characteristics of aerials, and measurement of signal strength.

The book is well printed on good paper, and the diagrams and illustrations are clearly reproduced. A set of seven curves at the end of the book for facilitating calculations of inductances, wavelengths and radiation resistances completes this useful volume.

Electric Driving in the Paper Mill on Heat Economy Lines.*

By A. B. MALLINSON.

As compared with most other manufacturing processes, the electrification of paper mills has, until recent years, been backward. However, even in 1914, possibilities of fuel economy to be attained by electrification of the paper machines in conjunction with a suitable heat-extraction power plant, were receiving attention, and the post-war conditions of fuel supply have made the matter one of first importance.

MANUFACTURING REQUIREMENTS.

For paper manufacture in this country steam is an absolute necessity, being used :—

1. As a means of heating in the chemical treatment of the raw material, such as: (*a*) Waste paper boiling and softening at 1 lb. to 15 lb. gauge pressure; (*b*) chemical pulp softening at 1 lb. to 10 lb. gauge pressure; (*c*) rag boiling at 20 lb. to 50 lb. gauge pressure; (*d*) esparto digestion at 30 lb. to 60 lb. gauge pressure; (*e*) straw digestion at 40 lb. to 70 lb. gauge pressure; (*f*) soda recovery in esparto plants at 5 lb. to 20 lb. gauge pressure.
2. For generation of power, to drive beating, breaking and refining plant, also electric power and lighting plant, usually by compound condensing mill engines.
3. For power to drive and heat drying cylinders of paper machines, steam being utilised at from 1 lb. to 20 lb. (or even 30 lb.) per square inch.
4. To warm the air in the buildings, particularly in the machine houses, and so obviate troubles from condensation, being used at 5 lb. to 50 lb. pressure.
5. As a direct or indirect heating medium for sundry purposes in the mill (accelerating bleaching, size mixing, softening of pulp, freeing of paper stock as delivered to machine, &c.).
6. Steam injectors for hosing down at machine wet end.
7. Condensation losses in the distribution of the steam throughout the mill.
8. In the boiler-house, for auxiliaries in steam raising.

The steam requirements under the various headings vary materially for different classes of paper. Table I. may be taken as representing good practice in most mills; for old mills the figures would be appreciably more.

It is obvious that in general no electrification scheme from a public supply could entirely supersede the steam-raising plant. In every class of mill, a practically constant quantity of steam per ton of paper is required for the paper-making machines. This factor is liable to variation. Each paper machine is usually driven by two independent high-speed engines; the "wet end" engine drives the agitators, screen, shake and various pumps at constant speed, and takes practically the same power for any speed of running of paper machine; the "dry end" engine is a variable-speed unit, the speed being varied according to the calliper of sheet to be made. These steam engines are almost invariably high-pressure engines, consuming about 35 lb. per hour per I.H.P. supplied from boilers at about 100 lb. to 120 lb. pressure, or, if from a high-pressure boiler, through a reducing valve.

The weight of paper turned out per hour is approximately constant, the speed being varied to suit the thickness of the sheet. Fig. 1 shows how at one point only can the steam used for power correspond to the amount required for drying. If this point comes low down on the curve then there must be considerable surplus steam blown to waste at higher speeds.

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* Abstract of a Paper read before the Institution of Electrical Engineers in Manchester.

Table I.—*Pounds of Steam per Ton of Paper.*

Class of paper made.	For boiling or digesting, &c.	For main power.	Paper machine drive and dry.	Total.
	lb.	lb.	lb.	lb.
News, 25 per cent. sulphite	—	7 500 to 8 500	7 500 to 8 500	15 000 to 17 000
Cheap unbleached printings	—	14 000 to 15 500	8 500	22 500 to 24 000
Bleached printings	—	21 000 to 25 000	8 500	29 500 to 33 500
Pure esparto paper	21 000 to 30 000	21 000 to 29 000	8 500 to 9 000	50 500 to 68 000
Esparto wood papers, 50 to 50 per cent....	8 000 to 15 000	12 500 to 26 500	8 500	29 000 to 50 000
Pure rag writings	6 000 to 10 000	48 500 to 65 500	8 500 to 9 500	63 000 to 85 000
Wood rag writings, 50 to 50 per cent. ...	3 500 to 5 000	22 000 to 28 500	8 500	34 000 to 42 000
Browns	900 to 8 000	7 600 to 34 000	8 500 to 9 000	17 000 to 51 000

In every class of mill enough heat passes away in the condensing water to supply all, or a considerable portion of, the requirements for heating purposes. Hence by the adoption of a suitable type of power unit, with such a steady demand for power and heating steam, electrification of machines used for drying the steam from the power unit should lead to material fuel economy.

In addition to fuel saving capital outlay is often of great importance. Hence the possibilities of utilising existing prime movers on heat-economy lines deserve strict attention.

Driving Requirements on Heat-economy Lines.

The various requirements involve :—

Preparation.—Comprising rag and grass dusters, choppers, conveyors, rotary digesters, pulpers, bleach plant, &c., the details of which drives present no difficulties. Typical examples of such drives and the power taken under stated conditions of tests are given in the original Paper, requirements varying from 2 h.p. to 6 h.p. for bleach mixers, to 45 h.p. to 60 h.p. for dry paper pulpers and conveyors.

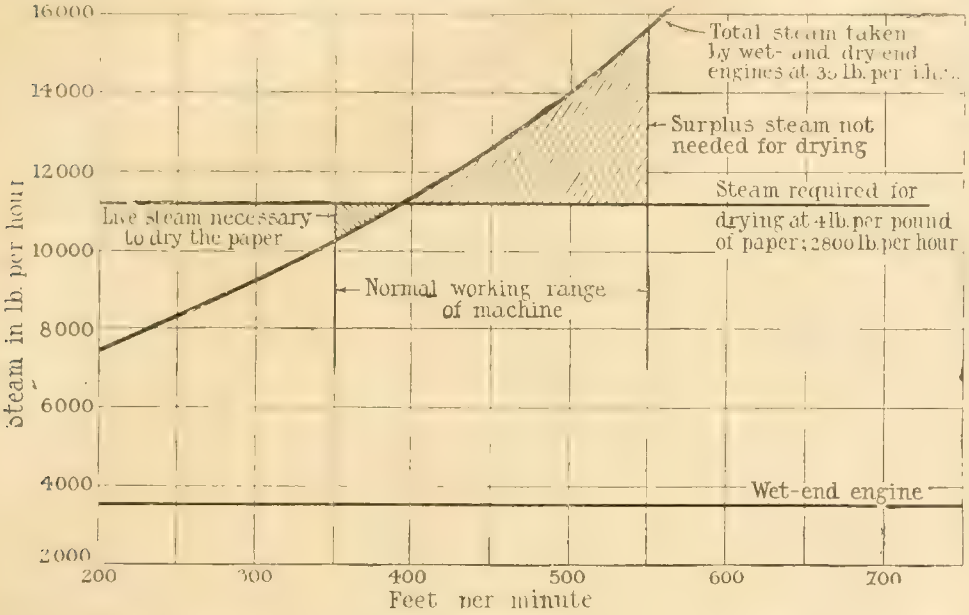

Fig. 1.—130-inch News Machine, Approximate Steam Consumption for Heating and Power.

Breaking, Beating and Refining.—Where stock is treated until ready for letting down into machine chests. This section is almost universally a mechanical grouped drive, the prime mover being coupled direct or by ropes to a main shaft in the beater cellar from which the various drives in turn are taken. Advantages of this system are : (*a*) All machines require to run continuously to facilitate charging and discharging, so there is no gain in being able to stop and start individually ; (*b*) all machines are easily subject to heavy overloads, which would involve very liberal rating for individually-driven motors ; (*c*) it is cheapest, both in capital outlay and running cost.

Particulars of typical electrically-driven machines forming this group are also given in the original Paper. Loads here are higher for example, 150 b.h.p. to 170 b.h.p. for two news breakers and chest and pump, and 160 b.h.p. to 180 b.h.p. for four tower beaters.

Paper machines are electrically driven. The wet end represents simply a constant-speed drive.

The finishing department comprising calendering, reeling, cutting and making-up of finished paper. These machines are in general already electrically driven and present no great difficulties. Calenders and cutters require speed variation, under generally easily secured by ordinary shunt control. Typical drives for finishing department machinery are also given in the original Paper.

As the driving shafts of many of the machines used in the paper mill run comparatively slowly (60 revs. per min. for cutters, 100 to 150 revs. per min. for beaters, &c.), the use of high-speed motors is not to be recommended.

Switchgear and Wiring.

Switchgear cannot be too good for the paper mill ; the conditions of handling, hours of service, humidity of atmosphere, bleach fumes, &c., will soon make trouble otherwise. Wiring in tubing and on the lead-covered system is of no use. Cab tyre sheathing stands up well if carefully erected, using separate insulators with ample gripping surface (preferably not ridged). For three-phase work, armoured cable with sealing boxes on standard lines is worth the slight extra outlay. Bitumen-insulated cables should not be used in the machine houses, where the roof temperature is sometimes 130°F. or 150°F. Generally speaking, for both switchgear and wiring, there will not be much trouble if good mining practice is followed.

Reliability.

All equipment, whether power plant, individual motors or machine drives, must be absolutely reliable. Paper mills run night and day, and obtain their maximum output by keeping the paper machines running with the minimum of "shut." A stoppage in main power plant, with the present system of engine-driven machines, of even half an hour does not affect the weekly output, since the paper machine carries on, having sufficient reserve of prepared stock in the chest in front of it ; on the other hand, on an electrically-driven machine the tripping of a circuit-breaker, causing machine motors to shut down for just a few seconds, is fatal, as it entails washing down the wire, with attendant loss of time, output and stock. Generally speaking, the simpler the equipment the better.

Heating Requirements.

Before any choice of power plant can be made, the heating requirements need thorough consideration. For drying the web on the paper machine, where there is a continuous draw of steam for drying purposes, the conditions are fairly simple. About 3½ lb. to 4 lb. of steam are required for every pound of paper delivered on the reel ; roof heating in machine houses requires 0·2 lb. to 0·5 lb. per pound of paper. The actual measurement of the steam used and the study of pressure are of great value. Fig. 2 shows the steam consumption with various degrees of back pressure ; the gain by keeping this back pressure down to a minimum, particularly where medium-pressure boilers are being used, is obvious.

Paper-mill practice lends itself well to the return of heat to the boiler feed. The hot-well temperature should be not less than 150°F. to 160°F. All pure condensed steam should be returned to the hot well. With reciprocating engine prime movers, oil in the exhaust should be removed by an efficient separator. Steam at 180 lb. to 200 lb. pressure, with superheat to 550°F. to 600°F., is advisable ; but often lower pressures of even 120 lb. can be used, enabling saving in capital outlay. Superheat is essential to ensure dry steam for the heating requirements.

Types of Power Plant.

For the purposes under consideration, the various types of power plant are : (1) Back-pressure high-speed compound steam engine ; (2) back-pressure horizontal compound drop-valve engine ; (3)

back-pressure steam turbine; (4) heat-extraction horizontal compound condensing steam engine; (5) heat extraction or bleeding condensing steam turbine; (6) utilisation of existing prime movers with mixed-pressure turbine, and other additional power units.

A typical one-machine equipment may include :—

Boiler : 30 ft. × 8 ft. 6 in., 180 lb., superheat to 550°F., hand-fired.

Engine : Horizontal drop-valve compound 400 h.p., 15 lb. back pressure, driving four beaters, revolving boilers, dynamo for machine, and usual auxiliaries.

Machine : Driven by 30 h.p. motor, speed range 8 ft. to 125 ft. per minute.

Output of paper : 70 tons weekly.

This mill averages about 16 000 lb. of steam to every ton of paper made, a figure fully 30 per cent. less than on mills with the usual condensing main engine and high-pressure machine engines. No particular type of prime mover will suit all paper mills. Heat extraction or bleeding condensing turbines are recommended where the demand for steam fluctuates or is required at different pressures. In general, turbines are best installed in conjunction with complete electrification. In some cases the use of existing plant may be contemplated to reduce capital costs; but the conditions of such plant requires careful scrutiny.

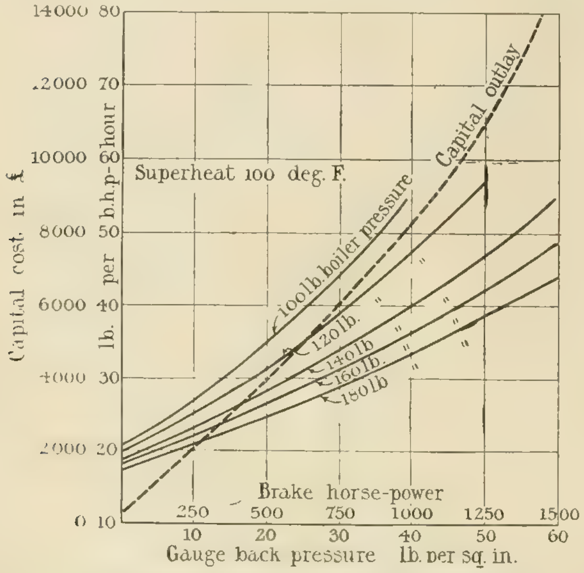

Fig. 2.—Back-pressure High-speed Steam Engines up to 1 500 b.h.p.

Curves showing effect of boiler pressure and back pressure on steam consumption, also capital cost at 160 lb. to 180 lb. boiler pressure and 15 lb. back pressure.

Conditions of Electricity Supply and Drive.

Direct current supply was usual in early mill installations, with a view to obtaining the necessary range of speeds. As mills are fairly compact, transmission problems scarcely arise, and 220 V is usual. When a whole mill is to be electrified, alternating current should now be selected. A frequency of 50 is now standardised; 25, however, does well for paper-mill drives. A paper machine is really a group of machines interlinked. The wet end requirements vary from 10 h.p. on narrow, low-speed machines up to 350-400 h.p. on the largest news machines. Dry ends vary from 20 h.p. up to the 350-500 h.p..

A considerable speed range is needed. The variable high-speed steam engine has a working range of 9 to 1, which satisfies all requirements. In many cases a range of 3 to 1 for actual paper-making is ample; one can, however, get a total range (allowing a working overlap) of 8 to 1 with a simple shunt-wound motor. One must be able to run the machine continuously at low speeds for warming up, washing felts, dryer scraping, trueing up of presses, and possibly buffing of rolls, and to provide a satisfactory start-up from cold. The advances in speed from point to point should be as equal as possible over the whole range, and the speed must remain constant, as variations may cause overweight or underweight of finished paper. The method of control must be as simple as possible. The point of control should be preferably where the machinist has a full view of the running machine. Absolute reliability of action is essential.

Methods of Drive.

The driving of the "dry end" can be either :—

Single motor : Taking the place of the engine, and retaining the present taper belt pulleys, involving as alternatives :—

(*a*) Shunt and series control, direct-current motor, from mill supply; (*b*) shunt control, direct-current motor, from mill supply; (*c*) potentiometer control, direct-current motor, from a separate dynamo; (*d*) potentiometer and shunt control from a separate dynamo; (*e*) Ward-Leonard control from mill supply; (*f*) booster control from mill supply; (*g*) alternating-current commutator motor from mill supply; (*h*) direct or alternating-current constant-speed motor with variable oil gear.

Multi-motor : A motor connected to each of the shafts from couch to reel, involving, alternatively :—

(*a*) Direct-current motors from mill supply with either a mechanical of an electrical interlock between each section of the complete drives; (*b*) alternating current commutator motors, with or without an interlock between each draw; (*c*) constant-speed alternating or direct-current motors with variable oil transmission.

Comparing these various alternatives for single-motor systems the author remarks that shunt and series control, as used on early installations, gave rise to great variations in speed, which were the cause of endless complaints. Shunt control (*b*) has given good results where only $3\frac{1}{2}$: 1 speed control is necessary. Potentiometer control (*c*), with a speed range of 6 or 7 : 1, has also proved reliable, while the combination (*d*) gives a speed ratio of 10 or 12 : 1. This method is illustrated, and attention is drawn to the simplicity of lay-out. The Ward-Leonard system, a modification of (*d*), can work on either alternating or direct-current; but it involves extra capital outlay. Booster control was designed to obviate drawbacks of (*e*). For direct current, 250 V, it is satisfactory allowing a range of speed of 12 : 1.

Finally, the author discusses the use of alternating-current motors. Variable-speed commutator motors provide a speed range of 3 :1 with an efficiency little less than that of direct-current motors. By series control the speed range can be increased to 6 : 1 or 10 : 1 for starting purposes, with the advantage that variations in speed, being effected by moving the position of brushes, are gradual. The principle is illustrated in detail in the original Paper.

There are great possibilities before this type of motor in the paper mill, both for the machine drive and other duties requiring variable speed, such as calenders, cutters, &c.

The possible objections to the system are :—

(*a*) The double-wound rotor is a complication which may eventually result in failure, due to continuous running and consequent lack of time for systematic cleaning. (*b*) The commutator necessarily becomes rather large in diameter, and at high speeds may not prove as good in commutation as the present-day direct-current machine. (*c*) The first cost of the motor will be higher than in the direct-current shunt system, though probably little, if any, dearer than the complete Ward-Leonard system. (*d*) It has not yet had the extended trials on which the opinions of direct-current systems are based.

Its other advantages, however, make this type of motor worthy of consideration for a machine drive where a three-phase supply is installed, particularly when only a maximum running speed range of 3 to 1 is desired.

Variable Oil Gear.—Whilst not an electrical device, the possibilities of a special variable-speed drive must be mentioned. This oil gear gives a gradual rise in speed and, provided proper cooling of the oil is arranged, the speed keeps absolutely steady. The sole control is by one small hand-wheel. It has not yet been used for a machine drive in this country, but there is no reason why it should not prove quite effective. The possible objections are the losses in efficiency in the oil pump and oil motor, amounting to about 20 per cent., and the possibility of trouble arising in time due to wear of the working parts when running constantly night and day.

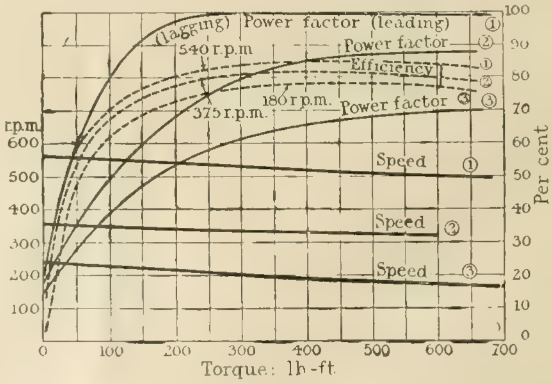

Fig. 3.—Power Factor, Speed and Efficiency Curves of a 3-phase B.T.H. A.C. Commutator Motor working at 400 V, 50 periods, 180 to 540 revs. per min.

Dealing with multi-motor systems, it is remarked that (1) direct-current motors with shunt control involve difficulties in keeping the various sections of the machine in relation to one another. There are considerable varieties of direct-current systems with interlocks. The Harland* system is illustrated in the original Paper.

An experimental equipment has been in operation for five years at speeds up to 250 ft. In Canada a fast-running machine was started last year, and is said to have given good results. In America, the General Electric Company† and the American Westinghouse, Companies are installing special machines, involving high speeds and the Metropolitan Vickers Company and the British Thomson-Houston Companies have also developed systems with possibilities. So far, apparently, alternating-current commutator motors do not appear to have been actually used for multi-motor drive, but the driving of each shaft of a machine by a constant speed (say a squirrel cage) motor through an oil gear is quite feasible.

In conclusion, the author presents a table, compiled with the help of the Paper Makers' Association of Great Britain and Ireland, giving particulars of practically all machines now electrically driven in this country. Generally speaking, the author concludes that electrification of existing machines will be on the single-motor system, although for new machines there are various advantages in favour of the multi-motor system, notably in regard to reduction in amount of gearing, and consequent economy in space, enabling the system to be applied to a wider machine.

Discussion at Manchester.

A large audience listened to the above Paper, when it was read at Manchester. It was also the first to be delivered this session by a local member. A keen discussion followed. Mr. Mallinson, who spoke well, gave evidence of commendable restraint in urging the electric drive only where it could be justified fully on economic grounds, and the Paper, although largely descriptive, contains information that will be useful to those engaged in electrifying new or in converting steam driven mills. The discussion revealed the controversy between the electric and the mechanical drive and the strenuous efforts being made to retain the latter.

Mr. F. C. **Anderson** expressed disappointment at the author's treatment of the subject, suggesting that the wide ground covered had been touched on too lightly. It was difficult to understand why the author did not advocate the electric drive more strongly. The older types of drive only gave an approximately constant draw, as tests carried out on the slip and creep of belts made at Sibley College, U.S.A., clearly indicated. Paper-mill conditions were far more unfavourable than the constant laboratory conditions under which these tests were performed. A paper-maker had told him that after converting from engine to motor drive he could work to a 15 per cent. keener specification. The electric drive gave the paper-maker a constant draw for the first time in history. He denied that hunting occurred in the Harland drive. The adoption of multi-motor drives resulted in big savings, not, perhaps, wholly due to the electric drive. The paper trade realised that modern high-speed news machines, such as the Laurentide machine, must be electrically driven.

Mr. W. **Adamson** said that the increase in size of machines had introduced the electric as a rival to the mechanical drive, but he desired to emphasise that the largest machine in the world was mechanically driven. On one wide mechanically-driven machine, producing per day 80 tons of news print, which in Canada was 95 per cent. mechanical pulp made, sometimes within two hours of the withdrawal of the logs from the river, only one break per day occurred. The electric drive had advantages in high-speed machines, 1 000-1 500 ft. per min. The American engineers were developing such machines but a normal British machine took 25 per cent. less power.

Mr. A. L. **Boyle** said that he had had experience in two paper mills, and in one the adoption of a turbine had resulted in 50 per cent. fuel saving, but the installation of the individual motor drive pointed to the fact that the electric drive was favoured.

Mr. C. R. **Kemp** was gratified that the author had expressed his indebtedness to Mr. Adamson's Paper, and said that no comparative fuel consumptions had been given for the mechanical and electrical drives. He desired to know whether the author accepted Mr. Adamson's figures, which showed the latter worse than the former. It was probable that Mr. Adamson's figures were on the high side for the electric drive, and that the respective consumptions were in practice nearly equal. The author's figure of 35 lb. steam consumption was open to question. The speaker created considerable amusement by reading a few extracts from a pamphlet circulated, doubtless by those interested in the old type of drive, among paper-makers, to the effect that motors reproduced faithfully the speed variations of the parent generator; that they, in common with all electrical apparatus, were sensitive to temperature changes; and that even the largest steam turbine was not so efficient as a small engine.

Mr. F. P. **Spicer** said that electrical engineers must go into paper making to help the paper-maker to produce a better and cheaper product, and paper-makers should meet them in the spirit of receptivity.

Mr. S. J. **Watson**, criticising the author's remark that "no electrification scheme from a public supply could entirely supersede the steam-raising plant," said that there were mills taking their power from a public source, and the users were satisfied. The main difficulty was th question of providing heating steam, but in one case an original battery of boilers giving steam for power and drying had been reduced to one-fourth for drying only. Future power supply would be alternating, and if wide speed variations were required conversion might be necessary. For those mill requirements involving constant speeds alternating-current motors were very suitable. Alternating-current commutator motors would solve a difficult problem, and information as to relative efficiencies and cost of alternating-current and direct-current commutator motors would be welcomed. Potentiometer control was the best and simplest, giving fine regulation. He would also like information on oil-gear drives, to which the author had referred.

Mr. A. B. **Mallinson**, in reply, said that the difficulty was to convince a paper-maker that the electric drive was really the better, since paper was made on existing machines, and paper making engineers were conservative. The necessity for steam for drying had prevented high efficiency being attained in the mechanical drive. His reference to hunting in the Harland gear was to an experimental machine. Clients who converted their mills from steam to electric drive were satisfied. He did not advocate an "all-electric" drive, but only on paper machines and auxiliaries. His figure of 35 lb. per horse-power was based on actual measurements, and was also given by engine makers. Answering Mr. Watson, he adhered to his statement for mills working on heat economy lines. The paper trade was special and should have its self-contained power plant. He also advocated potentiometer control. Alternating-current commutator motors had an excellent future and were little more costly than direct current motors with potentiometer control. Regarding oil gears, he had found the Williams-Janney a fascinating gear and its efficiency was good at top speeds. For speed variations near the maximum it was excellent.

Discussion at Liverpool.

A discussion on Mr. **Mallinson**'s Paper also took place at Liverpool. We give an account below:—

Mr. T. D. **Clothier** said it seemed surprising that only 20 out of 548 paper machines in this country were electrically driven. Such machines, however, formed only a small part of the plant of a paper mill. The best practice was to produce the steam required for processes as economically as possible, to use electricity for power purposes and for the public authority to employ any surplus heat for generating electricity. Could the electrolytic bleaching process, used successfully in laundries, be applied in paper mills? Mr. Clothier contended that the speeds being used for making paper were too slow. Reduction gear was not necessary except with very small turbines, a direct drive to the alternator was preferable. For the dry end of a paper mill the Harland arrangement seemed a good means of using electric drive. The lay-shaft was, however, troublesome to carry to all machines, and in some devices this was being replaced electrically.

Mr. G. **Rattenbury** suggested that pipe-ventilation for the larger switchgear, as well as motors, was often desirable. In referring to possible objections to auxiliary regulators, he asked what was the maximum change of speed permissible without damage to the paper, and how this varied with the thickness and quality of materials. It seemed preferable for progressive speed changes to increase by a constant percentage rather than arithmetically; this would reduce arcing on regulator contacts. Could one use a 3 : 1 variable speed motor for the working range with a suitably geared small auxiliary motor for slow speeds for washing and starting up, as was done with calenders? Another possible arrangement was two motors of equal size coupled together with differential gear. For multi-motor drive the three-wire system suggested possibilities.

Mr. A. E. **Malpas** referred to troubles arising from sweating in roofs, which had been experienced in certain munition works during the war. How was the roof-heating provided? He noticed that most of the plant tabulated comprised direct-current machines, and with the limits of speed-regulation specified, he thought direct-current machines could hold their own. Capital cost of plant was often a determining factor, leading to avoidance of slow speed motors. He made it a rule that when plant ran 168 hrs. per week continuously a duplicate stand-by must be provided. The plan of supplementing existing prime movers by mixed pressure turbines was out of date. He thought that in general the cost of commutator motors was prohibitive.

Mr. A. S. **Wilson** emphasised the need for a check on steam blowing through pipes. A leak of 1/100 sq. in. in a pipe at 150 lb. pressure might mean a waste equivalent to 40 tons of coal per year. He did not think the cost of commutator motors prohibitive in view of the saving in cost of control gear. There was also a saving in wiring.

Mr. A. B. **Mallinson**, in reply, said that the best paper was still being made in the old mills built 50 to 100 years ago. Improvements had been made in making "news" paper, but the process applying to the finer varieties had changed but little. On the average, 250 h.p. was needed per machine installed, and some mills used four to six machines. Adequate supplies of water were vital, about 100-150 tons being needed to make 1 ton of paper. Two paper mills had started supplying power to adjacent ones. Some of the old cumbrous machinery in use was pitiable. The introduction of ball bearings would in some cases reduce the power to one quarter. There were machines requiring 40 h.p. to make paper which still took 36 h.p. when the paper had passed off. Paper makers were keen on increased speeds and there had been notable progress in this respect in the United States. If interlocks once got out of order this might cause great trouble and delay. He did not agree with the installation of the main drive electrically. Forced ventilation of the switch pillar deserved attention. He agreed with Mr. Rattenbury that the speed-jumps demanded were rather hard on electrical designers. Auxiliary motor systems were applicable to calenders, but the complication was not justifiable for paper machines when slow speeds were only needed for a short period at starting each week. He agreed with Mr. Malpas that direct-current machines, if big enough for the work, could still do good service. He agreed that sweating and condensation was a great trouble in paper-mill work, being frequently responsible for breakdown of wiring. The use of existing prime movers was simply a compromise in cases where the cost of a complete new scheme could not be met. Direct-current motors reached a steady speed after a certain period of running. A paper mill ran for 132 hours, and after 6 hours a constant speed was attained. There were great possibilities in the alternating-current commutator motor, but while the switchgear element was cut out, the resistance inserted between stator wires and brushes must be taken into account; also the interlock between brush position and supply oil switch.

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* *See* The Electrician, Vol. LXXXIV., p. 344.

† *See* The Electrician, Vol. LXXXVI., p. 192.

Electrical Developments at Salford.

An interesting point in the history of electricity supply in Salford has just been reached. It is a story which is not unfamiliar. Supply from the Frederick Road Station was commenced in 1901 with eight 800 kW sets, these being supplemented in 1907 by the addition of one 1 000 kW low-pressure direct-current turbine set, giving a total capacity of 7 400 kW. With the growing demand for electrical energy in Salford, however, it became necessary in 1913 to obtain a bulk supply of 2 000 kW from the Lancashire Electric Power Company, this being one of the first cases of interconnection for mutual benefit of contiguous undertakings. This arrangement, however, only brought temporary relief, and in 1915 it was decided that a new generating station would have to be erected to meet the future demands in the Borough for electricity supply. The war, however, prevented this really urgent work from being started, and carried through at a speed which was desirable, and further temporary expedients had therefore to be resorted to.

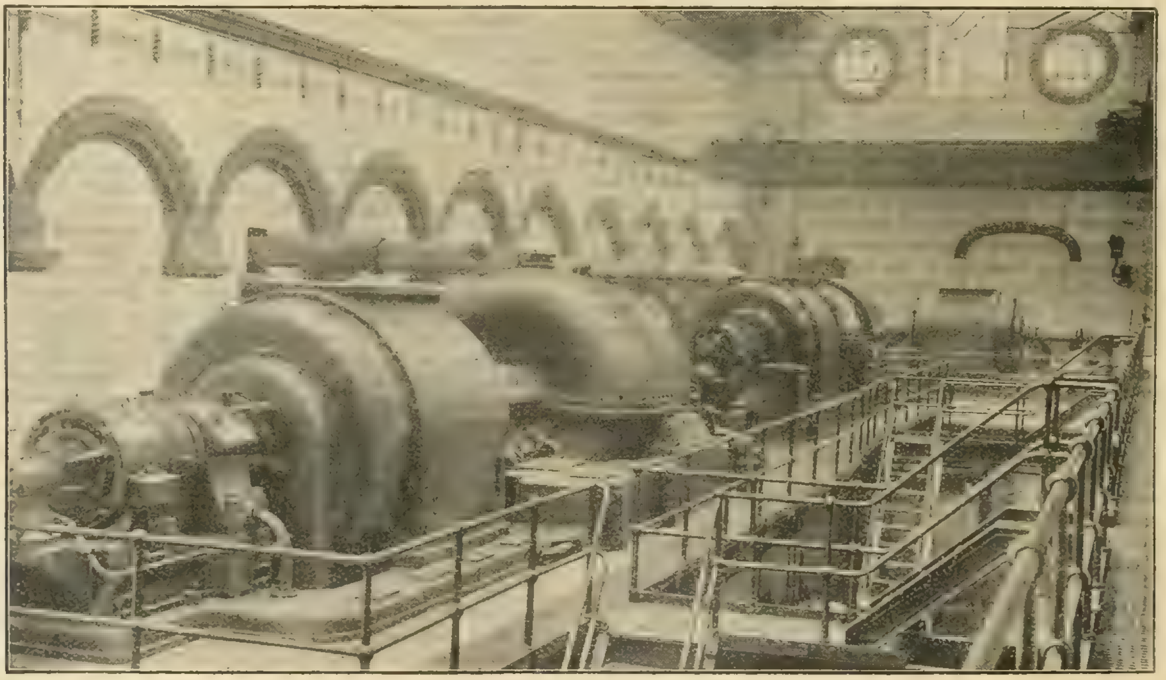

Fig. 1.—View in the Turbine Room with the Recently Installed 5 000 kW Set in the Foreground.

In 1918 the Electricity Committee of Salford entered into an agreement with the Manchester Corporation under which a bulk supply of 4 000 kW was furnished at a pressure of 33 000 V. This is the highest pressure which has so far been used for underground transmission in this country and a description of the apparatus which made this development possible was given in The Electrician for January 23, 1920.

A New Turbo-Alternator.

In addition it was decided to augment the existing generating plant by the installation of a 5 000 kW turbo-alternator of the Metropolitan-Vickers Electrical Company's design. This set, of which a view is given in Fig. 1, was recently set to work, and with its installation the ultimate capacity of the Frederick Road site may be said to have been reached. The general design of the Metropolitan-Vickers turbo-alternators are well known to readers of The Electrician, but it may be mentioned that the set runs at 3 000 revs. per min., and is equipped with a self-contained system of feed water heating by which a saving in the coal consumed of approximately 4·75 per cent. can be obtained, as compared with a turbine which is not so fitted. This feed heater is arranged within the turbine casing, across which it extends at the exhaust end. The water tubes are exposed to steam delivered from the main turbine at a pressure which corresponds to a vacuum of about 20 in. The feed water is circulated through the heater by the main condenser extraction pump, and is heated to a temperature of approximately 160°F. The heater is also arranged to utilise leakage steam from the turbine glands and other sources. In fact, it may be said that no opportunity has been neglected of eliminating every source of heat loss.

Nozzle Boxes and Valve Mechanism.

The nozzle boxes are made in the shapes of pipes, suitable slots being provided for the admission of steam to the nozzles which are bolted to the box. These boxes are free to expand independently of the turbine casing, this freedom of movement being a great advantage where high steam pressures and temperatures are in use. The valve-operating mechanism is arranged so that forces all act in one plane, and all parts which are subjected to wear are removed as far as possible from those parts which are subjected to high temperatures. At the alternator ample space is provided for ventilation, and every effort is made to ensure that the construction is as rigid as possible. In general design these machines follow the lines of those supplied by the Metropolitan-Vickers Company to the Clyde Valley Company, of which a detailed description appeared in our issue of June 3, 1921.

The Agecroft Station.

With regard to the new station from which a site of about 50 acres has been acquired at Agecroft on the banks of Irwell, it is proposed to design this for a capacity of 50 000 kW with generating sets of no less than 10 000 kW output each. A steam pressure of 350 lb. at a temperature of 700°F. will be employed, with the result that it is hoped that the normal fuel consumption will not exceed 2 lb. per unit developed, as compared with 3·2 lb. at Frederick Road. When this station is completed Salford's electrical troubles will have been solved, and it will also have been placed in possession of a really up-to-date station. In chronicling these advances we take this opportunity of paying our due to the enterprise and skill of Mr. J. A. Robertson, the Borough Electrical Engineer, who is responsible for carrying out not only the extensions we have just described, but for the design of the new station.

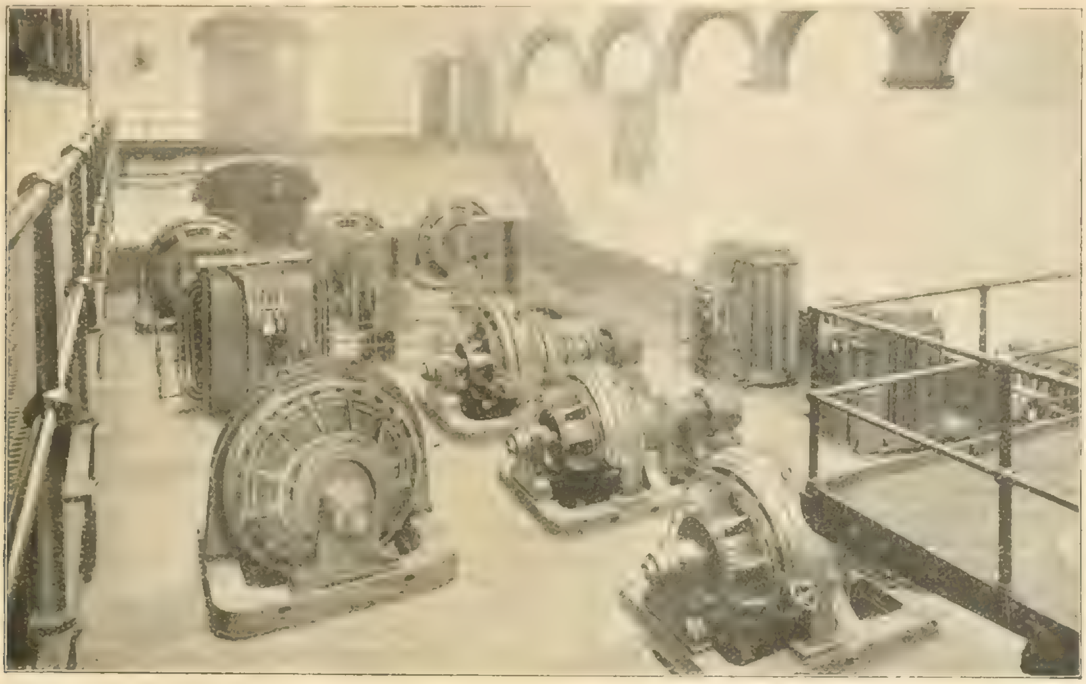

Fig. 2.—The Converting Plant at the Frederick Road Generating Station, Salford.

"Single Phase" Not Condemned in Europe.

By STANLEY PARKER SMITH.

In the "Electric Railway Journal" for March 5th, 1921, an article by Mr. E. C. Zehme, a Privatdozent in Berlin, appeared under the above heading. In this article the following statements were made :—

> "It has been customary to consider Germany, Switzerland, Austria and Sweden as the advocates of the single phase system, but they are not so to-day. Only Switzerland and Austria are extending their single phase roads at present, whereas no definite conclusions have as yet been reached as to the standard system in Germany, Sweden, Norway and Holland, and even in Italy." "Recently doubts have been advanced from several sides as to the practicability of the single phase system from the main railroads of Germany . . . . . Nevertheless the authorities still manifest a preference for the single phase system and have decided to call an International Congress this year in Germany to go over the whole matter, presumably hoping that the present view-point of the Prussian State Railways in regard to the system will be justified."
>
> "The Swedish State Railways plan to electrify additional lines, principally in the South, and primarily for passenger traffic.—Here the question of system has again been studied very carefully . . . . . Although the single phase system is estimated to be somewhat more economical than the other, the difference is small and is being considered in connection with the inductive disturbances in telegraph and telephone lines caused by the alternating current operation. A special commission on this subject has studied the phenomena carefully, together with the remedy for the trouble, and has presented a long report. This is unfavourable to the single phase system."

That these allegations do not appear to be well founded as far as Germany and Sweden are concerned, would appear from the following refutations :—

An official announcement appears in the "Deutsche Allgemeine Zeitung" of May 14th, 1921, of which a translation is given below :—

The Electrification of Railways.

> In the American technical paper, "Electric Railway Journal," a Privatdozent, Mr. E. C. Zehme, of Berlin, published an article entitled "Electrification in Central Europe," in which among other things it is stated that Germany had not yet finally decided what system to adopt for electric railways, and in order to settle this question intends to call shortly an International Congress. These statements are no correct. The German National Railway Administration has, like the railway administrations of the several German States before it, as far as electrified lines are concerned, always regarded the simple single phase current as the only system to be considered for their long-distance railways, and has never, not even temporarily, deviated from this standpoint. As all the existing long-distance railways of the German National Railway Administration are operated with single phase current, so also the single phase current alone has been considered for the electrification of further sections. Under these circumstances there is also no object in calling a congress to discuss the question of the systems. Though in February last there was an exchange of opinions between the railway Administration and well-known outside experts on questions of electrification, this was chiefly in connection with the question of supply.

The following statement was also supplied by Mr. F. Ofverholm, the chief electrical engineer of the Swedish State Railways :—

> "I have now got the number of March 5th, 1921, of the "Electric Railway Journal," and found the article by Mr. Zehme. This article is not correct at all. First, the total length of the electrified railroads now in Sweden is 260 miles, out of which only 20 miles is direct current and the other 240 all single phase.
>
> "Then Mr. Zehme states that the report about the disturbances in telegraph and telephone lines was unfavourable for single phase. I sent you that report with letter of September 3rd, 1920, and you can judge for yourself. I think you will find the contrary. In the end of this year we will have 400 miles of single phase roads and the old 20 miles of direct-current roads in this country. The statement that we are not extending our single phase roads is, therefore, surely not correct."

In these days when the "battle of the systems" is so much to the forefront, misleading statements such as these quoted from Mr. Zehme's article should be carefully avoided. The issues at stake are far too important for all countries to allow such misstatements to pass uncorrected.

It is estimated that there is sufficient water power in Palestine for generating 1 000 000 e.h.p. In a scheme recently outlined in the "Times" a Jewish engineer, Mr. Rutenberg, proposes to erect hydro-electric works for utilising the water-power of the Jordan adn to establish a barrage at the southern end of the Sea of Galilee, where the main generating station would be established. The scheme would be carried out gradually, according as the demand for lighting and power increased.

Money for Nothing.

Discounts that Defeat their Purpose.

By "ELECTROCYNIC."

My knowledge of selling policies and systems of dealer distribution is chiefly indirect. It has never been my fortune to have to fix price rebates or determine the scope of their beneficence, and I trust that this lack of practical experience may be taken into account by the selling experts who honour me by reading this article. I am a child in these matters, and my purpose in writing is to learn rather than to instruct. There are many things I want to know about discounts, and I shall be grateful for any information which readers may vouchsafe in answer to the questions propounded or implied in subsequent paragraphs.

To begin with, what is a discount ? Of course, I know what it is in so far as it affects my own pocket. When I see in a catalogue that the trade discount is 33⅓ per cent., I know that by the employment of smooth words and someone else's visiting card I can acquire any article therein listed at two-thirds of the marked price.

Their Proper Function.

But what is the proper function of discounts ? I cannot say with any degree of certainty, because in the electrical business they seem to be given for the most frivolous and inadequate reasons. In a broad and theoretical sense, I suppose that discounts are intended to represent the payment made by manufacturers to factors and by factors to contractors as a reward for the work and expense of wholesale and retail distribution. It can hardly be said, however, that in the electrical trade the payment of discounts depends upon the performance of distributive services. In many cases, no doubt, the person or firm who receives a discount has done some work or incurred some expense which may justify the payment; but, speaking entirely from my own observation and experience, I should say that the vast majority of dealers in electrical apparatus do not earn the discounts which are flung at their heads by over-generous manufacturers.

Consider the Contractor.

The mere introduction of a customer does not, in my opinion, entitle a dealer to the full trade discount, the amount of which is, I presume, based on the assumption that the dealer incurs the entire cost and labour of retail distribution. Consider, for example, the selling methods of the average suburban contractor. He stocks nothing, and consequently requires no capital in his business. If, perchance, a customer should want to buy a fitting or a fire or an electric washer he is probably sent along to the manufacturer's or factor's show-room, the contractor having first given telephonic warning of the impending visit, in order that the discount may not go astray. When the would-be purchaser arrives at the manufacturer's show-room he is politely received and is entertained to an interesting demonstration. Finally, perhaps, he selects a fitting or an appliance, pays cash (at full list price), and his purchase is sent home at the manufacturer's expense. Subsequently a sum of money, representing a third or maybe a half of the amount paid, is credited to the contractor. In Heaven's name, why ? At the most, the contractor has earned 5 or 10 per cent. for introducing a customer.

Who is to Blame ?

As everyone in the industry is aware, such instances are as common as flies on a midden. They are not the exception that proves the rule, but the rule itself. Who is to blame ? Well, I can answer this question easily and without assistance. Of course, it is the manufacturer. He has, with the best intentions in the world, utterly spoilt the retailer. Not only have manufacturers passively encouraged the payment of unearned discounts, but in many cases they have made it a central feature of their selling policy. They have actually insisted on allowing discounts to contractors, who, if not unwilling, were certainly undeserving and had had absolutely nothing to do with the transactions responsible for this flood of eleemosynary frenzy.

Here is a case in point. Some months ago I was making tentative inquiries with a view to buying an electric cooker. (I didn't buy it, but that is another and more tragic story.) In the course of my investigations I visited the show-room of a fairly well known manufacturer. I did not divulge the fact that I was in the electrical business, because, until it comes to paying, I prefer to be treated as a member of the lay and gullible public.

I Innocently Said....

Having duly admired the cookers, I innocently said, "And what is the trade discount ?" The salesman, without thinking, replied, "Twenty-five per cent.," and then added, "but, of course, *you* would have to pay the full price." "Then," said I, "who will get the discount ?" "Your contractor." "But I do not intend to employ a contractor, because I shall connect up the cooker myself. What happens then ?" "In that case," quoth the salesman, "we shall search out the contractor nearest your address, and pay the discount to him." I said, "You will do nothing of the sort. I am not asking for the discount myself (I should have done so later on), but I strongly object to your giving my money to a dealer who has had nothing at all to do with the matter." "But," countered the purveyor of cookers, "it is our selling policy." To which I rejoined, "Suppose this contractor, to whom you insist on paying a discount, had actually advised me not to come to you, and had, in fact, said that your cooker was a rotten piece of apparatus, would you still heap financial coals of fire upon his unrepentent head ?" He said, "We should," and I fled from his presence, muttering imprecations upon the stiffnecked foolishness of the present generation of electrical salesmen.

Just Fancy !

The salesman should not, as a matter of business tactics, have discussed discounts with me at all. The important point, however, is that since I came to his showroom as a private person, without contractorial introduction or allegiance, he should have sold to me at full list price *and kept the lot.* Just fancy sending a five pound note to an unknown wireman, merely because he happens to have a dirty little shop within a mile of my house !

The thing is all wrong. I do not care whether the same methods are followed in other businesses or not; but they are entirely illogical, and therefore unjust and immoral. By all means see that the contractor is given a fair discount on all material which he himself buys for resale. Give him, if you like, a smaller discount in cases where he merely introduces a customer to the manufacturer or wholesaler ; but in the name of all that is sensible do not pay him for nothing. That way ruin lies. Indeed, I am convinced that the lack of enterprise and general spirit of apathy which are exhibited by the retail section of the industry are largely, if not entirely, due to the absurd and mis-directed generosity of manufacturers.

The contractor has found that he can do a certain amount of very easy and profitable business, without holding stocks or incurring any sort of financial liability, and he has been only too quick to take advantage of the opportunity. Every one likes to be wet-nursed, but the process is as bad for adult businesses as it is for adult persons.

Essential Preliminaries.

It has got to be made clear to contractors of this kidney that they must buy before they can sell, and do both before they can collect discounts. When manufacturers are agreed upon some such policy we may expect a vastly increased sale for electrical appliances of all kinds. But while contractors are, in effect, paid a small but certain income for acting as signposts to the manufacturer's showroom, it is hardly likely that they will bestir themselves to seek out the shy and palpitant buyer, and, by the sweat of their brows and the selling eloquence of laborious argument, make him buy the thing he does not know he wants.

We may, as I have suggested on a previous occasion, learn many things from the rag trade. Certainly the wholesale draper can teach us something useful in regard to discounts. As a matter of fact, I believe he does not deal in discounts. Drapery prices are net, and when anybody buys who is not entitled to the net price, the salesman does little sums in addition. However, it comes to the same thing in the end. The point is that if you go to Cooks or Rylands as an ordinary member of the public, you can buy anything you want without having to answer silly questions about your retail supplier.

The wholesaler is only too glad to sell to you at full price, and to stick to the entire sum. He is not going to subsidise *that* sort of retail distribution.

The Tale of a Carpet.

I remember on one occasion going to a drapery warehouse near St. Paul's Churchyard, armed with a letter from a retail friend, who begged that I might be allowed to select the article that pleased me (it was a carpet), and the account be sent to him. In this artful manner I was to get the carpet at wholesale price. It didn't, as a matter of fact, come off. Naturally, the wholesaler wouldn't quote net prices, and all the figures he mentioned were supposed, or so he suggested, to represent a rough approximation to what my retail friend would charge me. I selected a carpet ; my friend sent me the actual bill which he had received from the wholesale house ; and lo ! and behold! the amount was just £1 higher than I should have had to pay at a retail shop for a precisely similar floor covering.

This was rotten luck for me, but the wholesaler's conduct was highly commendable, and sets a noble example to our discount-mad industry.

L'Envoi.

As I said at the beginning of this article, I know very little about discounts; but I hold some rather decided opinions on the subject of their distribution, and, although I have disclaimed any informative intention, I cannot refrain from concluding with a word of advice to manufacturers and factors. Give your full trade discount to those who buy and *hold* stocks for resale; give a reduced discount—10 per cent., say—to those who send customers to your showrooms and leave to you the trouble of selling and dispatch; and give no discount at all in cases where private customers buy without a definite introduction from a retailer.

Finally, never ask a casual customer the name of his contractor. He might tell you, and then the old temptation would recur.

Some Difficulties Experienced in Maintaining a Pyrometer Installation in a Works.*

By R. S. Whipple.

The high price of materials and labour emphasises the need of effective temperature control, and many firms have installed pyrometers in their works. It is doubtful, however, whether most of them obtain the maximum of help from such instruments, and in this Paper the author summarises some of the difficulties experienced, and the precautions that should be taken. Generally speaking if a pyrometer installation is unsuccessful it is because the wrong type of instrument has been installed, or it is not being used efficiently, or requires adjustment or correction.

The Work and the Instrument.

A purchaser, in selecting an instrument, should clearly understand the degree of accuracy desired and practicable. He should also decide definitely whether occasional or continuous readings are necessary. It is important to consider the actual nature of the work passing through a furnace or kiln. Managers naturally prefer to have the recorder installed in their offices, but it is usually preferable to place it somewhere where the fireman in charge can see it. The latter then comes to regard it as a friend, whereas if the recorder is in the manager's office he is apt to regard it as a policeman installed in order to ensure that he does his duty. The happy mean is to have two instruments in parallel, one in the manager's office, the other for the inspection of the fireman.

As a guide to the selection of instruments one may recommend:—For temperatures ranging from—200° to 700° C., the resistance thermometer; from 0° to 1 200° C., the thermo-electric thermometer; from 700° to 2 000° C. (or upwards), the optical or radiation pyrometer. For temperatures between 300° C. and 1 200° C. thermo-electric thermometers may be used, but above the latter temperature it is almost impossible to protect a couple from deleterious gases. Each type of instruments has limitations. An accuracy of 0·1 per cent. can only be obtained by taking special precautions. Inefficiency may be due to various causes, *e.g.* (1) destruction of the protecting envelopes of the pyrometer by excessive heat or mechanical breakage, owing to incorrect mounting in furnace, (2) vibration of support carrying galvanometer, (3) defective wiring or unsatisfactory connections, (4) dirt, (5) want of adjustment of indicator or recorder, (6) carelessness in handling of instrument or inattention to details.

Protecting the Tubes.

A great need is a satisfactory material for protecting tubes. Up to the outbreak of war the best material was made by the Royal Berlin Porcelain Works. The Royal Worcester Porcelain Works have developed a material almost as good as the German variety and better as regards porosity. Excellent porcelain tubes are also now being made in America and Japan. Position of mounting is extremely important. In some processes it is desirable to bring the pyrometers as close to the work as possible, and yet to avoid danger of breakage. The author discusses advantageous positions for various types of furnaces, amongst which furnaces devoted to heat-treatment of malleable iron present special difficulties. In a pottery-kiln two types, in the early stages a thermo-couple and in the later stages a radiation pyrometer, have to be used. The high temperature and destructive action of molten glass render radiation pyrometers essential.

Vibration is rarely serious in a works, but defective connections and intermittent contracts and varying resistances may naturally introduce considerable errors. The cases of recorders should be kept as free as possible from dirt, which may contain particles of iron. Such particles are apt to adhere to magnets preventing free movement of the galvanometer coil. Instruments should be checked against standards referred to the National Physical Laboratory. In a large laboratory an accurate potentiometer with accessories is desirable. Instruments can be also checked by known boiling of freezing points, values of which are given by the author for various metals.

Errors in Thermo-Electric Instruments.

Errors in thermo-electric instruments may arise from (1) gradual changes in the E.M.F. of couple, (2) the temperature of the cold junction being unknown or uncertain, (3) resistance of leads or defective connections, (4) temperature of indicator and changes in galvanometer. The most serious error in industrial pyrometry is that indicated in (2). Galvanometers should preferably have a high resistance so that variations in resistance of circuit will have relatively little effect. Care should be taken that the galvanometer is not over-heated; this may involve long leads, but the effect of such leads can be compensated and entails no serious disadvantage. Radiation and optical pyrometers are usually graduated to give true temperature under black body conditions, which may not always be realisable. The interpretation of results then involves care, but as pyrometers are often used merely to ensure reproduction of certain heat-conditions deviation from black-body conditions is not always a drawback. The two most common types of optical pyrometer are the "disappearing" filament and "polarising" varieties.

In conclusion the author emphasises the importance of arranging that it is definitely somebody's duty to supervise pyrometers and keep them in good order. If this is done little trouble should arise, especially as it is unnecessary to aim at reading an instrument to one or two degrees when the temperature of the furnace studied cannot be controlled within 10 or 20 degrees.

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*Abstract of a Paper read before the Ceramic Society.

Magnetos for Ignition Purposes for Internal Combustion Engines.

We give below an account of the discussion which took place in Birmingham on Mr. E. A. Watson's Paper on "Magnetos for Ignition Purposes for Internal Combustion Engines." An abstract of the Paper appeared in our issue of April 22nd, 1921.

Mr. W. **Wilson** referred to the earlier practice of fitting magnetos with a plurality of narrow magnets and contrasted this with the present practice of fitting a single magnet. He had heard it explained that the reason for the use of several magnets was that owing to the superficial nature of permanent magnetism it was necessary to provide as large an area of free surface as possible. He did not consider the explanation convincing and asked whether a more satisfactory reason could not be given.

Capt. **Cave-Brown-Cave** spoke on the advantages of a gap between the high-tension winding of the magneto and the engine sparking plug. He had heard of occasional trouble with jump-spark distributors owing to metal particles short-circuiting the high-tension leads, but his own experience with these distributors was satisfactory. He also mentioned the possibilities of influence machines for ignition purposes and asked for the author's opinion on such machines.

Mr. E. O. **Turner** questioned the advisability of using the same leak resistance for utility tests at high and low speeds, and thought that at high speeds a higher leak resistance than that used at low speeds would be more consistent with engine-working conditions. He also commented unfavourably on Mr. Watson's curve showing the performance of a battery and coil ignition apparatus and thought that the curve was not representative of well-designed apparatus He did not agree with Mr. Watson's advocacy of the jump spark distributor.

Dr. D. K. **Morris** referred to an important fact mentioned by Mr. Watson that in determining from the demagnetisation curve the suitability of the permanent magnet for magneto work, the useful figure was not remanence, nor coercive force, nor their product, but the product of those values of B and H on the curve which gave the greatest value.

Prof. W. **Cramp** said that the Paper not only provided new and useful information for the benefit of makers and users of magnetos, but lifted the subject from the region of empirical guesswork to that of scientific design.

Some Thermionic Tube Circuits for Relaying and Measuring.*

By W. H. ECCLES, F.R.S., and Miss W. A. LEYSHON.

Voltage Factor.

The voltage factor of a triode may be looked at from two distinct points of view. (*a*) The electro-geometrical standpoint; in this the change in anode voltage required to produce a given change in the electric field near the filament is compared with the change in grid voltage required to produce an equal effect. From this standpoint the relationship between these anode and grid voltage changes could be calculated from electrostatic theory and a knowledge of the dimensions of parts of the triode.

In (*b*) the experimental way of defining voltage factor, the change in anode voltage required to hold the anode current constant when unit E.M.F. is applied between grid and filament is the voltage factor at the given adjustment.

Measurement of Voltage Factor.

In the method now to be described the anode current is automatically kept constant by including a saturated diode in the anode circuit of the triode. Pairs of corresponding values of grid voltage (v_g) and anode voltage (v_a) may be determined for any given constant current through the triode.

In Fig. 1 *T* represents a triode and *D* a diode in series with it, *mA* is a milliameter, *V* an electrostatic voltmeter or quadrant electrometer. Sometimes a battery is used in series with *V* when this is an electrostatic voltmeter. The battery *B* must be of sufficient voltage to maintain the saturation current of the diode through the apparatus.

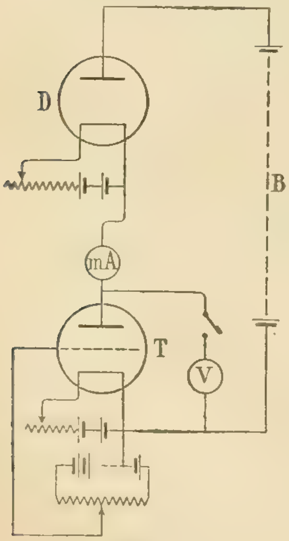

Fig. 1.

Suppose the relation between v_g and v_a is required for a triode at filament voltage 4 volts and an anode current of 0·4 mA. The triode filament-circuit resistance is adjusted until the filament circuit voltmeter reads 4 volts. The diode filament-circuit resistance is adjusted until the milliameter reads 0·4 mA. The triode grid voltage is adjusted to, say, 6 V and the anode voltage recorded by the electrostatic instrument is noted. The grid voltage is then raised in steps of one or two volts and the reading of *V* noted for each successive value of the grid voltage. The tangent of the angle of slope of the curve v_g v_a, gives the value of the voltage factor at any point.

Fig. 2 shows results obtained with an "R" triode, using different anode currents and different filament voltages. When the grid voltage is negative or only slightly positive the slope of the curves is constant and independent of anode current or filament voltage.

As the grid voltage is increased the observed voltage factor gradually falls to zero.

In the ordinary method of using a triode as a voltage amplifier, a high resistance is included in the anode circuit and the variations in P.D. across this resistance resulting from variations in the grid potential are utilised. In Fig. 3, let *E* be the voltage of the anode battery, *R* the resistance in the anode circuit, *r* the internal (differential) resistance of the tube, *v* the grid voltage, *i* the anode current, and *V* the P.D. across the resistance *R*; then for slight changes of grid voltage the change in anode current is given by $di = \nu dv/r+R$; when ν is the voltage factor; and therefore $dV = Rdi = \nu dv/1+r/R$. The amplification ratio is $dV/dv = \nu/1+r/R$.

Now when the resistance *R* is replaced by a saturated diode the resistance offered to small changes of voltage is very large. In the ideal case the differential resistance *R* tends to infinity and the amplification ratio approaches its largest possible value—*i.e.*, that of the voltage factor. Hence a diode may replace the resistance or impedance in a voltage amplifier with resulting increased sensitiveness in the amplifier.

Two Triodes in Series.

Fig. 4 shows an arrangement of two triodes in series, the current being limited by the saturated diode D. A voltage *e* applied across the grid filament of the first triode, results in a change in voltage of νe between A_1 and F_1 which may be indicated by the electrostatic voltmeter *Z*. If G_2 is connected to *F* through a suitable battery, which may be part of the battery *B* across the three tubes, then the difference of potential between G_2 and A_1 is altered by $\nu_1 e$—since the potential of G_2 is fixed and equal to that of *Q*, while the potential of A_1 has altered by $\nu_1 e$. This alteration of voltage between G_2 and A_1 will result in an alteration of voltage between A_1 and A_2 amounting to $\nu_2 \times \nu_1 e$. Therefore the change in the difference in potential between *F* and A_2 will be $\nu_1 e + \nu_2 \nu_1 e = \nu_1 e\ (1+\nu_2)$ and this voltage change will be indicated by *Z*; that is, the voltage applied between G_1 and *F* will be magnified $\nu_1 (1+\nu_2)$ times.

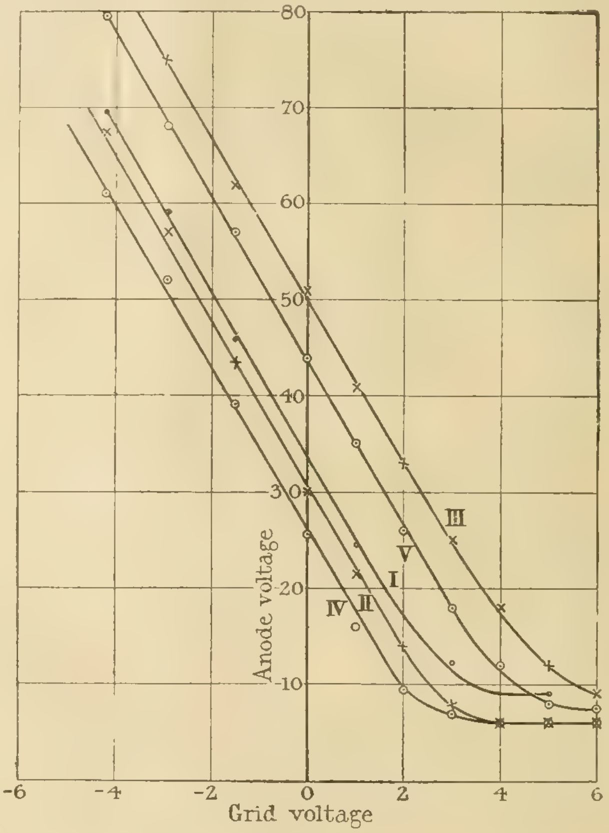

Fig. 2.

Curve I.—Filament voltage, 2·5; Anode current, 0·052 mA
II.—Filament voltage, 3·0; Anode current, 0·070 mA
III.—Filament voltage, 3·0; Anode current, 0·410 mA
IV.—Filament voltage, 4·0; Anode current, 0·070 mA
V.—Filament voltage, 4·0; Anode current, 0·41 mA

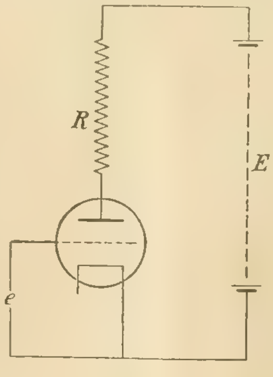

Fig. 3.

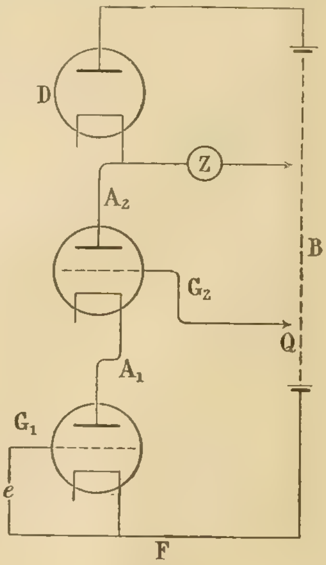

Fig. 4.

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* Abstract of Paper read before the Wireless Section of the Institution of Electrical Engineers.

Use of a Diode as Amplifier.

When in the circuit arrangements of Fig. 1 the filament voltage of the diode is raised gradually so that the saturation current of the triode is reached, the position of the two tubes is reversed—the triode now limiting the current through the apparatus. If the battery voltage applied across the two tubes is great, a very sudden change in the distribution of voltage may occur. With low filament voltages a very small change in the emission of the diode may bring about this sudden change.

When the filament emission of the diode is adjusted so that the saturation current is just less than the saturation current of the triode a small increase in the positive potential applied to the grid of the triode may result in an increase in the voltage across the triode. We have thus the unusual result of an increase in the grid potential of a triode resulting in an increase in the anode potential. The explanation is that when the grid is positive and the tube saturated, an increase in grid potential results in an increase of grid current at the expense of the anode current. The triode therefore behaves as if the saturation current had been lessened, and the distribution of voltage between diode and triode is disturbed.

The saturation current of the triode may be lessened by the application of an external magnetic field which tends to stop the flow of electrons across the tube, and may produce an increase of the voltage across the tube. In this experiment it is evident that the triode may be replaced by a diode.

Light-Contact Relays.

When the grid of a hard tube is not connected to the filament, but is left insulated, it gradually acquires a charge of negative electricity, which may result in its potential falling to as much as a volt below the potential of the negative end of the filament. If the potential applied to the anode is sufficiently high, the anode current flowing will be appreciable. If by the closing of a contact the grid is made much more negative this anode current will drop to a very small, even to zero, value. This change of anode current can be shown by a variety of methods.

Detection of Small Movement of a Conductor.

Very small changes in the capacity or inductance of an oscillatory circuit maintained by a triode valve can be detected by the heterodyne method. Thus Prof. Whiddington has showed that a movement of one plate of an air condenser through a distance less than the millionth of an inch could be thus detected by double heterodyning.

If another oscillatory circuit is coupled with the circuit maintained by the valve, this second circuit will, if the coupling be not too loose, affect the frequency of the oscillations to and extent depending on the constants of the added circuit. Some useful circuits are suggested in Figs. 5 and 6. Here *K* is the condenser of small capacity whose capacity variation is to be detected, *N* is a large inductance, *C*, *L* form the oscillatory circuit and *S* is a grid leak.

The change in the capacity of *K* may be brought about by the movement of one of the plates of *K* or by the movement of an independent conductor within the electric field of these plates. The conductor near or between the plates of *K* might be the leaf of a gold-leaf electroscope, or the pointer of a table galvanometer, or it might be a wire attached to the string of an Einthoven galvanometer.

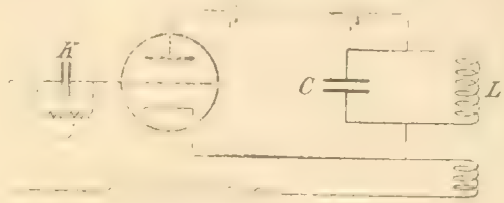

Fig. 5.

Both the light-contact experiments and those just shown may form the basis of relays which can be actuated by extremely feeble currents or by extremely slight movements of conductors. The indicating instruments might take various forms, *e.g.*, a galvanometer in the plate circuit of the valve, thus utilising the change in anode current brought about by the movement of the conductor, or a crystal and galvanometer across the condenser of an oscillatory circuit, or some kind of printing or self-recording instrument could be used in place of the galvanometer.

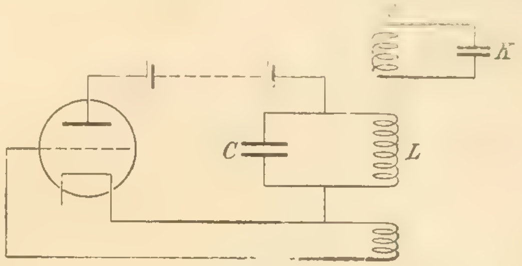

Fig. 6.

The Effect of Electron Emission on the Temperature of the Filament and Anode of a Thermionic Valve.*

By G. STEAD, M.A.

Introduction.

The experiments described were carried out in the Cavendish Laboratory in May, 1918, and were undertaken on behalf of the Wireless Telegraphy Department of H.M. Signal School, Portsmouth. The work is published with the consent of the Admiralty.

The temperature-distribution curves have already been given for filaments from which no electron emission is taking place.† In a thermionic valve, under working conditions, the filament is constantly emitting a stream of electrons. This affects the temperature of the filament for two reasons :—

(*a*) There is a latent heat of evaporation for electrons, *i.e.*, energy (about 5 watts per ampere of emission) must be supplied in order to liberate electrons from the surface of the filament. Thus the temperature of the filament will be lowered.

(*b*) If one connects the high-potential battery between the anode of a valve and the *negative* end of the filament, then a current, a little smaller than the emission current, must traverse the negative limb of the filament in the same direction as the filament current, and the filament is heated by this as well as by the current supplied by the filament battery. A small fraction of the emission current will also give rise to a current traversing the positive limb in the opposite direction to the current supplied by the filament battery, so that the positive limb will tend to cool, but the cooling will be much smaller than the heating of the negative limb. Thus the distribution of temperature along the filament will be unsymmetrical, the temperature rising to its maximum value more rapidly in the negative limb than in the positive one.

It is clear that the effects (*a*) and (*b*) act in opposite directions, and that they will be most marked in the case of a very hot filament of small diameter.

Effect of Electron Emission on Filament Current.

Any change in the average temperature of the filament will give rise to a corresponding change in filament resistance. Hence the filament current produced by a given filament voltage will also alter. In the original Paper tabular data showing the effect of emission in reducing filament current are presented. Thus, filament currents of 4·38, 4·3, 0·825 and 0·762 A are recorded with various filaments, lengths and diameters, with no emission ; with emission the corresponding values are 4·20, 4·15, 0·805 and 0·752 A.

In a thermionic valve under ordinary working conditions the average anode current is usually about half the total emission, so that the effect is less than that shown. Where the emission current is small, as in a receiving valve (*e.g.*, 5 mA), the effect is inappreciable.

Effect of Emission Current on Temperature Distribution.

In order to investigate this effect a special two-electrode valve was made consisting of a straight filament, about 3·5 cm. in length and 0·0088 cm. in diameter, surrounded by a cylindrical anode, provided with a narrow longitudinal slit through which could be seen any desired part of the filament. Any portion of the filament could be sighted through a Cambridge optical pyrometer. The temperature distribution could thus be observed for any desired values of the filament current, and emission current. Corrections were made for absorption of light by the bulb and for the emissive power of tungsten.

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* Abstract of a Paper read before the Institution of Electrical Engineers.

† "Journal" I.E.E., 1920, Vol. LVIII., p. 107.

Before carrying out the pyrometer observations the valve was highly exhausted by means of a Gaede pump, followed by charcoal and liquid air, and was subjected to the usual baking process to remove gases from the glass, whilst the anode was raised to a bright red heat by electron bombardment to get rid of occluded gases. In order to avoid blackening the bulb the electrodes were surrounded by a loose inner glass tube, subsequently slipped aside.

The filament formed one arm of a Wheatstone bridge. Its resistance could thus be measured when there was no electron emission, and again when emission was occurring. The resistance was found to increase when emission took place, thus indicating a rise of average filament temperature.

In Fig. 1 are shown curves of temperature distribution, that marked $i=0$ being obtained when no emission takes place, while $i=160$ m.a. corresponds to maximum saturation. There is evident increasing assymmetry with increased electron emission current, to which increase in maximum filament temperature appears to be roughly proportional. By the aid of the curves presented it is calculated that the emission is increased by 35 per cent. when the emission current is about 11 per cent. of the filament current.

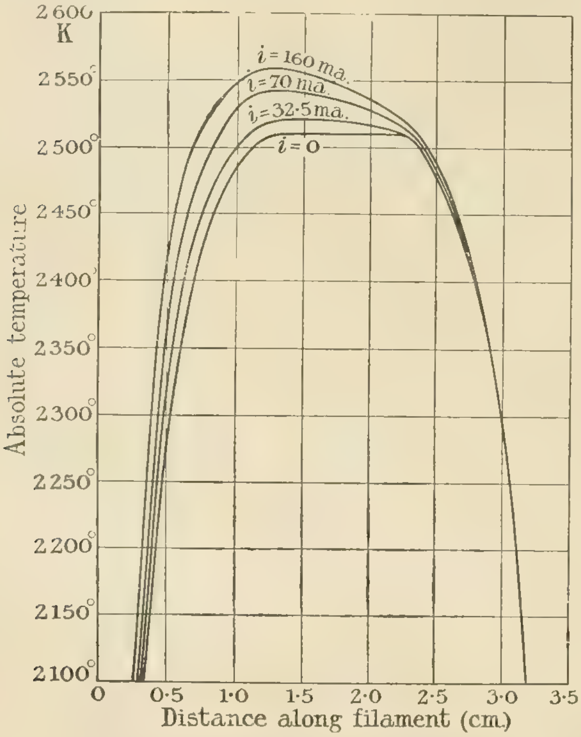

FIG. 1.—DISTRIBUTION OF TEMPERATURE ALONG AN EMITTING FILAMENT.

DISSIPATION OF ENERGY BY THE ANODE.

The power represented by the product of the anode current and the anode voltage has to be dissipated by the anode, and its temperature rises until the rate of radiation is equal to the power supplied. Where the power is large, as in a transmitting valve, the temperature of the anode will be high, unless the anode has a very large surface area. The metal most commonly employed is nickel, the melting point of which, 1 720°K., fixes the limiting temperature. It is important to know the number of watts per square centimetre which can be dissipated by a nickel anode, without undue rise of temperature. Information on this point was obtained in the preceding experiments. For the larger emission currents employed the anode was raised to a red heat, and pyrometer observations were made to determine its temperature. The anode current and voltage were measured, and the area of the anode was known. It was therefore possible to plot a curve to show the relation between the temperature and the watts dissipated per square centimetre of anode surface.

It is very difficult to obtain accurate observations of the anode temperature near the melting point of nickel, owing to the rapid blackening of the bulb at such temperatures. Also a nickel anode does not radiate as a perfectly black body, so that pyrometer temperatures require correction. A rough correction was made by assuming that the emissive power of nickel for the wave-lengths transmitted by the optical pyrometer is the same as that of tungsten, for which observations are available. The temperatures recorded in Fig. 2 are only very roughly true temperatures on the Kelvin scale. Nevertheless, for purposes of valve design, the results are useful as a guide to the power which a nickel anode of given size is capable of safely dissipating.

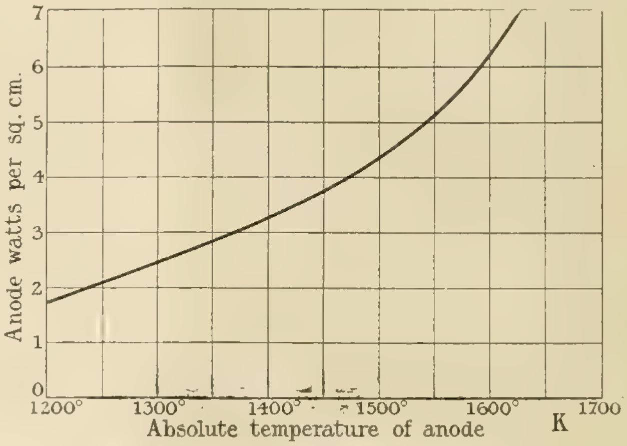

FIG. 2.—DISSIPATION OF ENERGY BY ANODE.

The Theory of Relativity.

The lecture delivered by Prof. Albert EINSTEIN at King's College, London, on "The Development and Present Position of the Theory of Relativity" may justly be termed one of the scientific events of the year. Lord Haldane occupied the chair, and there was a large attendance of scientists and the general public.

ADAPTING THEORY TO FACTS.

Prof. EINSTEIN, who spoke in German, begun by expressing his gratification at lecturing in the capital of that country from which the most important and fundamental ideas of theoretical physics had spread throughout the world—the theories of motion and gravitation of Newton and of the electro-magnetic field on which Faraday and Maxwell had built up the theories of modern physics. It might well be said that the theory of relativity formed the finishing stone of the elaborate edifice of Maxwell and Lorentz by endeavouring to apply the physics of "fields" to all physical phenomena, including the phenomena of gravitation.

The theory of relativity was not of any speculative origin, but arose solely from the endeavour to adapt the theory of physics observed to facts. It must not be considered as an arbitrary act, but rather as the result of the observations of facts, that the conceptions of space, time, and motion, hitherto held as fundamental, had now been abandoned.

Two main factors have led modern science to regard time as a relative conception in so far as each inertial system had to be coupled with its own peculiar time: the law of constancy of the velocity of light *in vacuo* sanctioned by the development of the sciences of electro-dynamics and optics, and in connection therewith the equivalence of all inertial systems (special principle of relativity) as clearly shown by Michelsen's famous experiment. In developing this idea it appeared that hitherto the interconnection between direct events on the one hand, and the space co-ordinates and time on the other, had not been thought out with the necessary accuracy.

THE SPECIAL THEORY OF RELATIVITY.

The theory of relativity endeavours to define more concisely the relationship between general scientific conceptions and facts experienced. In the realm of the special theory of relativity the space co-ordinates and time are still of an absolute nature in so far as they appear to be measurable by rigid bodies, and by clocks. They are, however, relative in so far as they are dependent upon the motion peculiar to the inertial system that happens to have been chosen. According to the special theory of relativity the four dimensional *continuum*, formed by the amalgamation of time and space, retains that absolute character which, according to the previous theories, was attributed to space as well as to time, each individually. The interpretation of the spatial co-ordinates and of time as the result of measurements then leads to the following conclusions: motion (relative to the system of co-ordinates) influences the shape of bodies and the working of clocks; energy and inertial mass are equivalent.

The General Theory.

The general theory of relativity owes its origin primarily to the experimental fact of the numerical equivalence of the inertial and gravitational mass of a body; a fundamental fact for which the classical science of mechanics offered no interpretation. Such an interpretation is arrived at by extending the application of the principle of relativity to systems of co-ordinates accelerated with reference to one another. The introduction of systems of co-ordinates accelerated with reference to inertial systems causes the appearance of gravitational fields relative to the systems of co-ordinates. That is how the general theory of relativity, based on the equality of inertia and gravity, offers a theory of the gravitational field.

The Failure of Euclidean Geometry.

Now that systems of co-ordinates, accelerated with reference to one another, have been introduced as equivalent systems of co-ordinates, based on the identity of inertia and gravity, it follows that the laws governing the position of rigid bodies in the presence of gravitational fields do not conform to the rules of the Euclidean geometry. The results as regards the working of clocks is analogous. These conclusions lead to the necessity of once more generalising the theories of space and time, because it is no longer possible directly to interpret the co-ordinates of space and time by measurements with measuring rods and clocks. This generalisation of metrics, which in the sphere of pure mathematics dates back to Gauss and Riemann, is based largely on the fact that the metrics of the special theory of relativity may be considered to apply in certain cases also to the general theory of relativity. In consequence, the co-ordinate system of space and time is no longer a reality in itself. Only by connecting the space and time co-ordinates with those mathematical figures which define the gravitational field can the objects which may be measured by measuring rods and by clocks be determined.

Newton's "Absolute Space" Unsatisfactory.

The idea of the general theory of relativity has yet another basis. As Ernst Mach has already emphasised, the Newtonian theory of motion is unsatisfactory in the following point:—If motion is regarded not from the casual but from the purely descriptive point of view it will be found that there exists a relative motion of bodies with reference to each other. But the conception of relative motion does not of itself suffice to formulate the factor of acceleration to be found in Newton's equations of motion. Newton was forced to introduce a fictitious physical space with reference to which an acceleration was supposed to exist. This conception of absolute space introduced by Newton *ad hoc* is unsatisfactory, although it is logically correct. Mach, therefore, endeavoured so to alter the mechanical equations that the inertia of bodies is attributed to their relative motion with reference not to absolute space but with reference to the sum total of all other measurable bodies. Mach was bound to fail, considering the state of knowledge at his time. But it is quite reasonable to put the problem as he did. In view of the general theory of relativity this line of thought comes more and more to the fore, because according to the theory of relativity the physical properties of space are influenced by matter.

The general theory of relativity could only solve this problem satisfactorily by regarding the universe as spatially finite and closed. The mathematical results of the theory of relativity forced scientists to this view, if they assumed that the average density of matter within the universe was of finite, if ever so small a value.

Telephones in Vienna.

According to the Vienna correspondent of "The Times," the telephone system in that city possesses all the qualities necessary to send its subscribers into an early grave. The Vice-President of the Association of Telephone Subscribers considers this is due to poor discipline, the need of a firm directing hand and lack of funds. The suggested remedy is a private telephone company, and if the demands of the subscribers are not met by July 1 a strike will be proclaimed. In Vienna, as in London, one of these remedies may be regarded as an ideal and the other as likely to be entirely without effect so long as the State holds the monopoly. It will be interesting to see whether the attempt to break this monopoly by the introduction of private ownership is any more successful in Vienna than it has been in this country.

Reviews.

The Electrical Handling of Materials. Vol. II., Structural Work. By H. H. Broughton. (London: Benn Brothers.) Pp. xvi + 292. 25s.

As in volume one, covering electrical equipment, so in this the second volume comprising structural work and mechanical equipment, the same high quality of style and clearness of general arrangement of the various sections is maintained. It is evident that the author has set himself the task of dealing with the electrical handling of materials in a more comprehensive manner than has ever before been attempted; and it is also now apparent, as we would have expected from the excellence of the author's previous works, that he is succeeding in accomplishing his ambition in a manner well in keeping with what is possibly, at the present moment, the most important branch of electrical and mechanical engineering.

The volume under review contains 18 chapters: Structural steel work and formulæ diagrams and tables for the calculation of cranes are comprised in the first three chapters, extending to about one-third of the volume, which is not excessive, taking into account the importance of the section. This portion of the book is well worth the purchase price alone, as it deals with calculation of the structural work of cranes, or anything which can be classed as such, for instance, runways, gantries, bogies, carriages and trucks, and also contains a section devoted to specifications modelled on standard up-to-date practice. The other sections deal fully with spur gearing, worm gearing, gear arrangements, variable speed transmission gears, transmission chains, axles, shafts and couplings, transmission screws, bearing and axle boxes, lifting ropes, lifting chains, hooks, lifting tongs and blocks, winding drums, trucks, wheels, brake and brake gear, and grabs. The type is clear and the illustrations are of fine quality, and it should be pointed out that most of the latter have never before been published.

In reviewing a work written by a recognised authority, as the author is, it is only permissible to indulge in a few comments on sections or points which appear to require further treatment or apparent correction. While, therefore, congratulating the author on the continued excellence of his production, we take the opportunity to make the following short criticism: The author refers to the Maag system in his chapter on spur gearing, but refrains from much comment on the advantages claimed for this system. It appears premature to pronounce a verdict in favour of this system until we have actually witnessed a test of gears cut on the system, applied to a reversing mechanism working under widely varying load and varying speed conditions, but at the same time we would have welcomed evidence or a definite expression of opinion from the author as to the superiority of gears produced by the system over herringbone type gearing, as used at present for all high-class work.

In the comprehensive chapter on worm gear no mention is made of the rather important condition which arises in cases when the drive is used for a mechanism which has to start a suspended load—a rather common feature in machines used for the handling of materials. We refer to the momentary high initial static torque required to put the mechanism into motion after it has been standing still with the load suspended, and held by means of the worm shaft brake. The cause of this trouble is, of course, the rise in value of the co-efficient of friction at the point or points of contact of the worm and wheel. This circumstance should be carefully looked after in the design of hoisting apparatus. A high efficiency in the gear during running is not the only consideration in designing worm drives for such mechanisms.

When dealing with couplings we observe that the author recommends flexible band couplings in cases where there is likely to be faulty alignment of the shafts. The reviewer does not consider that the use of such couplings should be encouraged in any way for the purpose of compensating for the want of alignment. Perfect alignment is a necessity, as is rigidity of support for the motor and pinion bearings. If perfect alignment is not present flexible couplings give great trouble through wear of their more or less flexible parts. Correctly speaking flexible couplings for heavy work should be looked upon as acting with shafts perfectly aligned, purely as shock absorbers. Band type flexible couplings on the frequent reversal of torque rapidly become slack when excessive wear takes place with ultimate breakage. We agree with the author in his expressed preference for drums built of mild steel as opposed to cast-iron, and he might have added that a very considerable saving in energy when accelerating is not the least advantage of the adoption of the lighter but more reliable material.

When dealing with the subject of brakes we are of opinion that the author should have included a more extended description of electric winder brakes, both pneumatic and hydraulic, as these are, perhaps, the most interesting form of brake which fall within the subject matter of the book. When mentioning shoe brakes, block brakes or post brakes, we observe that no mention is made of the fact that if the fulcrum pins are not arranged on lines tangent to the point of contact of the drum with the centre of the shoes, unequal wear of one or other of blocks occurs, when the rotation of the machines during braking is in one direction only. This is, of course, made clear by examining the formulæ given on page 258.

But in passing above comments we would also point out that the work is one which should be studied, not criticised. No engineer can afford to be without these volumes, as they form almost the only work which deals really and effectively with the subject from *a* to *z*. The increase in manufacturing costs of any commodity which, of course, include handling, can only be kept below the limit of competitive cost by the exclusion, to as great an extent as possible, of all forms of manual labour. The engineer must, therefore, in order to exist at all, strain his inventive power to the utmost to create new methods or perfect existing labour-saving mechanism. He will find in this complete book a necessity in setting about that task.

Chas. E. Raeburn.

Modern High-speed Influence Machines. By V. E. Johnson, M.A. (E. & F. N. Spon.) Pp. viii.+178. 14s. net.

This is a book which could be reduced in size by at least 50 per cent. with advantage. The author's style is apt to be diffuse; and a more critical selection of his matter would have eliminated a good many prolix accounts of experiments of a somewhat rudimentary type and a certain amount of ingenuous and laboured arithmetic. We hope too that at the first opportunity the author will delete such sentences as the following (p. 247):—

> After playing about with this piece of apparatus for some half-hour or so, I decided to abandon it as useless; the sparks varied in both length, volume and rate, and the entire idea gave me the impression of working "just anyhow."

The value of publishing information in the following form may be questioned:—

> Experiment X. After a series of experiments had been carried out, it was noticed that one of the connections. . . . had fallen off.

and further on:—

> This result was in some ways so startling that the writer promptly put the machines away, and, it being very late, went straightway to bed.
>
> Experiment XVIII. . . . .the writer knew quite well that a dielectric disc can be influenced from or on (whichever may be the really correct term) both sides with considerable advantage.

A whole if brief chapter is devoted to demonstrating that a transformer can be used for "stepping down" as well as for "stepping up," the author concluding that "We hear so much about the latter that we are apt to forget the former."

The book is almost wholly descriptive in character and contains a good deal of miscellaneous information. About a third relates to the evolution of the influence machine as we know it to-day, and this is the best part of the book. The author's experiments purport to have led to a more efficient type of electrostatic generator, but which, we gather, is still in the experimental stage. G. W. C. Kaye.

Shorter Notices.

Electric Bells, Alarms and Signalling Systems. By H. G. White (London: S. Rentell & Company, Ltd.) Pp. 113. 3s. 6d. net.

This is a second edition of a very useful little book. Its contents are rather more extended than its title would indicate, for in addition to dealing very fully with bells it contains a good deal of information on mine signalling apparatus, and a full discussion of the various ship signalling systems now in use. Adequate space is given to the important question of faults, and mechanically-operated systems of signalling are also dealt with. The diagrams, printing and general get up of the book are better than is usual in many of the cheaper post-war productions, and Mr. White's well-known connection with this side of electrical engineering practice should ensure the book receiving the attention it undoubtedly deserves.

Coal in Great Britain. By Walcot Gibson. D.Sc., F.G.S. (London: Edward Arnold.) Pp. vii.+311. 21s. net.

Electrical engineers are so used to considering coal from the financial and thermal points of view that a book on the geological aspect of the question, throwing as it does a new light on this very vexed subject, should be welcome from its very novelty. Mr. Walcot Gibson's work is amply designed to fulfil an object of this kind. It is primarily intended to supply mining engineers with a concise account of the more important facts relating to the geology of coal generally and to the position, structure and resources of the coal fields of Great Britain in particular. It can be recommended to those who desire to go more closely into what must be for engineers a little known branch of a very burning question.

Lubricating and Allied Oils. By E. A. Evans, F.C.S. (London: Chapman & Hall). Pp. xv+128. 9s. 6d. net.

This book has been written to help the non-specialist to compile such specifications as may be necessary to enable him to purchase lubricating oil. In accordance with this policy it consists essentially of details of the tests commonly used in testing lubrication, and is therefore worth adding to the library as a work of reference. The get up is good, the print being large and the diagrams clear, but the price is certainly high for so small a book.

Correspondence.

"CONDUIT MANIA."

TO THE EDITOR OF THE ELECTRICIAN

Sir: May I suggest that the article in your issue of June 3rd on "Conduit Mania," by Electrocynic, merits consideration, and I should like to see further discussion on the matter in The Electrician.

It is obvious that the success or failure of any system of wiring must finally depend on the work being well done, and also quite as much on the care and skill with which the installation is planned in the first instance. Screwed conduit offers so many opportunities for bad workmanship and erection, while the constant danger of abraided wires cannot be considered too seriously. Furthermore "conduit" introduces the risk of moisture from condensation.

A twin lead system approaches very nearly to the ideal, if proper care is taken in seeing that all exposed places are protected with a light steel or wood casing. Well-insulated conductors are in this case properly contained in a damp-proof case and all fear of abrasion is avoided. In the case of work carried out after the completion of a building there can be no comparison between the amount of cutting away and general knocking about that is entailed; and indeed any want of skill in carrying out conduit work emphasises this point.

If a job is properly supervised it is easy to see that the bonding of a lead system is perfect, and moreover it is always open to a very simple electrical test. On the other hand, an abraided conductor need not necessarily be in contact with the conduit at the time when an insulation test to earth is made (supposing that this is always done). It seems to me that the mechanical protection offered by conduit should be considered under two distinct heads, namely, that of fire risk, and risk of expense in upkeep from wilful or careless damage.

So long as insurance companies are content with a type of fuse that can be replaced by a fuse wire of any size to say nothing of the proverbial "ginger beer bottle wire," the fire risk is a real one. Could not this be avoided by insisting on properly designed cartridge fuses? The hollow wooden floors of most buildings give great facility for stowing wires, but in the modern monolithic floors of concrete buildings matters are quite different. The exposed reinforced beams of such a building add greatly to the difficulty of fixing conduit and to the number of elbows and amount of screwing required. On the other hand a lead system suffers owing to the difficulty of nailing saddles to hard plaster over breeze concrete. If the lead is laid on top of a wood batten previously fixed to the walls and ceiling one is coming very near to using lead-covered cable in wood casing. Is not the ease of nailing casing to a wall a plea for a more general return to that system, perhaps in a slightly modified and improved form?

Perhaps some of our leading manufacturers would find it worth their while to put their ingenuity into bringing wood casing and its accessories to the same perfection that they have brought the lead and conduit systems. This, combined with the co-operation of architects in making provision for the wiring, might easily lead to great improvements in existing methods.—I am, &c.,

Cambridge, June 13th. E. B. Moullin.

ENGINEERS' CLUB.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Allow me to make a correction in your report of the Engineers' Club meeting on the 2nd June. I said that "in less than four weeks"—not months as stated in your report—"the applications for membership had risen from 1 197 to 1 665." The first application was received on the 14th March and to-day (10th June) they total 1 754.—I am, &c.,

London, E. L. Hill,
June 10th. Hon. Secretary.

The Directive System of Street Lighting.

Hitherto street lighting lanterns have been designed to distribute light downwards so that each unit illuminated a circular area. The disadvantages attendant on the use of such methods have been overcome in the directive system patented by Mr. Hadyn T. Harrison and employed in lanterns recently placed on the market by the General Electric Company. This system allows nearly all the luminous energy of the light source to be used for illuminating a long and narrow area represented by a street, with a result that the maximum illumination of the street is increased by some 10 to 20 times, depending on its width. The cost both for electrical energy and maintenance is reduced and the illumination obtainable from existing installations can thus be improved. The light distribution mechanism of these lanterns comprises two parts, the more interesting of which is a specially designed reflector which collects the upper hemispherical distribution and directs it on to two plane mirrors arranged radially from the light source at such angles as will produce powerful illumination up and down the street. Adjustments of the angles of the plain mirrors can be made to allow for different distances between the lamps and to suit the various widths of the street.

We understand that by the courtesy of Mr. Spurrell, the borough surveyor of Holborn, and the Metropolitan Electric Supply Company, one or two of these lanterns are to be displayed on lamp posts in Holborn immediately east of Kingsway. The attention of members of the Institution of Municipal and County Engineers, whose meeting is being held this week in London, will be called to them, and it is hoped that the display may be continued until after the annual general meeting of the I.M.E.A. in London at the end of July.

Mr. Ernest Benn's American Tour.

Mr. Ernest J. P. Benn, managing director of Messrs. Benn Brothers, Ltd., who left England on April 23, accompanied by Mr. Frank H. Elliott, another director, for a visit to the United States, arrived back in Liverpool on Tuesday last. On his return to the office on Wednesday, Mr. Benn found awaiting him in the board room a presentation from the staff, consisting of a handsome leather attaché case, with an inscribed silver plate inside, and a gold-mounted Waterman pen, also inscribed. Accompanying the presents was an unsigned card in the following terms:—"To Mr. Benn. The Staff of Benn Brothers, Ltd., ask your acceptance of the accompanying attaché case and fountain pen as a very simple but sincere expression of welcome on your return home."

Engineering Conference.

The full programme of the Engineering Conference, which is to be held under the auspices of the Institution of Civil Engineers on Wednesday, Thursday and Friday, June 29 and 30 and July 1, has now been issued. The Conference will be preceded by the 27th James Forrest Lecture, which will be delivered by Sir George T. Beilby, F.R.S., on "Fuel Problems of the Future" at the Institution at 9 p.m. on *Tuesday, June 28*.

On *Wednesday, June* 29, at 10 a.m., the President of the Institution of Civil Engineers, Mr. John A. Brodie, will open the Conference and will welcome delegates from the American engineering societies, who will thereafter convey a message of goodwill from American to British engineers and will present the John Fritz Medal awarded to Sir R. A. Hadfield, Bart.

The Conference is organised into seven sections dealing respectively with railways, roads, bridges and tunnels, with harbours, docks, rivers and canals, with machinery, with mining and metallurgical processes, with shipbuilding, with water works, sewerage and gas works, and with electricity works and power transmission. Of this last section Sir John Snell is the Chairman and Mr. L. B. Atkinson, Mr. Roger T. Smith, Mr. C. P. Sparks and Mr. C. H. Wordingham Vice-Chairmen, with Mr. H. R. J. Burstall, Col. F. A. Cortez-Leigh and Mr. T. C. Ekin as Hon. Secretaries.

Subjects for Discussion.

The following are among the subjects which will then be discussed at the Conference: "The Development of Cranage Facilities for Discharging Vessels of the Largest Size," introduced by Mr. H. J. Deane; "Comparison between Reciprocating Pumping Engines and Turbo-Driven Centrifugal Pumps," introduced by Mr. H. Lupton; "Exhaust Steam: Its Employment for Power, Heating, &c.," introduced by Mr. E. R. Dolby; "Recent Developments in Coal Cleaning Processes," introduced by Mr. R. Nelson; "The Utilisation of Waste Heat in Gas Works," introduced by Mr. E. G. Stewart; and "Low Power-Factor," introduced by Mr. R. O. Kapp. At 9 p.m. on Wednesday evening a series of photographs of the war areas in Flanders and France from Zeebrugge to Verdun, which have been especially taken by Sir Alexander Kennedy, F.R.S., will be shown by him as lantern slides.

On *Thursday* the following will be among the subjects for discussion: "The Influence of the Automatic and Semi-Automatic Machine on the Skill and Resourcefulness of the Mechanic and Operator," introduced by Mr. A. H. Hall; "Mechanical Appliances and Labour in Loading and Unloading Ships' Cargoes," introduced by Mr. A. Musker; and "Battery Locomotives," introduced by Mr. J. Dalziel.

On *Friday*, July 1, the following will be among the subjects for discussion: "The Mechanical Advantages of Electric Locomotives Compared with Steam," introduced by Sir Vincent Raven; "The Utilisation of Exhaust Steam in Turbines," introduced by Mr. M. Deacon; "Steam v. Electric Winding," introduced by Mr. W. C. Mountain; "Low-Voltage Overhead Distribution," introduced by Mr. B. Welbourn; and "Economic Limits of Distribution from Coal-Fired Stations."

Arrangements have also been made for visits to be paid to a number of engineering works, including the National Physical Laboratory, the Stonebridge Park power station of the London and North-Western Railway, the Charlton works of Messrs. Siemens Bros. & Company, the Erith works of Messrs. Vickers, Ltd., Lots-road power station of the London Electric Railways, and the Fuel Research Station at East Greenwich, the Erith works of Messrs. Fraser & Chalmers, the Wimbledon power station and repair shops of the London & South-Western Railway and the automatic and trunk-line telephone exchanges of the General Post Office.

Until recently, Finance in Relation to Industry was regarded as synonymous to finesse by the vast mass of workers, and, without doubt, is one of the contributory causes of the unrest prevailing. It was, and still is, one of the weaknesses in industrial progression, and it is a little surprising that employers have not realised long ere this that only through the medium of personally interesting themselves in the educative influences at work will the erroneous views of employees be eliminated. In this connection it is interesting to notice the continued expansion of the work of the Industrial League and Council, as the Leeds branch, which has recently become the autonomous centre for Yorkshire, has organised for the week-end a big conference of employers and employed, at which the subject for consideration will be the vexed question, "Finance in Relation to Industry." The conference is to be held at Marlborough House, Ilkley, and will be presided over by Mr. C. E. Warren (ex-president, Incorporated Leeds Law Society). The speakers will include Mr. John Murray, M.P., Mr. Graham Ford, Mr. W. Crossley (Leeds Trades Council), Mr. A. Godfrey, &c. A number of employers, managers, foremen, trade union officials, shop stewards and individual employees are attending

Press Advertising for Electrical Engineers.

This, whether we like it or not, is an age of advertising, and, whether we like it or not, it follows that the better the advertisement the greater the good it does, if it does any good at all. Hence all that mass of the high art, well-thought-out typography and pungent appeal which are features of present-day advertising. It is, therefore, necessary that electrical engineers should not lag behind in calling the attention of the public through the advertising columns of the press to what may be done by using electricity for all kinds of purposes and in indicating how electrical apparatus can assist in carrying out the daily round. We are glad to find that the British Electrical Development Association is alive to this need, and a pamphlet which they have recently issued entitled "Press Advertising" should be of great use to electricity supply undertakings, firms and contractors who, while desirous of employing press advertising to develop their business, are not in a position to produce their own copy and blocks.

The booklet advances some trenchant arguments in favour of continuous advertising, points out the advantages of seasonal advertising, and gives a number of most useful hints on preparing the advertisement under the sub-titles of the headlines: The Illustrations, The Copy and The Lay Out. Some tactful remarks on dealing with the printer are appended, but in our opinion the most useful part of the publication is the typical advertisements which are illustrated. This idea of pictorial examples is further developed by the inclusion of a folder containing half-a-dozen or so well-thought-out advertisements. The edges of these are perforated so that they can be actually used after the addition of the name of the firm. It is hoped that all those in the electrical industry who see the need of advertising their wares (and they should be many) will take advantage of the useful information given in this publication, which, along with other aids to business, can be obtained for a small sum from the British Electrical Development Association, at Hampden House, Kingsway, London.

Electric Housing in Glasgow.

The Glasgow Corporation recently decided—by way of experiment—to install electrical equipment in two houses of a semi-detached block on their Riddrie Housing Scheme. The equipment in each house will consist of an electric oven, electric cooker, electric wash boiler, electric washing machine, while the rooms will be heated by means of electric fires. In one of the houses the hot water supply will be provided by means of a coal fire in the living room, and in the other, water will be heated by means of an electric calorifier set fitted to a storage tank, the living room in this case being heated by an electric fire. The purpose of the experiment is to obtain comparative figures of the actual cost of energy for the two different types of installation. We reproduce herewith (Fig. 1) a photograph of a standard semi-detached block consisting of two houses of five rooms each, and (Fig. 2) a photograph of a similar block, which will be equipped electrically and in which the absence of the gable chimney heads may be noted. The saving in building construction in the latter case is estimated at £80.

Owing to the restrictions placed upon the use of the gas supply, it has been found desirable to displace gas cookers by electric cookers in the two National Kitchens in Glasgow. Actual figures prove electricity to be as cheap as gas and the equipment is giving every satisfaction. A number of restaurants in the city have discarded their gas cooking appliances and installed electric cookers. The photograph reproduced (Fig. 3) shows an electrical equipment which has displaced a gas outfit in a famous Glasgow restaurant. Fig. 4 shows how one of the electric delivery vans of the Glasgow Corporation Electricity Department is used for advertising purposes.

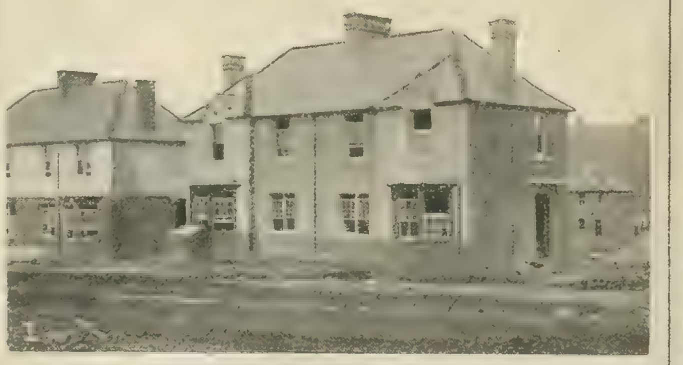

Fig. 1.—Standard Semi-detached Block-Riddrie.

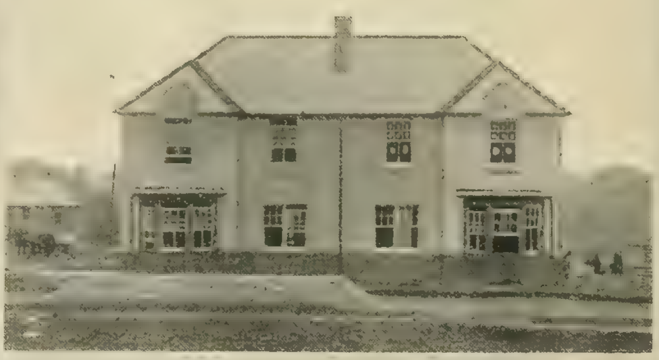

Fig. 2.—Semi-detached Block for Electric Equipment Riddrie. (Note absence of gable chimneys.)

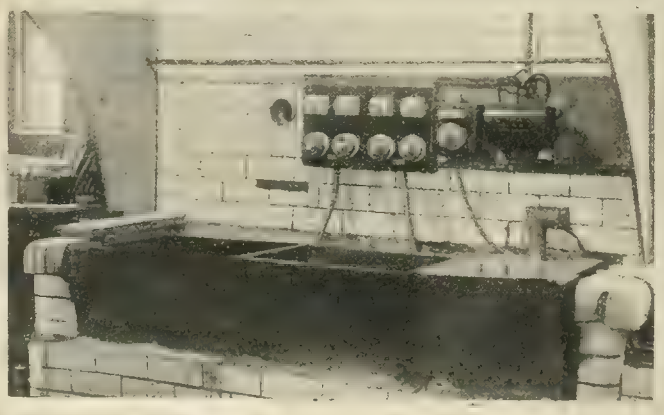

Fig. 3.—Electric Cookers Displacing Gas Cookers in Famous Glasgow Restaurant.

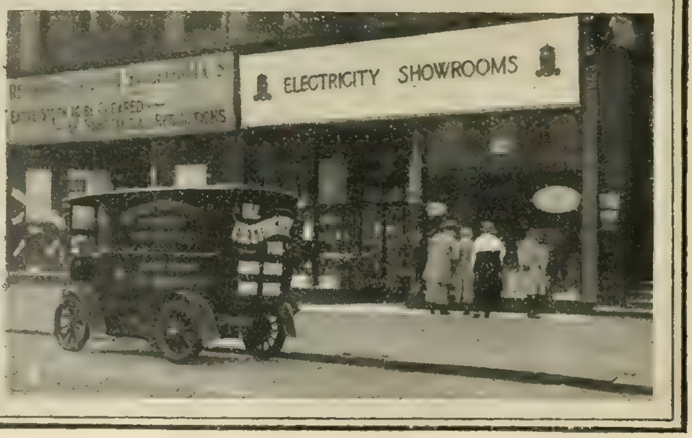

Fig. 4.—Advertising an Electric Delivery Van.

The London Electricity Schemes.

On Tuesday, at the Institution of Electrical Engineers, the Electricity Commissioners (Sir John F. C. Snell, M.I.C.E., Mr. Harry Booth, O.B.E., Sir Harry Haward, Mr. W. W. Lackie, C.B.E., M.I.C.E., and Mr. A. Page, M.I.E.E.) commenced consideration of the schemes which have been submitted for the reorganisation of electricity supply in the London Electricity Supply Area, including those of the London County Council, the Conference of Local Authorities owning Electricity Undertakings in Greater London, the London Electricity Joint Committee (1920), Ltd., an independent scheme by Poplar Borough Council for East London, and schemes by the Great Eastern Railway and the L.B. and S.C. Railway Companies for supplying their own requirements and for other purposes.

Particulars of the various schemes were given in our issue of May 27.

After the Commissioners had been welcomed by Mr. Ll. B. Atkinson (President of the Institution), he said the area to be dealt with was more important than those previously dealt with by the Commissioners, and that the Institution believed that the inquiry would prove to be historic and that it might have a definite bearing upon the question whether London would advance as a great city or whether it would decline.

Sir **John Snell** asked that the inquiry might be kept as far as possible to matters of principle, and that overlapping of evidence might be avoided. The schemes would be taken in the order in which they are set out above. It will be remembered that the Commissioners postponed their decisions upon the County of London Company's proposal to build a station at Barking and that of the West Kent Electric Company to build a station at Erith until after the present inquiry.

Position of L.C.C.

Mr. **Craig Henderson**, who appeared for the London County Council, said he wanted to make clear the Council's attitude. His position was not that of a counsel before a Parliamentary Committee dealing with other parties as opponents. The Council regarded it as their duty to come to the assistance of the Commissioners in dealing with the difficult task of drawing up the best scheme for the area they had delimited. The interest the Council had taken in electricity supply and electricity legislation in the past would be remembered by the Commissioners, and when the Act of 1919 was introduced as a Bill the Council set out to support the Bill, and see what they could do towards drawing up the kind of scheme which would be suitable for the area. Before the Bill became an Act they had entered into communications with the companies and local authorities on the subject. Nine of the companies had been trying to solve one part of the problem, at any rate—the technical side—and a report on the technical scheme had been drawn up by four engineers, Sir Alex. Kennedy, Mr. Partridge, Mr. Rider and Mr. Wordingham, on behalf of those three bodies, viz., the L.C.C., the Conference of Local Authorities, and the nine Electric Supply Companies.

The area delimited by the Commissioners was very large. In the technical scheme figures were given which showed that the increase in demand in the area had been a progressive one of about 18 000 kW per annum. The cost of production was given as 1·55d. in 1919-20, compared with 0·69d. in 1914, the increase being practically entirely due to the war time increased charges for material and labour. The great difficulty of the problem was that one might get greater economy in fuel consumption by building more modern plant and larger units, but to get that economy it was necessary to build new stations or install new plant, and the economy gained in fuel consumption might be more than swamped by the increased capital charges, owing to the present financial conditions. Therefore, the scheme outlined was not the same scheme as would have been outlined if pre-war conditions had prevailed, because capital expenditure was involved in replacing existing stations built with capital borrowed at pre-war rates. It was impossible to-day to shut down certain stations which might otherwise have been advantageously scrapped, and the scheme, which was based on the retention of certain existing stations with the gradual replacing of other stations, contemplated that it might be possible to build one or more capital stations by 1925-26. The Commissioners asked for supplementary particulars to be lodged by the promoters of the schemes, and the engineers got together information from published statistics and elsewhere, and they became convinced that, having regard to the capital expenditure involved, it was not advisable—taking into consideration the present financial conditions—to fix any definite year for the commencement or termination of the first or second stage, and that it would not be advisable for a Joint Electricity Authority to burden itself at present with the cost of a capital station. The Council believed the financial conditions were improving, and hoped that in a short time it would be found more advisable to undertake the expense of erecting a capital station. In the supplementary particulars the first stage was deferred, and the first task which it was suggested the Joint Authority should undertake was the proper organisation of such facilities as existed to-day. They believed it would be necessary in the future that certain stations would have to be shut down. The scheme proposed that eventually there should be in the area four new capital stations, each of 250 000 kW, and that two of the existing stations should eventually be reconstructed on a larger scale. Three of the proposed new stations would be upon the river, east of Blackwall Tunnel, and the other in the west—he believed at Chiswick. The engineers found it would be impracticable to work from one station instead of three, having regard to the physical difficulty regarding mains in the London area. The engineers also dealt with other sources of supply, and suggested that arrangements might be made for railway companies owning power stations, or which might build power stations for their own needs to erect additional plant, and give supplies to a Joint Authority. One railway company, at least, had signified its willingness to build a station, and give a supply to a Joint Authority. The promoters of the different schemes were in general agreement with regard to administration, but naturally there was considerable difference of opinion as to the personnel of the Joint Electricity Authority.

Constitution of Joint Authority.

The Council took the view that it should be as small as possible, and proposed that it should consist of 28, or possibly 29, including the Chairman, if he were elected from without. Of these it was proposed that eight should be elected by the L.C.C., six by the local authority undertakers, six by the company undertakers, four by the purchasing authorities outside the Administrative County, and that two should represent the railway companies, and other large consumers and two the workers in the industry. The company undertakings in the County of London represented capital expenditure of 16·45 millions, and companies outside 3·7 millions, local authorities in the London area 16·45 millions, and outside 4·1 millions. The L.C.C. thought the Council should have the considerable representation which they proposed, because it acted as trustee for the whole public in the London area in the interests of consumers at large. It proposed to transfer its purchase rights to the Joint Authority, to which it would be in a position to give financial assistance. The Council suggested a form of agreement under which the companies would get a longer lease of life, and in return for a longer life as distributors the companies might be willing to agree to the complete vesting of their undertaking in a Joint Authority at a certain date, the station continuing to belong to the present undertaker until the existing plant was obsolete, and any new plant being installed at the expense of the Joint Authority. In some cases the transfer would be much later than 1931. In the 1919 Act power was given to the Commissioners to compel undertakers to enter into agreements for the purposes of supply in a particular area. The essential feature of carrying out a scheme of that kind was that there should be a central controlling body, supervising, directing and organising, and the County Council suggested that the undertakers' stations should be used by the owners as the Authority should direct in so far as it should be necessary to secure that effect should be given to the technical scheme, and the advantage secured of the unification of control.

Financial Proposals.

In regard to finance, the Council's scheme was on the basis of the Bill now before Parliament. The only financial clause that raised a question of principle was sec. 58. For a certain period a Joint Electricity Authority might have administrative expenses to meet without having revenue to meet them, and it was proposed that the Authority might make a charge on the various undertakers mentioned in the schedule until such time as the Authority was giving a supply to such undertakers. The L.C.C. suggested such charges should be on the basis of the units sold by the various undertakers in their areas.

Mr. G. H. **Hume**, examined by Mr. Henderson, said he had been chairman of a Special Committee of the L.C.C. on London Electricity Supply since its formation in 1912. The Council came to the conclusion that if anything satisfactory was to be done in regard to electricity supply in London centralised control was necessary. The grounds on which the Council claimed its representation on the Joint Authority were that they were the authority for purchasing the London companies, and that the Council had been for many years in a position to consider the interests of the consumer in the London area and had the interests of the consumer at heart. It was the only authority that would directly represent the consumers. The assessable value of the area delimited by the Commissioners was 65½ million, of which the London County represented 45½ million. The population was 4½ million in the County and 3·4 million outside. The units sold by local authorities in the County of London in 1918-19 and in 1919-20 averaged 174 million per annum, and outside the County area the average for the two years was 113 million, making a total of 287 million for local authorities. The Companies in 1919 sold in London 240·8 million and outside 71·9, total 312 million.

In reply to Mr. **Sydney Turner** (for the Conference of Local Authorities owning electricity undertakings in Greater London), Mr. **Hume** said there were 40 stations owned by local authorities and 44 owned by companies in the area, and he accepted Mr. Turner's statement that the plant was owned to the extent of 218 000 kW by the local authorities, and 247 000 kW by companies. The capital expenditure of the local authorities was roughly 12 million and that of the companies 20 million. Approximately the interest of the local authorities in the area as a whole was approximately equivalent to that of the companies. The 1919 Act provided that a Joint Electricity Authority should be representative of various undertakers, and after that certain people might be added. He thought giving the local authorities six and the companies six of the 28 representatives on the Joint Authority could be said to be representative of the various undertakers.

Mr. **Turner** said the Act of 1919 provided that the right of purchase might be transferred to the Joint Authority subject to an order providing for adequate representation on the Joint Authority of the transferring local authority. The L.C.C. scheme gave the local authorities 10 representatives and kept for themselves and the companies 14. Did Mr. Hume think that gave the local authorities proper representation?

Mr. **Hume** said he thought it was fair representation. The Council was in a position to protect the consumers. When the companies proposed to increase their charges the Council was appealed to to protect them. He agreed that in safeguarding the interests of consumers by getting adequate representation on the Joint Authority the Council was also safeguarding its own interests. The Council's financial policy would be affected by the representation it got.

In reply to Mr. KENNEDY, representing the London Electricity Joint Committee, Mr. HUME said the Council's scheme and the other schemes were in agreement in regard to the most important parts of the problem. The Council's view was that the Joint Authority should take over the generation and leave the distribution to the present undertakers. If the Council had to purchase the companies' undertakings it would involve the raising by the Council of very large sums of money, which was not a pleasant prospect at present. He had only considered on very broad lines the terms on which the Joint Authority should purchase. It might involve taking over stations at different dates. The Council might be able to afford substantial assistance to the authorities in any case. If the companies were able to combine, in view of the purchasing powers, the Council would have to consider in a favourable way any real business suggestion put before it as an alternative to purchase. If no agreed scheme was arrived at he was afraid the companies would go on with the menace of purchase in 1931 hanging over them. Instead of their having to drag on for the next few years, the situation should be cleared up as quickly as possible. The present situation did not tend to rapid development on the part of the companies. There was a suggestion to set up a company for 50 years, but the Council trusted that during the period of extinction the company would set aside a sinking fund to extinguish the expenditure. If a period of 60 years were suggested the Council would be prepared to negotiate. It would depend on the other terms of the agreement. He agreed that if the companies put up a large sum of money they should have a voice in proportion to the amount of money they put up. From the administrative point of view he did not think the proposed area was too large for one Authority to deal with.

In reply to a representative of Poplar Council, witness said if the larger scheme broke down he would advise his committee to assist any scheme which covered a large part of the area. He did not think it would be easier to solve the problem if there were a number of autonomous areas, though it would be possible to group together the power companies in the North of London to form one entity, and the municipal authorities in the East to form another. A better system of supply would be obtained by dealing with the larger area. The idea of the present schemes was to benefit the larger number rather than particular districts. The County Council was not concerned in looking after the interests of the industrial consumer primarily. The industrial consumers could usually look after themselves to a certain extent. The Council first had to look after the interests of the individual consumers. By picking out a certain area and giving it autonomy the level of the larger area would be lowered. The question whether the Joint Authority would want £50 000 a year for administration expenses depended upon what the Authority set out to do. Even at the outset it would have an enormous amount of work to do. In reply to the suggestion that it would be unfair to the five municipal stations which were linked up in the east of London if the other districts were a charge on the Joint Authority, he presumed that the linked mains would be taken into account. It was not proposed in the Council's Bill of 1914 to hand over the municipal supplies to a private undertaking, but to set up a statutory company for operating them.

Sir HERBERT NIELD, K.C. (for Hertfordshire and Surrey County Councils), said Mr. Hume had always been somewhat Napoleonic as to the area over which the County Council should have dominion, and suggested that he was the author of the scheme which reset out the Heptarchy—that the area of the London County Council should not be smaller than that of the Metropolitan Police area.

Mr. HUME said he humbly thought the area chosen for electricity supply would be a very suitable one. He agreed that Hertfordshire did not touch the County of London area within 12 miles. The engineers were not instructed to deal with Hertfordshire in the reports, but they had thought it advisable to do so.

The London County Council would raise no objection if the Electricity Commissioners thought it desirable to give the Port of London Authority direct representation With regard to the continuation of the Authority's present contracts for power, he could not conceive of the new body repudiating contracts already in existence.

Sir JOHN SNELL said it would be a matter for Parliament. The Commissioners would have every regard for the obligations and duties laid upon the Port of London Authority by Parliament.

In reply to a question as to the direct representation of the railway companies on the Joint Authority, Mr. HUME said the L.C.C. would be quite willing to leave that in the hands of the Commissioners. It was not the Council's object to take away from the railways any protection they had under the Electric Lighting Clauses Act and the Act of 1919.

Mr. SIDNEY MORSE said some of the companies —certainly the County of London and the City of London Companies—did not consider the purchase in 1931 a menace.

In reply to a question on behalf of the ELECTRICAL POWER ENGINEERS' ASSOCIATION and the CHIEF TECHNICAL ASSISTANTS' ASSOCIATION, Mr. HUME said the Council had not attempted to dictate what classes of workers should be represented on the Joint Authority. They would welcome one of the representatives being a member of a technical staff.

In re-examination by Mr. Henderson, witness said the position of the L.C.C. was different from that of other County Councils, as it was the purchasing authority. With regard to Provisional Orders, such matters as alterations of frequency and so on were made subject to conditions imposed by the Council. He was not prepared to say whether the Council would have any power to guarantee interest on capital provided by the companies. It was important that the industrial areas should be linked up with the less industrial portions. By using the existing facilities in Hertfordshire with the facilities existing in other parts of the area economy could be obtained.

In reply to Sir Harry Haward, witness said the Council thought it would be in keeping with the drift of things to-day to have the workers represented on the Joint Authority. He did not think the Joint Authority would be a large employer of labour. One reason for the L.C.C. having substantial representation was that it had been used to dealing with large matters. He thought all the bodies represented on the Authority should make some contribution to the administrative expenditure.

In reply to Mr. Page, if a railway company wanted a supply from the Joint Authority they should give it if it were available, but it did not look possible for the next few years, and therefore it would devolve upon the railway companies, probably to provide their own supply, and it was hoped they would have a surplus for public use.

In reply to Sir John Snell, he thought it would be better that the whole of the companies undertakings should be controlled by a body such as was now proposed than that the whole of the companies' undertakings should be acquired in 1931.

The inquiry is proceeding.

No Profiteering in the Cable Industry

The report of the Sub-committee under the Profiteering Acts on the cable industry has been published, and pays a high tribute to British cable manufacturers in this country. Unlike many other trades, this industry, it is pointed out, has not suffered any serious effects from foreign competition. This may be accounted for by the facts that the trade is highly organised and that British manufacturers enjoy a world-wide reputation for the quality of their products, to which many witnesses have borne testimony.

The report states " it is abundantly clear that manufacturers operating outside the Association are well able to compete with the associated firms from the point of view of quality. The outstanding fact remains however, that the largest users, as a rule, are entirely satisfied with the service rendered by associated firms and are willing to pay a higher price for their products which they regard, rightly or wrongly, as in the nature of an insurance against interruption of electricity supply from failure in service and as a guarantee of durability."

GENERAL EFFECTS OF ASSOCIATION'S OPERATIONS.

The prosperity of the electrical cable industry may be confirmed by the financial position of the principal manufacturers concerned and by the dividends that have been paid over a course of years. There is no doubt that this prosperity was largely created by the Cable Makers' Association, which, by its organisation and research, initiated and has since maintained a high standard of quality, thus securing the confidence of buyers both in this country and abroad. We have no evidence to show that the Association has acted or is acting unreasonably and it is noteworthy that during the course of the inquiries there has been a marked absence of hostility towards the Association both on the part of users and on the part of non-associated firms. We are of opinion that, even if there should be any risk of unreasonable action in the future, the public would be sufficiently safeguarded if the recommendations contained in the report of the Committee on Trusts (of the 24th April, 1919) were adopted.

After referring to the operations of the Telephone Cable Makers' Association and the High Conductivity Association, the Committee finds no combination of manufacturers controlled by one central organisation, from the point of view of capital and output, but that there are in the industry or connected with it several associations, among the members of which arrangements are made as to the prices to be charged for their products. From the evidence heard, the Committee has no cause to believe that any of those associations have acted unreasonably, while the Cable Makers' Association has been largely instrumental in creating and maintaining the prosperity of the industry in this country and its operations have been favourable to the improvement of quality.

Parliamentary Intelligence.

L.C.C. (MONEY) BILL.

This Bill, which authorises the London County Council to borrow over £1500 000 new capital, has been read a second time in the House of Commons. Of the £1 000 000 required for tramways, £235 000 is in respect of the purchase of the London United Tramways, which the Council agreed to pay one year after the conclusion of the war. There is no provision for any new lines or projects.

LOCHABER WATER POWER BILL.

On the report stage of this Bill last week an unsuccessful attempt was made to introduce the following new clause :—" Inasmuch as the County Council of Banff and the County Council of Moray have in view using the waters of the watershed of the River Spey for the manufacture of electricity for use within the areas under their authority, the provisions of the immediately preceding section, in so far as they relate to the River Spey and all streams and tributaries flowing into the same, shall not come into operation until the expiration of ten years after the passing of this Act, and then only in the event of the said County Councils, or either of them, not having obtained authority for the supply of electricity within their areas as aforesaid."

The clause was opposed by the chairman of the Select Committee which considered the Bill and it was rejected by a large majority.

Electricity Supply.

Application has been made by **Barnstaple** Corporation for sanction to borrow £4 000 for condensing plant.

Hastings Corporation has increased the charge for electric current for heating to 2d. per unit plus 50 per cent.

Winchester Corporation has applied for permission to borrow £19 000 for three years mains extensions and house services.

Chichester City Council will purchase the local electricity works for £17 000, subject to the consent of the Electricity Commissioners being obtained.

Amble Urban District Council has applied to the Electricity Commissioners for a Special Order to authorise the Council to generate and distribute electrical energy in the Amble Urban district.

The **Haywards Heath** & District Company has applied for an order to establish electric supply works and the Urban Council will offer no objection if a purchase clause be inserted in the Order.

The accounts of **Southend** electricity department for the past year show income £105 721 and total expenditure £108 880—a deficit of £3 159. For the current year a surplus of £1 767 is estimated.

Glasgow Corporation has made an issue of £2 500 000 of Corporation 5½ per cent. redeemable stock in order to meet the requirements of the electricity supply, gas and other departments of the Corporation.

For the financial year ended May 31 the **Glasgow** Corporation electricity department shows substantial increases in receipts and output. The increase in revenue was about £300 000 and 187 500 000 units were generated (against 176 500 000 in 1920), but the coal consumed was only 241 625 tons (against 247 735 tons). The saving in coal has been effected by the new power station at Dalmarnock. Since April 27, owing to shortage of fuel, at the Pinkston power station of the Tramways Department, during week days from 50 to 75 per cent. of the electrical energy required for traction has been supplied by the Electricity Department; and at week-ends, *i.e.*, from Saturday night until Monday morning, the whole of the tramway load has been carried by that department. From April 27 until May 31 about 2½ million units were supplied for tramway purposes.

The **Walton** Urban Council has agreed to purchase the local electricity works, and application has been made to the Electricity Commissioners for sanction to increase the maximum price of electric current.

Redditch Urban Council has given instructions that every effort should be made to maintain the supply of electricity for power and has decided to purchase apparatus for spraying oil on coal with a view to improving the burning capacity of the fuel.

Hereford Corporation has applied for authority to borrow £3 300 for pneumatic dust extracting plant and £3 356 for covering in the coal storage in the yard of the electricity works. The price of current for power is to be increased from 60 to 100 per cent. above pre-war rates.

A distributing station was formally opened in Water-street, **Colne**, last week, by Councillor J. Thompson, J.P., chairman of the Electrical Committee, who mentioned that it was part of a scheme for linking up all electricity undertakings in the area. The cost of equipping the station was about £20 000.

Councillor **Waters** hoped the Council's representatives would seriously set about selling the electricity undertaking to a company, and thus get rid of the great losses year by year. In reply, Councillor **Cheyney** said it was not opportune to make any statement with regard to that at present, but he hoped to present a report to the next meeting of the Council.

The **Kilmarnock** Corporation has applied for a special Order to authorise the extension of its electricity supply to the burghs of Ardrossan, Saltcoats, Kilwinning, Stewarton and Cumnock, and certain adjoining parishes, &c.; and also to acquire the undertaking authorised by the Ardrossan, Saltcoats and District Electric Lighting Order, 1910, and for powers in regard to the supply and distribution of electricity in the added areas.

The **Cannock** Urban Council has sealed the agreement with Wolverhampton Corporation for the supply of electricity in bulk in the district, and, acting on the advice of the consulting engineer (Mr. Arthur Ellis), the Council has intimated to the Cannock Chase Coalowners' Association that as soon as it receives definite information from the local collieries as to the supplies of current required, the laying of cables will be commenced. The Corporation bear the cost of laying the cable to the Cannock boundary, and the Urban Council will lay the cable from Wedge's Mills to the transformer station in Queen-street, Cannock.

Chester Corporation has approved the arrangement for obtaining a supply of electrical energy in bulk from H.M. Factory, Queensferry. The North Wales Power and Traction Company will, in the event of statutory effect being given to the Electricity Commissioners' recent decision (by which the company would own and operate all the main transmission lines in the North Wales and Chester Electricity District), ultimately take over at the cost incurred by the Corporation the transmission line from Queensferry to Chester, together with the step-up transformers at the factory and step-down transformers at the substation. The line of route for the transmission line and the prices to be paid for the plant are to be approved by the Company.

In a report on the scheme the electrical engineer (Mr. S. E. Britton) stated that the cost was estimated at £51 300, and application has been made to the Electricity Commissioners for sanction to borrow £52 000.

The report of the Special Committee on the method of charging for electric current at **Sheffield**, which was abstracted in our last issue, caused a lively discussion at the meeting of the Corporation last week, but ultimately it was adopted by 25 votes to 21.

The chairman of the Committee, Councillor Blanchard, who moved the adoption of the report, said it was in the interests of the development of the city that manufacturers should get power at the lowest possible price. The question of power-cost very often made all the difference between getting an order and losing it, and if orders came to Sheffield workmen as well as manufacturers benefited. They must not play fast and loose with an undertaking that had cost nearly three millions.

Councillor **Graves** moved an amendment that the proposed reduction to one class of consumer only be confirmed, and that all consumers should be charged at the same rate, whether for light or for power. The report contained neither information, nor argument, nor anything else. There was neither system nor reason in the operation of the present tariffs, and he cited some instances of the varying prices charged for "exactly the same commodity." Fifteen years ago a unit cost 2d. more than it did to-day, but instead of knocking the 2d. off, it had actually been added to the price, which was now 4d. plus 50 per cent. He said, "We want a clean, straight way of selling this current which will eventually bring it within everybody's power to buy it easily." His idea was a standard of 3d. per unit, [illegible] down to the price paid to-day by the big consumer of power.

Ald. **Hobson** said Councillor Graves was assuming that the "grinding out" of current was the whole question. The distribution was a more costly procedure. It could not be expected that for lighting, or for the occasional use of current, the same payment should be made as for current used all the year round. The man who used power during the summer was entitled to a lighter charge, because he was finding revenue at periods when otherwise the undertaking would be idle. The large power user, instead of having his power below cost, was largely cheapening the cost of lighting in the city, and had done very much to enable electricity to be sold cheaply here.

Sir **Wm. Clegg** and Ald. **Styring** also supported the adoption of the report, and in reply Councillor **Blanchard** compared Sheffield's charge for electric lighting per unit with 60 other towns. Seven of these charged 1s., five 11d.; only three were as low as 6d. (and Sheffield's average was not 6d.), and the others varied from 6½d. to 9d.

Electric Traction.

The Transport Ministry have made an interim order authorising the tramway fares at **Wolverhampton** to be raised to 1½d. per mile, with a 2d. minimum; but, owing to the present industrial position, its operation will be deferred for a time.

The **Colchester** tramway accounts for the year ended March 31 show total revenue £24 927, an increase of £1 538 over that of the preceding year, gross profit £2 451, and a net deficit of £2 474. The revenue was the highest on record, but the number of tickets issued decreased by 499 620, doubtless owing to increased fares and unemployment. The increase in wages was £1 717 and in cost of electrical energy £1 141.

The accounts of **Birmingham** tramways department, which were adopted by the Council last week, show that during the year ended March 31 last, total revenue was £1 656 654, compared with £1 378 704 in the previous year, and working expenses were £1 328 943 (against £1 094 622), leaving gross profit £327 711 (£284 082). Interest and sinking fund charges were £165 565 (£148 664), and net profit was £171 162 (£151 471), which has been transferred to reserve. Traffic revenue per car-mile was 24·136d. (21·538d.) and working expenses were 19·442d. (17·184d.). Passengers carried were 218 222 927 (225 129 814), and car-miles run 16 404 585 (15 288 095).

The annual report of **Nottingham** tramways department for the year ended March, 1921, shows receipts £403 114, an increase of £24 167 over the previous year, and working expenses £365 361, increase £71 137, leaving a gross profit of £37 752, compared with £84 723. Interest required £16 320, redemption of capital £18 916, and bank interest £1 860, leaving net profit £655. Salaries and wages increased by £31 864, rates and taxes by £15 719 and electrical energy by £8 215. Passengers carried were 62 166 373, increase 3 416 719, and the tramcars and three motor-'buses which were put in service early in the year ran 4 321 453 miles, increase 232 883. The 'buses showed a loss of £1 093 in running expenses alone, but are of value as feeders to the tramway system.

The **Glasgow** Corporation has authorised the use of an improved tramcar lifeguard, which has been tried by the Tramways Department. A grant of £200 has been made to the patentee, a coach-builder employed by the department, for out-of-pocket expenses and for protecting the patent, on condition that the Corporation be allowed to use the patent without fee or royalty.

The invention is an improvement on a device which Mr. Dougan, a member of the staff, patented 15 or 16 years ago. The device, which had for its object the maintaining of the front gate of the well-known Tidswell or Hudson-Boring lifeguard at a uniform height above the street irrespective of the pitching of the car, was thoroughly tested for some time, and latterly the Corporation decided to equip all the Glasgow cars with it. In operation it has been quite satisfactory, although the maintenance cost was probably a little high, and the new invention is simply an improvement in the mechanism with the object of reducing the maintenance cost to a minimum. So far, the Corporation have only a few cars fitted, but it is anticipated that the maintenance cost will be reduced very considerably.

Personal and Appointments.

Mr. S. C. Marston has been appointed manager of the Stockton electric supply undertaking at £650 per annum.

Mr. H. Robinson, D.Sc., has resigned his position as senior lecturer in Physics and Assistant Director of the Physical Laboratories at Manchester University, to take effect as from Sept. 29 next.

After 40 years' service Mr. Wm. Brown, J.P., has retired from the position of manager of the Dundee District of the Post Office Telephones. Mr. Brown's retirement synchronises with the transfer of the Dundee administrative section to Edinburgh.

Mr. Harold E. Webb, A.M.I.E.E., has been appointed London office manager by Messrs. Bruce Peebles & Company, Ltd. Mr. Webb has a long connection with the company and is well known to their many customers in the London area.

The salary of the city electrical engineer and tramways manager of York (Mr. J. W. Hame) has been fixed at £900 per annum, of which £600 will be borne by the electric supply department and £300 by the tramways and light railways undertaking.

London County Council has appointed Mr. Geo. W. Stubbings and Mr. S. H. Wigner, grade 2 technical assistants in the electrical branch of the tramways, department at a commencing salary of £250, rising to a maximum of £300 a year by annual increments of £12 10s.

Mr. and Mrs. William Alex. Smith, of Helensburgh, have just celebrated their golden wedding. Mr. Smith is the last surviving member of the first board of the National Telephone Company and was a director when the Company's undertaking was taken over by the Post Office in January, 1912.

Mr. Charles L. Tomlinson, late London manager of Messrs. Van Raden & Company, Ltd. (Coventry), for home and export, and recently sales manager of Edison & Swan for primary and secondary batteries, has just vacated an appointment with the Hart Accumulator Company, and is now open to consider proposals from other firms.

Mr. E. J. H. Bluett, who has resigned his position as electrical engineer to the Ascot & District Gas & Electricity Company, has been presented with a silver tea set and tray from the directors, and a malacca and horn stick from the staff. In partnership with Mr. A. T. Archer, Mr. Bluett has purchased the Sunningdale business of Messrs. John Drake & Company, electrical and general ironmongers.

The Franklin Institute has awarded the Franklin Medal to Mr. Frank J. Sprague, the well-known American electrical engineer, "in recognition of his many and fundamentally important inventions and achievements in the field of electrical engineering." The Franklin Medal is awarded annually to those workers in physical science or technology, without regard to country, whose efforts have done most to advance the knowledge of physical science or its applications.

The Albert Medal of the Royal Society of Arts for 1921 has been awarded by the Council, with the approval of the President, H.R.H. The Duke of Connaught and Strathearn, K.G., to Prof. John Ambrose Fleming, M.A., D.Sc., F.R.S., in recognition of his many valuable contributions to electrical science and its applications, and especially of his original invention of the thermionic valve. The medal was instituted in 1862 as a memorial of the Prince Consort and is awarded annually for "distinguished merit in promoting Arts, Manufactures and Commerce."

Mr. L. Tibbenham, A.M.I.E.E., winner of the First Prize in the recent Foundrymen's Competition, is managing director of the Suffolk Iron Foundry (1920), Ltd., Stowmarket. He served his apprenticeship with Messrs. Ransomes, Sims & Jefferies, Ipswich, afterwards being appointed chief tool draughtsman at the works of Messrs. Ruston, Proctor & Company. Prior to building the foundry which gained the Foundrymen's prize, Mr. Tibbenham was in charge of a small agricultural implement business in Stowmarket, as well as managing director of the A.G.E. Electric Motors, Ltd.

Catalogues, Price Lists, &c.

A price list of their "Ecal" Hack Saw blades has been issued by the engineering and Colliery Appliances, Ltd., Rockingham-street, Sheffield.

Messrs. Henry Sotheran & Co., 140, Strand, London, W.C.2, have recently issued a catalogue (No. 777) of sets of periodicals and publications of the Learned Societies.

Messrs. Rayner & Heald, Ltd., Duke-street, Derby, are circulating their stock list of two- and three-phase induction motors. The particulars include capacity, speed, voltage and phase of squirrel-cage and slip motors.

The Edison Swan Electric Company, Ltd., of Ponders End, have issued their illustrated price list (No. H.H. 226) of Ediswan Electric Fans, which gives particulars of the design and construction, dimensions of blades, current consumption, speed, price and other details of a number of table, desk, ceiling, port-hole and exhaust fans for direct or alternating circuits.

From an illustrated catalogue and price list of 36 pages issued by Messrs. Geo. MacLellan & Company, Ltd., a good idea can be gained of the numerous mechanical purposes to which rubber is now being applied. A good index facilitates references to the large variety of goods listed, which are mainly manufactured at the company's works in Glasgow. The firm claim to be the largest private asbestos and rubber manufacturing company in the United Kingdom, and for the same price British goods are superior to those produced by any other country. Readers can obtain a copy of the list from the Glasgow Rubber Works, Maryhill, Glasgow.

Miscellaneous.

The commercial airship, R.36, made successful endurance and Wireless Navigation Test Flights on Thursday and Friday last. Constant communication by wireless was maintained with various land stations and her position was located either by wireless direction finding or by direct message at several stations.

The June issue of the "Faraday House Journal" contains some interesting items of domestic news and appointments secured by Faradians with short articles on "Uniflow Steam Engines," by Mr. T. R. Warren and "A.C. Over-Pressures to Earth on D.C. Systems caused by Earth Faults on Armatures," by Mr. L. Romero.

At the seventh annual meeting of the British Imperial Council of Commerce, on the 8th inst., it was decided to hold the next triennial congress of chambers of commerce of the British Empire in London in 1923. Lord Derby was unanimously elected president for 1921-22; Mr. E. Manville, M.P., chairman, in place of Mr. Stanley Machin, and the Hon. J. G. Jenkins, vice-chairman, in succession to Mr. A. J. Hobson.

On the 10th inst. General Smuts, who has come over to take part in the Imperial Conference, was the recipient on the Castle liner "Arundel Castle" of Greetings by Wireless Telephony from Sir Edgar Walton, the High Commissioner of S. Africa. The message, which was telephoned through the Marconi station at Poldhu, contained a brief news summary. General Smuts, in a reply transmitted by telegraphy on the Marconi long-range apparatus with which the "Arundel Castle" is equipped, accepted, on behalf of Sir Thomas Smartt and himself, an invitation to the Rhodes' scholars' dinner at Oxford on Saturday. Five sets of telephone receivers were available on the "Arundel Castle," and the speech from Poldhu is reported to have been clear and strong.,

The fourth qualifying course for the Royal Corps of Signals will commence at the Signal Training Centre on Oct. 1 next, and will extend over a year. The course will comprise visual signalling, procedure, electricity, instruments, wireless telegraphy, cable laying and air line construction and the application of signal training. For this particular course officers who have less than three years' commissioned service will be eligible. Officers will be seconded to the Royal Corps of Signals after the first three months, and those who successfully pass the examination held at the end of the course will remain seconded for four years from the original date of seconding. They will receive a certificate from the Institution of Electrical Engineers, which will entitle them to signal pay from the date of the examination.

We regret to learn that the negotiations on the WAGE REDUCTIONS in the ENGINEERING INDUSTRY have broken down and that the crisis has now become very acute. Subsequent to the posting of the notices by the employers ten days ago the Ministry of Labour attempted to effect a settlement and informal conferences took place between the parties. The Unions offered to accept the shipyards' agreement, namely, a reduction of 6s. a week in time rates, and 15 per cent. on piece work prices, in two instalments, on condition that the employers withdrew the demand for the abolition of the 12½ per cent. day workers', and 7½ per cent. piece workers', bonus under the Churchill award.

The employers would not agree to this, but they submitted a modification of their proposals, which would involve the same reductions but over a longer period. In turn the Unions rejected the modified terms of the employers and the latter have issued a statement in which they say that "they are compelled, in the interests of the industry, and with a view to reducing unemployment by being able to quote for contracts at less cost of production, to enforce the notices which have been posted in the works."

Imperial and Foreign Notes.

Wireless Receiving Apparatus, with a range of 12 500 miles, is reported to have been erected at the Perth (W. Australia) observatory here.—Reuter.

Perth (W. Australia) Council's electric supply department shows a revenue of £119 656 (increase, £16 882) for the year ended October last. The gross profit was £45 440 (increase, £1 318) and the net profit £18 093.

The net profit in the Melbourne Council's electric supply undertaking during 1920 was £38 976, compared with £30 491 for the previous year. The revenue was £303 588 (against £240 081). The charges for current were the same in both years.

At Mildura (Victoria) there have been serious breakdowns of the electrical generating plant, and it is understood that the Borough Council, which has now taken the plant over from the Shire Council, will take energetic measures to ensure a continuous and adequate supply.

Some time ago the inhabitants of Bright (Victoria) expressed approval of a proposal to establish electricity supply works for the town, but in view of the fact that the estimated charge for wiring has been increased from 22s. 6d. to 33s. per point and the charge for current from 9d. to 1s., the matter is to be referred again to the potential customers.

The Brazilian Electro-Metallurgical Company proposes to instal two electric furnaces at Ribeirao Preto, capable of a daily output of 60 tons of structural iron.

Arrangements have been made by which the L. M. Ericsson Telephone Company has acquired the whole of the shares of and amalgamates with Messrs. H. T. Cedergren Telephone Company. By this transaction practically the whole of the TELEPHONE MANUFACTURING BUSINESS of Sweden comes under the control of the Ericsson Company.

Institution Notes.

According to a report of the Committee, the membership of the Liverpool Sub-Centre of the North-Western Centre of the Institution of Electrical Engineers has risen from 294 to 367 during the past session.

The Committee of the Students' Section of the North-Western Centre of the Institution of Electrical Engineers record another very successful session, during which a number of interesting Papers were read and visits paid to several works.

The Batti Wallahs Society will hold their last luncheon for the present session on Monday next, the time and place being as usual, the Holborn Restaurant at one o'clock. There will be no set speaker but members, especially those who do not usually attend these functions, are invited to offer suggestions for furthering the objects of the Society. We hope the week-end will see many useful brain waves generated.

The annual conference of the Institution of Municipal and County Engineers began in London on Wednesday last and continues until to-morrow. The president is Mr. Norman Scorgie, borough engineer and surveyor, of Hackney. Yesterday afternoon a demonstration took place in Lincoln's Inn Fields of mechanically propelled vehicles used in municipal work. We were sorry to see so few electrically operated vehicles, but we noticed a dust van shown by the Hackney Borough Council, a petrol-electric vehicle exhibited by Messrs. Tilling-Stevens and a Garrett 2½-ton lorry with an end-tipping body, specially designed for municipal work.

The British Cast Iron Research Association has now been constituted under the presidency of Lord Weir of Eastwood with offices at Central House, New-street, Birmingham. The main objects of the Association are to promote co-operation amongst firms connected with the production and utilisation of cast iron in Great Britain with a view to the establishment of a scheme for scientific and industrial research. Arrangements will also be made for the distribution among members of information relating to the production, treatment, manufacture and utilisation of cast iron and to co-ordinate the existing means of research and their further development. An interesting and suggestive programme of research has already been arranged.

Business Items, &c.

Messrs. C. H. Runnalls, electrical engineers, have removed to new premises in Grove-road, Sutton, Surrey.

Mr. William Raine has commenced business as an electrical engineer with his son, trading as William Raine & Company, at 9, Conescliffe-road, Darlington.

The telephone numbers of the Publicity Organisation of the General Electric Company, Ltd. (Head Office, Magnet House, Kingsway, W.C. 2), are now Central 2604 and 2605. The address will remain as at present, 92/4, Queen Victoria-street, E.C. 4.

The Forest City Electric Services Supply Company are removing their offices and stores on the 20th inst. as follows: Offices, 10, Princess-street, Chester-road, Manchester; Stores: 2 and 4, Cornbrook Park-road, Manchester. The telephone number remains Central 5414. Goods and empties should be addressed to our stores.

Messrs. Leslie Dixon & Company, 91, Queen Victoria-street, E.C. 4, now represent Messrs. John Fletcher, Ltd., the well-known electrical slate manufacturers in the South of England. The works at Carnarvon are equipped with the most modern machinery for the preparation and finishing of electrical slates, and Messrs. Dixon & Company are prepared to execute all orders for slate bases for switchgear, &c.

Messrs. Geo. W. Wheatley & Co. have issued a useful booklet, which shows at a glance the cost of telephone calls under the new method of charging by distance. Lists of exchanges within the five-mile circle of Oxford-circus, in the inner London zone and within a radius of 25 miles of London are given. Copies can be obtained free of charge upon application to the company at 95, Upper Thames-street, E.C. 4, or 46/8, Beak-street, W. 1.

Mr. W. T. Bower, A.M.I.E.E., of 184, Jockey-road, Sutton Coldfield, near Birmingham, has been appointed as Midlands representative of Messrs. Buckley, Saunders & Company, Ltd., for their electric welders "Cycarc" welding process, electrodes and other welding specialities. Mr. Bower, who will be pleased to reply to inquiries and arrange demonstrations, &c., in his territory, has opened a central office at 7, Jamaica Row, Birmingham. Telephone number: Midland 1272.

Bankruptcies, Liquidations, &c.

Thos. Hardman, electrician, Holmfield, Burnley-road, Rawtenstall, has been adjudicated bankrupt.

Mr. H. W. Bowler, 30, North John-street, Liverpool, has been appointed trustee in the bankruptcy of Saml. Horace Dougherty, trading as the Mersey Electric Company, 106, Kensington, Liverpool.

The "London Gazette" announces that the first and final dividend payable at 26, Baldwin-street, Bristol, to creditors of Jas. S. Denley (trading as Denley & Company), is 2s. 8¼d. in the £, and not 3s., as announced previously.

A deed of assignment has been executed by Harold Stead, electrical engineer, Dyson-street, King Cross, and 103, King Cross, Halifax, under which debtor undertakes to pay any deficiency between the amount realised and the amount required to pay costs, &c., and a dividend of 5s. on the debts. Unsecured liabilities, £358; estimated net assets, £130. Mr. A. Gray, 9, Fountain-street, Halifax, is trustee.

Tenders Invited and Accepted.

Pontypridd Guardians require tenders by June 23 for three months supply of electrical material. Further particulars from the Clerk, Union Offices, Pontypridd.

Bury (Lancs) Housing Committee want tenders by June 22 for wiring and fitting in 92 houses in the Walmersley district. Specification from the Borough Electrical Engineer.

Edinburgh Corporation requires tenders by June 22 for the wiring of houses comprised in the Gorgie housing scheme (southern section). Specifications from the Engineer, Dewar-place, Edinburgh.

Manchester Electricity Department require tenders by June 28 for about 27 000 yards of weldless steel upright and socket tubes. Specifications from Mr. F. E. Hughes, Town Hall, Manchester.

Manchester Electricity Committee require tenders by June 28 for six months' cable requirements, and by June 21 for six months' supply of marine stores. Specifications, &c., from Mr. F. E. Hughes.

Manchester Tramways Committee require tenders by June 21 for the supply of points, tongues, crossings and hardened steel centres. Specifications from the General Manager, 55, Piccadilly, Manchester.

Manchester Education Committee want tenders by June 21 for wiring and fitting Plymouth Grove and Upper Jackson schools. Specifications can be obtained at the Education Offices, Deansgate, Manchester.

The Isle of Wight County Council invite tenders by June 27 for an electric lighting installation at the Longford House, Havenstreet, Sanatorium. Particulars from the County Surveyor, Mr. S. R. Cox, St. Thomas-street, Ryde, Isle of Wight.

Islington (London) Borough Council require tenders by July 4 for h.t. switchgear for 2 500 V and metal-cored flame carbons for Excello type flame lamps. Specifications from the Engineer, 50, Eden-grove, Holloway, N.7.

Tenders are required by June 26 for the supply and erection of motors, control equipment and transformers for the operation of eight pumps at the Dry Docks at Kattendyck, Antwerp. Specifications can be seen at the Department of Overseas Trade, 35, Old Queen-street, S.W.1.

The Ministry of Posts and Telegraphs of the Kingdom of the Serbs, Croats and Slovenes invites tenders for the supply of 18 000 kilos of iron zinced wire, 80 000 curved carriers and 80 000 porcelain insulators; and also 250 complete sets of tools, &c. Tenders by 29th June and 30th June respectively. Specifications at the Department of Overseas Trade, 35, Old Queen-street, S.W.1. It is desirable that firms intending to compete should be represented locally.

The Electricity Commission of Victoria, 673, Bourke-street, Melbourne, require tenders by Aug. 15 for the following plant and material for the Morwell power scheme: steel work for power station, &c. (specification 95) and boilers, stokers, fans, steel chimneys, sooting and dust extraction equipment, ash-handling plant, &c. (specification 99). Specifications, &c., from the Agent-General, Victoria House, Melbourne-place, Strand, London, W.C.

Barberton (Transvaal) Municipal Council invite tenders for two boilers (3 000 lb. of steam per hour at 180 lb. pressure), two 75 kW three-phase 2 200 V (50 periods) steam alternators (engines to be high-speed and coupled direct), switchboard and instruments, steel chimney, piping, feed pumps and connecting cables; steel poles, conductors, insulators, lightning arresters, &c.; three 30 kW three-phase and 10 5 kW single-phase transformers, house services and meters for 150 consumers. Specifications from Prof. W. Buchanan, 75, Louis Botha-avenue, Johannesburg, and tenders to the Town Clerk, Municipal Offices, Barberton, by July 20.

Sydney (N.S.W.) Council have accepted the tender of W. T. Henley's Telegraph Works Company for the supply of cables at £32 065.

York Corporation has accepted the tender of Callender's Cable and Construction Company for cables.

London County Council has accepted the tender of Dorman, Long & Company for the supply of track rails, according to the new Engineering Standards Association's section No. 8, for £86 231. 5s., cut.

Blackburn Council has placed an order with the Metropolitan-Vickers Electrical Company for the supply and erection of e.h.t. switchgear at Jubilee-street generating station, and with the English Electric Company for two rotary converters and switchgear.

The following tenders have been accepted by Glasgow Corporation: Metropolitan-Vickers Electrical Company, switchboards for Kenning Park Station, £2 039, and Partick sub-station, £351; British Thomson-Houston Company, switchboard for Elliot-street sub-station, £1 642; Sloan Electrical Company, Wm. McGeoch & Company, W. Brown & Company General Electric Company, Wood & Cairns, British Thomson-Houston Company, and Simplex Conduits, Ltd., for electrical fittings.

The Metropolitan-Vickers Electrical Company has secured the contract for the supply of five 12 500-kW, three-phase turbo-alternators to the Electricity Commissioners of Victoria, at £300 000. The alternators will generate current at 6 600 V, 50 periods, at 3 000 revs. per min. The first set has been promised in 11 months, with completion in 17 months. The surface condensers will be made in Victoria, while an American firm will supply the switchgear and transformers. Competition was open to all the world, and was especially keen in view of the fact that the undertaking will be one of the highest tension transformer schemes in the world. The power house at Morwell is 60 or 70 miles from Melbourne, to which a transmission line will be erected.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by Messrs. Mewburn, Ellis & Co., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

Complete Specifications.

132 259 Kreher. Electrodes for electrical accumulators. (3/11/17.)
139 152 American Bosch Magneto Corpn. Magnetos. (20/2/19.)
139 5[illegible] Siemens & Halske Akt. Ges. Vapour arc lamps. (26/7/20.)

The luminosity of a vapour arc lamp is increased by the discharge being effected through a tube device so that the cross-sectional area of the vapour track is reduced, whilst by means of a protecting device (which may also serve as a cooling arrangement and extend close up to the discharge end of the tube) the arc is prevented from spreading over the edge on to the outer surface of the tube.

140 074 Foehl. Electro-magnetic device for re-magnetising permanent magnets. (20/3/18.)
140 748 American Bosch Magneto Corpn. Magnetos for multi-cylinder engines. (27/3/19.)
141 756 Akt.-Ges. Brown, Boveri et Cie. Method of preventing injurious earthing currents in electric nets. (17/4/19.)
142 488 Western Electric Co. Machine switching telephone exchange systems. (14/9/17.)
145 477 Metallbank und Metallurgische Ges. Akt.-Ges. & Lilienfeld. Process for electrical gas purification. (8/8/18.)
146 079 Automatic Telephone Mfg. Co., Ltd. Code signalling arrangements for party line telephone systems. (30/6/19.)
147 774 Apple. Building commutators for dynamo electric machines. (22/1/17.)
160 529 British Thomson-Houston Co., Ltd., Hastings & Lacock. Electric furnaces. (19/12/19.)
160 531 Midgley & Vandervell & Co., Ltd. Electric switchboards. (19/12/19.)
160 547 Hirst & Brook. Automatically-operated electric switches for controlling electric switches. (22/12/19.)
160 554 Coles & Cowper. Manufacture of plates or sheets by electro-deposition. (22/12/19.)
160 559 Adams. Trip-mechanism for electric-ignition devices for internal combustion engines. (23/12/19.)
160 569 Boardman, Boardman & Boardman. Electric arc lamps. (24/12/19.)
160 570 Boardman, Boardman & Boardman. Reflectors for electric arc and other lamps. (24/12/19.)
160 571 Boardman, Boardman & Boardman. Electric arc lamps. (24/12/19.)
160 582 Quain Electric Co., Ltd., & Spink. Electric cigar lighters and similar devices. (31/12/19.)
160 589 Automatic Telephone Manufacturing Co., Ltd., & Roseby. Alternative current track circuits for railway signalling. (3/1/20.)
160 595 Green. Electric accumulators. (6/1/20.)
160 6[illegible] Coates, Gittings, Davie & Metropolitan-Vickers Electrical Co., Ltd. Electrical switch gear. (5/1/20.)
160 609 Ewart. Means for facilitating the timing of electro-ignition apparatus of internal-combusiton engines. (16/1/20.)
160 611 British Thomson-Houston Co., Ltd., Young & Durrant. Electric condensers. (17/1/20.)
160 637 Fennimore. Electric lamp. (10/2/20.)
160 641 Henley's Telegraph Works Co., Ltd., & Gregoire. Flame-proof boxes for switches, fuses and similar electrical fittings. (14/2/20.)
160 645 Marks (Landers, Frary & Clark). Electrically-heated utensil. (23/2/20.)
160 663 Sykes Interlocking Signal Co., Ltd., & Tarrant. Railway electric track circuits. (16/3/20.)
160 711 March & Newey. Conduit fittings for driving electric conductors. (19/7/20.)
160 715 Wade (Mills). Electric motor for driving phonographic and other machines. (22/10/19.) (Divided Application on 154 411.)
161 602 Taylor. Distribution connected with single-phase alternating current systems. (26/9/19. Cognate Application 2 858/20.)
161 603 Morgan Crucible Co., Ltd. & Spiers. Electrically-heated melting and other furnaces. (7/10/19.)
161 607 British Insulating & Helsby Cables, Ltd. & Astley. Electric rail and other metal body bonds, and like connecting devices. (14/10/19.)
161 619 Western Electric Co., Ltd. (Western Electric Co., Inc.) Electric-discharge apparatus. (28/11/19.)
161 650 Moulin (nee Cenhard), Bull & Favre. Electro-magnetic clocks. (9/1/20.)
161 652 Nottage & Parkin. Wireless telegraph calling devices. (9/1/20.)
161 659 Jefferson & Jefferson, Ltd. Electric plug connecting appliances. (10/1/20.)
161 661 British Thomson-Houston Co., Ltd. (General Electric Co.) Electric switches and like apparatus. (10/1/20.)
161 667 Velde & Furnival. Wireless direction-finding means for aircraft. (12/1/20.)
161 696 Jensen & Tilney. Magnetos. (16/1/20.)
161 703 Osgood & Dean. Construction of electric fire. (19/1/20.)
161 704 Conner & Puckette. Circuits of ignition systems of internal combustion engines. (19/1/20.)
161 706 Powell, Baden-, Electrical method of reproducing distant scenes visually. (19/1/20. Cognate Application 23 133/20.)
161 707 Merryweather & Sons, Ltd., Osborne & Brown. Electrically-operated pumps. (19/1/20.)
161 745 Berry. Electric fires. (2/2/20.)
161 746 Cox. Submarine telegraphy. (2/2/20.)
161 748 British Thomson-Houston Co., Ltd. (General Electric Co.) Electric induction apparatus. (2/2/20.)
161 755 British Thomson-Houston Co., Ltd. (General Electric Co.) Regulating systems for electric circuits. (4/2/20.)
161 758 Watson & C. L. I. Manufacturing Co., Ltd. Dynamo-electric generators for use in motor vehicles and like lighting and ignition systems. (5/2/20.)

APPLICATIONS FOR PATENTS.

December 29, 1920.

36 321 Automatic Telephone Mfg. Co., Mercer & Gillings. Measured service telephone systems.
36 357 Beckert. Safety device for incandescent lamps.
36 362 B.T.-H. Co., Milner & Wheat. Photometers.
36 407 Automatic Telephone Mfg. Co. Electro-magnetic mechanism. (7/9/20, U.S.
36 416 Addison & Scott. Step by step motors.

December 30, 1920.

36 432 Railing, Garrard & Coales. Electric cut-outs.
36 443 Sawle. Electric flash signs, &c.
36 448 British Insulated & Helsby Cables & Blades. Jointing armoured electric cables.
36 449 Reed. Electric furnace. (27/3/20, U.S.)
36 474 Day. Switches.
36 482 Sharratt. Accumulator cells.
36 488 Fairburn. Protective device for d.c. motors.
36 492 Cudney. Electric exploders.
36 499 Sayers. Dynamo electric machinery.
36 503 Allmanna Svenska Elek. Aktiebolaget & Ytterberg. Apparatus for testing electrical machinery.
36 505 & 36 506 Metropolitan-Vickers Electrical Co. Fuses. (12/1/20, U.S.)
36 522 Johnston. Automatic cut-outs for electric boiling appliances, &c.
36 528 Eimer. Electric furnaces. (18/7/14, U.S.)
36 530 Whitehead. Detecting direction and sense of earth's magnetic field, &c.
36 540 Creedy. Windings for a.c. machines.

December 31, 1920.

36 599 Callender's Cable & Construction Co. & Watson. Electric cables.
36 623 B.T.-H. Co. (G. E. Co.) Measuring instruments for lamps.
36 624 B.T.-H. Co. (G. E. Co.) Protecting transmission or distribution systems.
36 626 B.T.-H. Co. (G. E. Co.) Current-collecting devices for electric machines, &c.
36 630 Western Electric Co. Radio transmitting apparatus. (31/12/19, U.S.)
36 652 Bethenod. Means of communicating between vehicles of electric trains. (3/1/20 France.)
36 666 South Wales Electric Power Distribution Co. & Wisdom. Cable-dividing boxes.
36 668 Urbasch. Primary batteries. (28/12/19, Austria.)

January 3, 1921.

2 Taylor. Electrical power transmission systems.
28 Marsh & Sanderson. Covers for switches.
126 Telegraphen Ges. Telephonographs.
160 Longue. Preservation of electric motor from action of surrounding medium, &c.
163 Mylo. Electric conductors resistance bands, &c., for reproduction of sound waves. (2/1/20, Germany.)

January 4, 1921.

185 Bethenod. Electrically-controlled signals. (22/11/18, France.)
215 Woodell. Switches.
240 Rogers. (Meaker Galvanising Co.) Electro-galvanising machine.
242 Shearor & Taylor. Electric controller.
263 Metropolitan-Vickers Electric Co. & Hansell. Transformers.
265 Cachemaille. (Westinghouse Lamp Co.) Vapour-electric current rectifying apparatus.
297 Eckersley. Wireless signalling aerials.
306 Cie du Chemin de Fer de Paris a Orleans. Electric railways. (3/8/17, France.)
308 Merz & McLellan. Fuel-superheating devices.

January 5, 1921.

335 Eaton. Electric lanterns.
340 Macdonald. Telephone systems.
346 Brook & Hirst. Switchgear for controlling motors.
356 Dubilier. Electric condenser. (18/1/16, U.S.)
367 Eustice. Cartridge fuse. (23/7/14, U.S.)
368 Eustice. Safety fuse. (14/3/17, U.S.)
369 Eustice. Cartridge fuse. (22/6/14, U.S.)
370 Eustice. Enclosed electric fuses. (21/6/18, U.S.)
371 Eustice. Fuses. (3/9/18, U.S.)
372 Eustice. Fuse terminal attaching means. (31/3/19, U.S.)
373 Eustice. Knife-blade fuse. (7/3/18, U.S.)
377 Willson. Electric signal or alarm apparatus.
400 Edmunds. Switches.
431 Brydon. Electric relay devices.
436 Siemens & Halske A.-G. Contact springs for switching apparatus. (29/5/14, Germany.)
437 Siemens-Schuckertwerke. Electric insulating materials. (20/10/17, Germany.)
438 Siemens-Schuckertwerke. Operation of electro-magnetic couplings. (12/12/19, Germany.)
461 McLachlan. Electric relays.
466 Thor Electric Safety Lamp Co. Combined resistance and cut-out.

January 6, 1921.

493 Davis & Hudson. Switches, ceiling roses, &c.
504 Columbine, Rooks & Hargreaves. Electric fittings.
578 B. T.-H. Co. & Shuttleworth. Motor control.
603 Mason. Switches. (8/7/19, U.S.)
613 Froese. Electrode for introducing medicaments into the skin. (16/5/19, Germany.)
638 Ges. fur Drahtlose Telegraphie. Wireless antennæ. (11/10/19, Germany.)
639 Ges. fur Drahtlose Telegraphie. High and low frequency telephone systems. (7/1/20, Germany.)
652 Schroter. Regulating terminal voltage of electrical valve tubes. (1/9/19, Germany.)
657 Hodges. Fusible cut-outs and distribution fuse boards.
668 Bergmann Elektricitats Werke A.-G. Polyphase transformers. (22/10/17, Germany.)
669 Bergmann Elektricitats Werke A.-G. Conductors for electric machines. (26/11/17, Germany.)
670 Bergmann Elektricitats Werke A.-G. Conductors for electric machines. (20/2/14, Germany.)

January 7, 1921.

691 Regnauld de Bellescize. Receivers for electro-magnetic wave systems. (10/10/19 France.)
693 Dance. Series field windings for continuous-current dynamos.
723 Ireland & Lucas. Electric ignition apparatus.
730 Lowy. Electric exploration of interior of the earth. (27/3/19, Germany.)
731 Fery. Electro-magnetic clocks. (5/1/20, France.)
760 Savidge & Terrey. Step-down transformers.
765 Edmunds. Control of electric circuits.
771 Metropolitan-Vickers Electrical Co. Fuses. (12/1/20, U.S.)
787 Luzy. Electric pocket lamps. (4/8/19, France.)
795 Apex Electrical Mfg. Co. Vacuum cleaning devices. (9/7/15, U.S.)
796 Apex Electrical Mfg. Co. Suction cleaning devices. (29/9/15, U.S.)
797 Apex Electrical Mfg. Co. Suction cleaning devices. (17/1/17, U.S.)
798 Apex Electrical Mfg. Co. Vacuum cleaning devices. (25/11/16, U.S.)
827 Sarnmark. Wireless and light signalling devices. (1/12/19, Sweden.)
836 Hanson. Wireless phonographs. (3/6/18, U.S.)
842 Soc. Anon. des Usines J. Gallay. Electric head-lights. (9/10/19, Switzerland.)
853 Wise. Incandescent electric lamps. (7/2/19, U.S.)
880 Sankey & Sons & Stevens. Electrical transmission for motor vehicles, &c.
892 Le Tellier. Electric pocket magneto lamps. (10/1/19, France.)

January 8, 1921.

918 Campbell, Meredith & Heap. Electric cranes.
926 Raybould. Revolving nose-pieces for gas and electric fittings.
946 Wilde. Galvanic battery. (10/12/19, Austria.)
950 Highfield & Calverley. Apparatus for converting or transforming electric currents.
958 Widerstand Akt.-Ges. fur Elektro-Warme Technik. Frames for windings of heating elements, &c. (13/9/18, Germany.)
959 Behn. Electrical resistances. (4/1/16, Germany.)
963 Wright. Electrical cooking apparatus. (5/2/16, U.S.)
983 Siemens & Halske A.-G. Testing arrangements for telephone installations. (26/3/18, Germany.)
984 Siemens & Halske A.-G Mercury vapour-jet pump with arc. (3/10/19, Germany.)
985 Siemens-Schuckertwerke. Insulating material. (14/12/17, Germany.)
986 Siemens-Schuckertwerke. Insulating material. (8/1/18, Germany.)
987 Siemens-Schuckertwerke. Submarine telegraph, &c., cable. (2/2/18, Germany.)
988 Siemens-Schuckertwerke. Cables with uniform gradation of voltage drop. (6/9/19, Germany.)
989 Siemens-Schuckertwerke. Suppression of earth-leakage current of high voltage networks.
1 087 Trichard. Electric time-transmitting apparatus. (13/7/17, France.)
1 089 Sarnmark. Transmitters for signalling. (1/12/19, Sweden.)
1 103 Signal Ges. Submarine sound receiver. (10/12/14, Germany.)
1 104 Signal Ges. Increasing sound energy with submarine sound transmitters. (2/10/15, Germany.)
1 105 Signal Ges. Tuning circuits for submarine sound receiving apparatus. (31/12/17, Germany.)
1 106 Signal Ges. Transmitting speech under water. (20/12/19, Germany.)
1 107 Ges. fur Elektromechanische Telephonapparate. Switching arrangement for telephone systems. (4/6/14, Germany.)
1 112 Bendmann. Electric arrester. (9/8/19, Germany.)

Companies' Reports, &c.

Messrs. Johnson & Phillips, Ltd., are inviting applications for £350 000 8 per cent. first mortagege debenture stock at 96 per cent.

The preference share and transfer books of the Automatic Telephone Mfg. Company, Ltd., will be closed from the 18th to the 25th inst. inclusive for the preparation of the dividend warrants on the 6 per cent. preference shares, which will be posted on the 30th inst.

On Friday last Mr. Justice P. O. Lawrence, in the Chancery Division, appointed a receiver of the Manaos Tramways & Lighting Company Ltd. It was stated that the Company had issued debentures for £350 000, and that it was unable to pay the interest due on the 1st prox.

The directors of the Electric & General Investment Company, Ltd., have declared a dividend at the rate of 6 per cent. per annum, less tax (3s. per share), on the preference shares for the half-year ending the 30th inst. and payable on July 1.

The directors of the Madras Electric Supply Corporation, Ltd., have declared a dividend of 8 per cent. (tax free) on the ordinary shares for the past year. A sum of £15 000 is placed to general reserve, £1 000 to employees' gratuity fund and £9 620 carried forward.

For the year ended March 31 last the profit of Waygood-Otis, Ltd., was £83 069 after providing for all expenses and depreciation. With £14 446 brought forward, the total is £97 614. The directors have placed to reserve £30 000, to pensions fund £5 000 and they recommend a dividend of 9 per cent. on the ordinary shares, leaving £27 979 to carry forward.

The Rees Roturbo Manufacturing Company, Ltd., has declared a dividend of 8¾ per cent. (less tax) on the preference shares for the year 1915 and for the nine months ended Sept. 30, 1916, a sum of £5 000 is placed to depreciation reserve, £4 600 to general reserve, £5 000 to a taxation reserve, £4 523 for maintenance of buildings, plant, &c., and £117 to bad debts account, leaving £6 727 to carry forward.

The Eastern Telegraph Company, Ltd., announce the payment on 15th July next of a dividend at the rate of 3½ per cent. per annum (less tax) on the preference stock for the quarter ending the 30th inst., and a first quarterly interim dividend of 2½ per cent. on the ordinary stock (tax free) in respect of profits for the year ending 31st December, 1921. The Transfer books of the ordinary stock will be closed from the 2nd to 9th July inclusive.

The net profit of the James Keith & Blackman Company for the year ended March 31, after meeting debenture interest, excess profits duty, corporation profits tax, &c., was £49 670; with £13 220 brought in the total was £62 890. The directors recommend dividend for whole year on the ordinary shares at rate of 15 per cent. (tax free), to transfer to reserve £13 000 and to carry forward £18 272.

At the meeting of the Anglo-Argentine Tramways Company, Ltd., last week the chairman (Sir Geo. A. Touche, Bart.) dealt at some length with the position and prospects of the company. The traffic receipts rose from £3 127 784 in 1919 to £4 014 765 in 1920, an increase of 28·36 per cent. After including credits of every sort, the gross receipts reached the record figure of £4 413 164. The working expenses were also a record figure at £3 198 028. Their troubles during the war were almost entirely due to the difficulty in obtaining fuel and to abnormal prices which had to be paid for it. In 1919, the first year of peace, the decrease in the cost of current was £24 934, and now they had a further decrease of £107 840. The average cost of fuel used by the Supply Company during 1920 was 118s. per ton. Since the end of the year a new contract had been entered into by the company for one year's supply of American coal at $11·65 American gold, or a little over 60s. per ton c.i.f. Buenos Aires.

After giving a full analysis of the accounts, and explaining the position as to the supply contract, &c., the report and accounts were adopted.

The report of the directors of the Globe Telegraph & Trust Company, Ltd., for May 31, 1921, states that the net revenue after deduction of expenses amounts to £287 772, and makes with £1 379 brought forward, together with an amount of £10 000 transferred from reserve for contingencies account, a total of £299 181. From this amount the sum of £219 132 has been distributed in interim dividends, leaving an available balance of £80 049. The directors now recommend payment of the following final dividends, viz.: 3s. per share (less tax) on the preference shares, making, with previous distributions, a total dividend for the year at the rate of 6 per cent. per annum (less tax); and 5s. per share net, on the ordinary shares, making with previous distributions a total dividend on these shares at the rate of 10 per cent. net for the year. These dividends will absorb £77 868, leaving £2 181 to be carried forward. During the year under review 61 certificates of the Submarine Cables' Trust, belonging to the company, have been drawn and paid off at £120 per certificate. The proceeds are in course of reinvestment. The directors regret to report the death of their late colleague, Sir James Pender, Bart., which took place on the 20th ult., and Mr. J. C. Denison-Pender, M.P., has been appointed to fill the vacancy.

The directors of the British Electric Traction Company, Ltd., report that the gross profit for the year ended March 31 was £264 772, less general expenses £44 575, leaving net profit £220 197, plus brought forward £150 421, making a total of £370 619, of which debenture stock interest absorbs £85 136, leaving £285 483. The directors recommend placing to reserve £12 349, and a dividend of 4 per cent. for the year on the ordinary stock, carrying forward £177 318. No provision has been made for corporation tax (if any), as it is proposed to deal with it in the year in which it is paid. Aggregate receipts of associated companies for 1920 showed an increase, but expenses increased in a greater ratio, due in a large measure to fact that in majority of cases associated companies were not authorised to increase fares and charges until the latter part of year. The reserve at March 31, 1920, was £500 000, from which has been deducted £19 954, mainly in respect of loss on realisation of War stock. There has been added £7 605 in respect of discount on £11 286 5 per cent. pepetural debenture stock and £8 067 4½ per cent. second debenture stock purchased during year. The investments stand at £3 861 816.

The directors' report of Callender's Cable & Construction Company, Ltd., for 1920 states that the profit amounted to £182 920, less interest on debenture stock (£13 500). The dividends on the 6½ per cent. preference shares for the half-year, the appropriation for depreciation of buildings, plant and machinery (£30 000) and on office furniture (£500), leaving £97 920 plus £105 803 brought in, making £203 723. Dividend on the ordinary shares at rate of 15 per cent. per annum (less tax), making 3s. per share, is recommended, placing to reserve for corporation tax £7 500, and wiriting off balance of new issue expenses (£13 122), leaving to carry forward £108 100. In June last new capital was raised to meet expansion of business and also outlay on new buildings and plant at Erith. This new capital was available only in latter part of year, and consequently full benefit therefrom was not experienced during the year. The £5 shares (both preference and ordinary) were in May, 1920, subdivided into five shares of 1 each. New workshops have now been completed, and the manufacture of supertension cables, for 30 000 V and upwards, is proceeding satisfactorily. Important orders have already been received for such cables. The reorganisation of Picardy works for manufacture of telephone cables has also been completed and large contracts have been secured.

The accounts of Richardsons, Westgarth & Company, Ltd., for the year 1920 show a profit (after providing for estimated liabilities to the Government) of £155 635. Adding net balance of profits for 1919 (£48 842) and deducting £42 000 for two years' preference dividend (paid in June, 1920), the balance is £162 478. Out of this has been paid the interest on the 4½ per cent. perpetual debenture stock and the preference dividend for 1920, and the directors propose to pay the directors' fees (£1 700), to place £45 000 to depreciation for the year, and write £25 000 off portion of capital expenditure in 1920, leaving a balance of £54 028. The directors propose to pay out of this balance two years' dividends on the preference shares, in addition to the year's dividend paid in December last. The preference dividend will then have been paid up to April 30, 1919. In consequence of the inability to obtain coal, the works are practically closed down. Many engine contracts remain to be completed, but it will be difficult to get further orders until the cost of production has been considerably reduced.

In moving the adoption of the report and accounts at the meeting of the Electric Construction Company, Ltd., on the 8th inst., the chairman (Mr. Philip E. Beachcroft) stated that the accounts surpassed those of any previous period. The net profit was £83 110, compared with £66 169, an increase of £16 941. The available total was £107 743, or, allowing for the interim dividends paid, £96 546. The directors recommended a final dividend at rate of 7 per cent. on the preference shares, and at rate of 9 per cent. on the ordinary shares, with a bonus of 2½ per cent., and the transfer to general reserve of £19 851, leaving £53 497 to be carried forward. Had times been normal, the bonus would have been increased without hesitation, but having regard to the prevailing financial and industrial conditions, the directors had come to the conclusion that the best interests of the shareholders would be conserved by making no increase in the distribution. In regard to the outlook for the new financial year, the statement in the report that recently orders had been difficult to obtain would not have caused surprise. Industrial conditions throughout the country, in consequence of the coal dispute, were deplorable. He ventured to think that, had the coal owners and miners been left to themselves to settle their own differences, without the intervention of the Government, the matter would have been settled sooner, and he did not think the dispute was altogether to be laid at the door of the miners. As it was, over 3 000 000, of whom over 1 000 000 were miners, were now unemployed. Their ranks were being increased daily, and unless a speedy peace was attained there was grave risk that many industries in the country, as well as the mines themselves, would to a great extent be irremediably destroyed.

Coal had been regarded as the life blood of industry, but the present stoppage of supply had to some extent found its remedy in the use of alternative heating energy. The mine leaders should take cognisance of that fact, and the miners themselves should realise that it was more than possible that their source of employment was endangered by the use of oil and other fuel for many, if not all, industrial purposes. Even if the coal dispute were settled, there could be no immediate recovery, because manufacturers of pig iron, steel and other staple articles of consumption would be reluctant to resume operations until they were satisfied that they could produce at prices which would compete with foreign manufacturers.

Before the country could recapture its export business, or meet foreign competition in the home markets, lower costs of production were essential, and those could only be brought about by a lower standard of wages and salaries and a lower margin of profit and by increased output. We must also have a complete cessation of the prodigal spending of public money by bureaucratic departments that had come into existence during the war. In the electrical industry the number of inquiries for plant and apparatus indicated that there was a large amount of work waiting to be done, but buyers would not place their orders in the expectation that prices would fall. The result was that new business for the moment was very unsatisfactory, but many factories were employed on orders which were placed several months ago.

New Companies.

The following list is compiled from information supplied by Messrs. Jordan & Sons, Ltd., company registration agents, Chancery-lane, London, W.C.2 :—

BEDESCO, LTD. (174 989.)—Reg. June 1, capital £2 000 in 500 preference and 1 500 ordinary £1 shares, to carry on the business of electrical engineers and contractors. Directors, Brig.-Gen. Sheckleton, C.B., C.M.G., R. R. Bishop and W. C. Devereux. Reg. office, 35, Bucklersbury, E.C. 4. Private company.

BRITISH CAST IRON RESEARCH ASSOCIATION. (174 990.)—Reg. June 1, to conduct scientific and experimental work in connection with the cast iron trade. Every member to contribute a sum not exceeding £5 if necessary. Directors, Lord Weir of Eastwood, Sir George Goodwin, Sir James McKecknie, K.B.E., and D. Vickers. Reg. office, Central House, New-street, Birmingham. Company limited by guarantee.

COOKE & GLOVER (ENGINEERS), LTD. (174 974.)—Reg. May 31, capital £5 000 in £1 shares, to carry on business of electrical, horticul-' tural and mechanical engineers. Directors, F. R. Glover and F. A. Glover. Reg. office, 98, St. Peter's-street, Radford, Nottingham. Private company.

GRAISELEY ENGINEERING COMPANY, LTD. (174 994.)—Reg. June 1, capital £10 000 in £1 shares, to carry on business of manufacturers and dealers in machines and tools. Directors, W. Riches, J. E. Turton and F. Woodward. Reg. office, Sidney-street, Wolverhampton. Private company.

MODEL CONSTRUCTION CAMPANY, LTD. (175 019.)—Reg. June 2, capital £10 000 in 9 000 £1 ordinary and 20 000 1s. founders' shares, to acquire and carry on business of manufacturers of models of all kinds. Reg. office, 2 and 3, West-street, Finsbury-circus, E.C. Private company.

NEALE MAGNET CONSTRUCTION COMPANY, LTD. (175 020.)—Reg. April 2, capital £30 000 in 28 000 £1 preference and 60 000 6d. deferred ordinary shares, to acquire invention of John Neale in relation to improvements in the design and construction of electro-magnets and turn same to account. Directors, J. Neale and J. A. Manners-Smith, B.Sc., A.M.I.E.E. Reg. office, 7, Suffolk-street, Pall-mall East, S.W. 1.

NEW WELDING COMPANY, LTD. (174 940.)—Reg. May 28, capital £15 000 in 5 000 preference and 10 000 ordinary £1 shares, to carry on business of electric and acetylene welders and engineers. Directors, A. H. Phillips, C. G. Arnold, and E. C. Simper. Reg. office, 26, Rosebery-avenue, E.C. Private company.

SENNYBRIDGE ELECTRIC SUPPLY COMPANY, LTD. (174 920.)—Reg. May 27, capital £1 500 in £25 shares, to carry on at Sennybridge, Debynock, Brecon, business of proprietors of an electric light undertaking. Directors, W. J. Davies, W. H. P. Rees, Edward Davies, Evan Davies, W. M. Davies, E. Thomas, and D. Powell.

Forty Years Ago.

(The Electrician, June 18, 1881.)

The Electric Light in Paris.—" L'Electricité " says that three more lamps have lately been erected in the Boulevard Montmartre and three more in the Rue Drouot.

Prices.—The prices as quoted are : For gutta percha, per lb., genuine, 4d. to 3s. 3d. ; reboiled, 3d. to 1s. 3d. For India rubber, fine Para, 3s. 7d. ; negrohead, 2s. 4d. ; Central American, 2s. to 2s. 6d. ; Assam and Pegu, 1s. 3d. to 2s. 2d. ; other East Indian, 1s. 9d. to 2s. 4d. ; Madagascar and Mozambique, 1s. 6d. to 2s. 4d. The market is reported as dull for all kinds.

The Telephone in Leicester.—The Corporation have lately connected their police stations by means of the Gower Bell telephone, rented from the Post Office. The wire and necessary apparatus have been erected under the supervision of Mr. G. N. Partridge, of Nottingham, Inspector of Postal Telegraphs for the North Midland District. The apparatus is said to work very well.

Electric Light in Dublin.—The Mansion House of this city has been lighted up by the Brush system. Six lamps were placed in the newly-erected supper room, and ten more were placed in the garden and in Dawson-street. The lamps were fed by a Robey engine. The Swan incandescent lamp has also been on exhibition, and is said to have been successful as far as light-giving power is concerned.

A Directory of Telephone Exchange Subscribers.—We have received a very well got up and neatly printed directory to the subscribers of the Bell Telephone Exchange in Philadelphia. The names are arranged alphabetically, followed by the address of the subscriber; opposite the name is the subscriber's number. The " Directory " also contains a few brief rules of procedure in using the telephone. We think that this list is worthy the imitation of telephone exchanges in this country.

The Editorial, Advertisement and Publishing Offices of " The Electrician " *are at* 8, *Bouverie Street, London, E.C.* 4. *Telegrams : Benbrotic, Fleet, London. Telephone : City* 9852 (5 *lines*).

The subscription to " The Electrician " *is* £2 12 0 *per annum in the United Kingdom, and* £2 14 0 *per annum Abroad. Advertisement Rates can be obtained on application to the Manager. Advertisement copy and blocks should be received on the Friday preceding date of publication.*

Arrangements for the Week.

FRIDAY, June 17th (to-day).

Royal Institution.

9 *p.m.* At Albemarle-street, London, W. Discourse on " Chemical Combination and the Structure of the Molecule," by Sir J. J. Thomson, O.M., F.R.S.

WEDNESDAY, June 22nd.

Faraday Society.

8 *p.m.* At the Chemical Society, Burlington House, Piccadilly, London, W. Papers to be read : " High Temperature Phenomena of Tungsten Filaments," by Mr. C. J. Smithells ; " A Simple Apparatus for Determining the Coagulations Velocity of Gold Sols," by Mr. E. Hatschek ; " Variation of Surface Tension with Temperature," by Prof. A. W. Porter ; " The Influence of the Solvent upon Ionisation and the Accompanying Heat Effect," by Mr. S. M. Neale ; " The Potential of the Iodine Electrode and the Activity of the Iodine Ion at 25°C.," by Mr. A. McKeown, and a demonstration of " The Transmission of Sounds by means of Rochelle Salt Crystals," by Mr. E. Kilburn Scott.

FRIDAY, June 24th.

Physical Society.

5 *p.m.* At the Imperial College of Science, South Kensington, London, S.W. Papers on : " Capacity and Eddy-Current Effects in Inductometers," by Mr. S. Butterworth ; " New Specific Heat Apparatus," by Dr. E. Griffiths ; " On Encounters between Non-Spherical Gas Molecules," by Prof. A. O. Rankine, and " An Electro-Culture Problem," by Dr. C. Chree, F.R.S.

Benn Brothers Journals.

Some Features of the Current Issues.

" The Cabinet Maker " : " The Decoration of Furniture " ; " Measured Drawings of Museum Pieces " ; and " Furniture Exports in May."

" Chemical Age " : " Vitamins in Food Substances : a Comparison between the Vitamine content of Natural and Manufactured Food Substances " ; " German Exporters and the Reparation Levy " ; and " Reviews of New Chemical Works."

" Farm and Home " : " The State and Agriculture " ; " Round the Shows " ; and " The Destruction of Charlock."

" The Fruit-Grower " : " Imported Plant Diseases Govern Action " ; " Decontrol of Agriculture " ; and " History of Kew Gardens (Illustrated) ."

" The Gas World " : " Gas in London County Council Housing Schemes " " Coal Stocks at Gasworks in Strike Periods " ; and " Meeting of French Society of Gas Engineers at Tours."

" Hardware Trade Journal " : " Tools for the Garden " ; " Holding Work in the Bench Vice " ; and " Trade, Travellers and Truth."

Prices of Metals, Chemicals, &c.

Tuesday, June 14.

		Price.	Inc.	Dec.
Copper—				
Best selected............	per ton	£74 0 0	—	—
Electro Wirebars ...	,,	£79 0 0	£1 0 0	—
H.C. wire, basis	per lb.	1s. 0d.	⅛d.	—
Sheet	,,	1s. 0½d.	—	—
Phosphor Bronze Wire (*Telephone*)—				
Phosphor-bronze wire, basis	,,	1s. 4d.	⅛d.	—
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1¼d.	—	—
Wire, basis	,,	1s. 1¼d.	—	—
Pig Iron—				
Cleveland Warrants .	per ton	£6 10 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£27 0 0	—	—
Lead Pig—				
English	,,	£23 15 0	5s. 0d.	—
Foreign or Colonial ...	,,	£22 10 0	5s. 0d.	—
Tin—				
Ingot	,,	£167 5 0	—	£1 5 0
Wire, basis	per lb.	2s. 3¾d.	—	¼d.

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £15.

,, (Roll-Brimstone).—Per ton £14 10s.

Sulphuric Acid (Pyrites, 168)°.—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £30.

Boric Acid (Crystals).—Per ton £69.

Sodium Bichromate.—Per lb. 7½d.

Sodium Chlorate.—Per lb. 4¼d.

Rubber.—Para fine, 11d.; plantation 1st latex, 8½d. lb.

The metal prices are supplied by British Insulated & Helsby Cables, Ltd., and the rubber prices by W. T. Henley's Telegraph Works Co.

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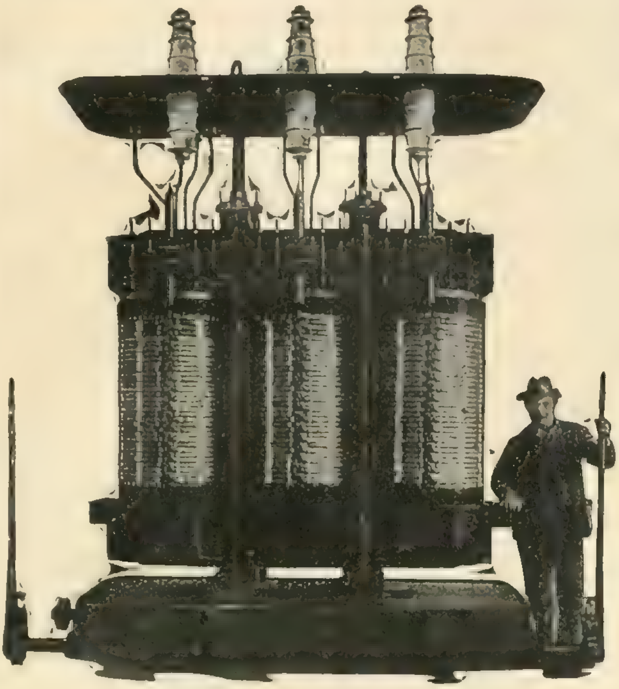

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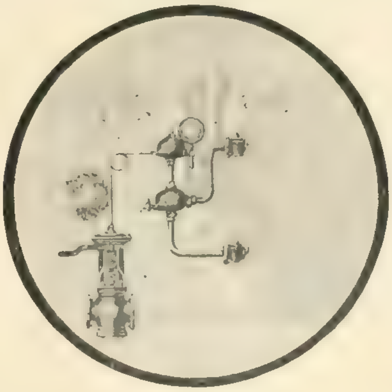

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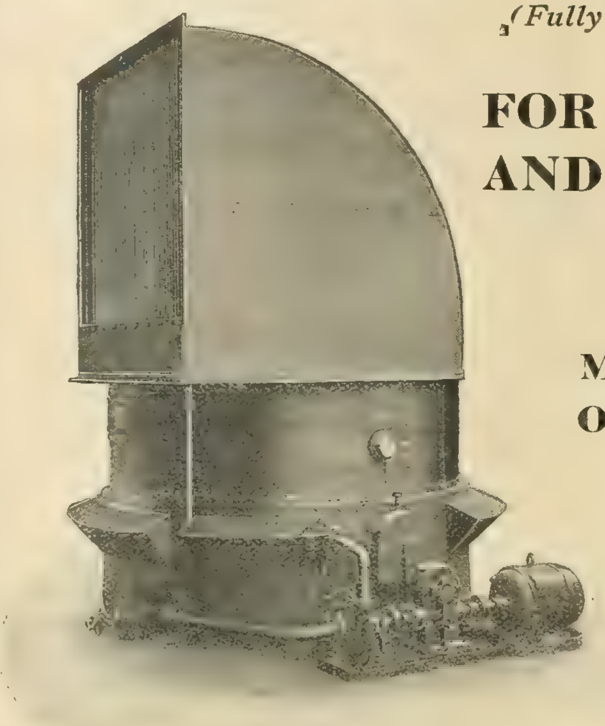

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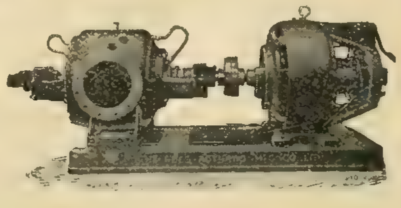

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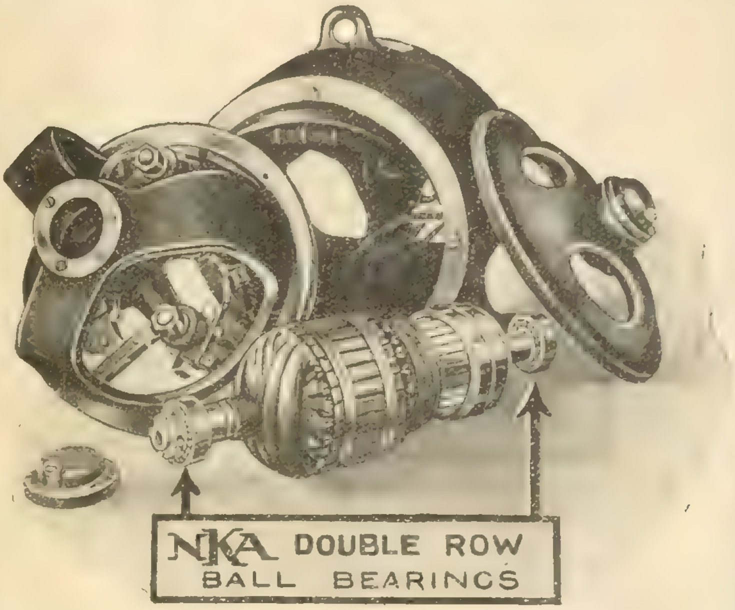

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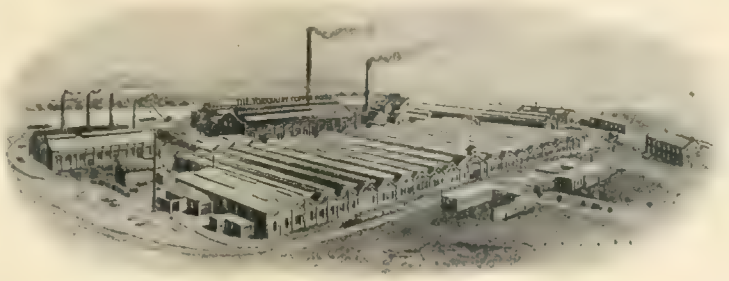

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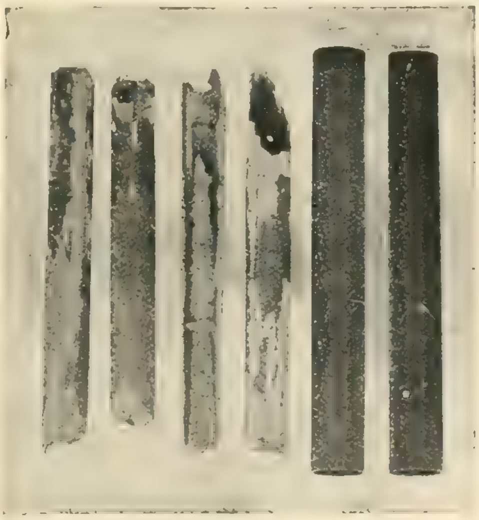

Admiralty Mixture. "Bemal."

2. **54 Weeks' Test.** The other three photographs show the result of a further test made, when tubes of brass (70/30) and Admiralty Mixture (70/29/1) were obtained from various outside sources of good repute to test alongside the "BEMAL." These tests, which extended over a period of 54 weeks, entirely confirmed the previous results.

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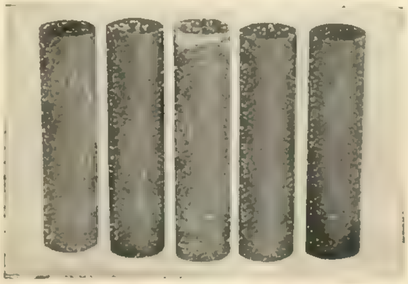
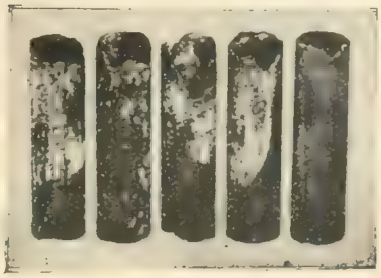


"Bemal."



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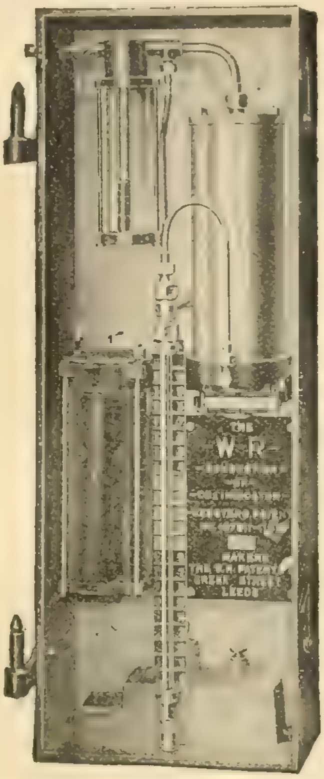

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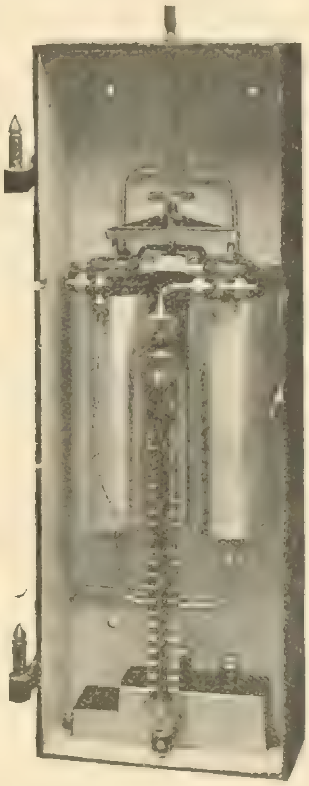

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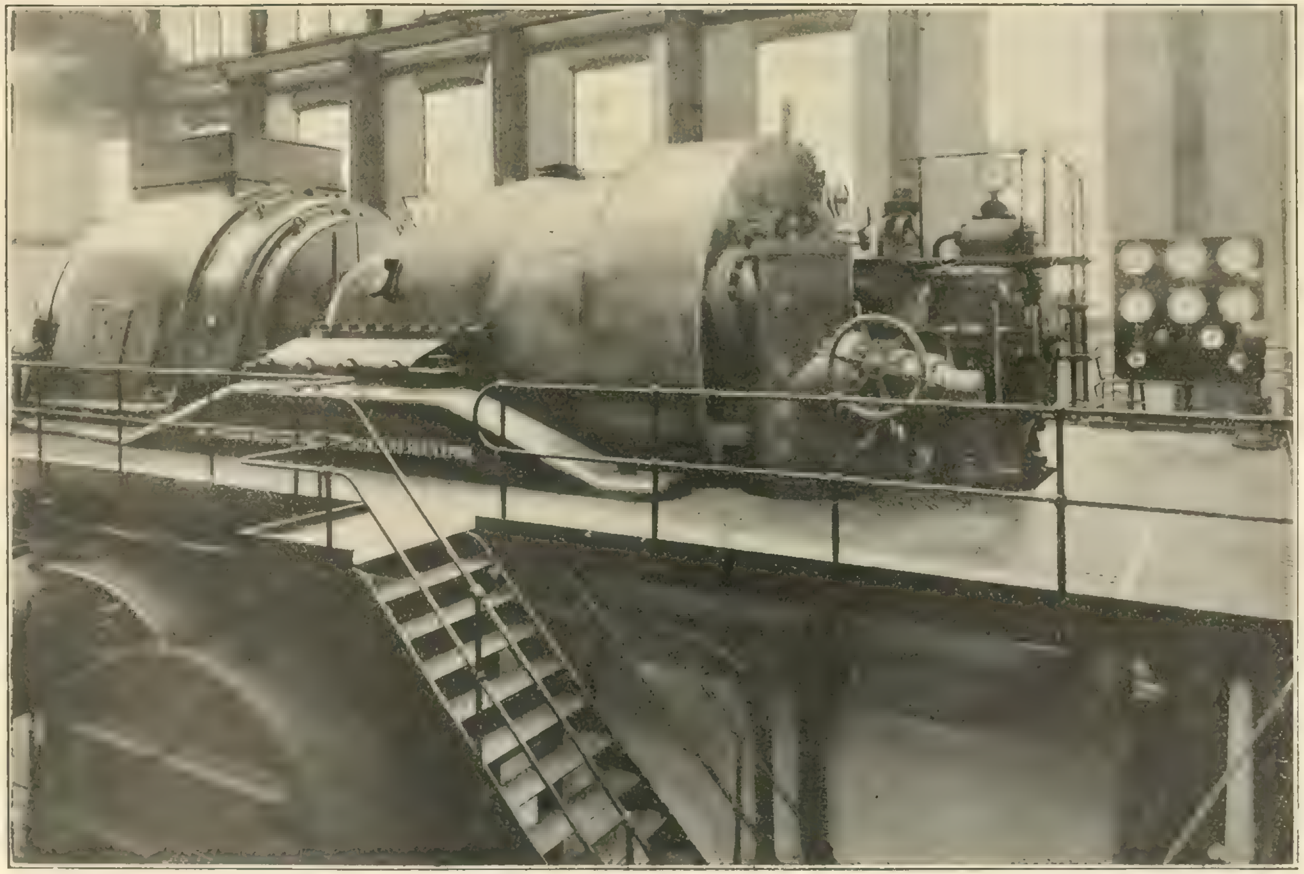

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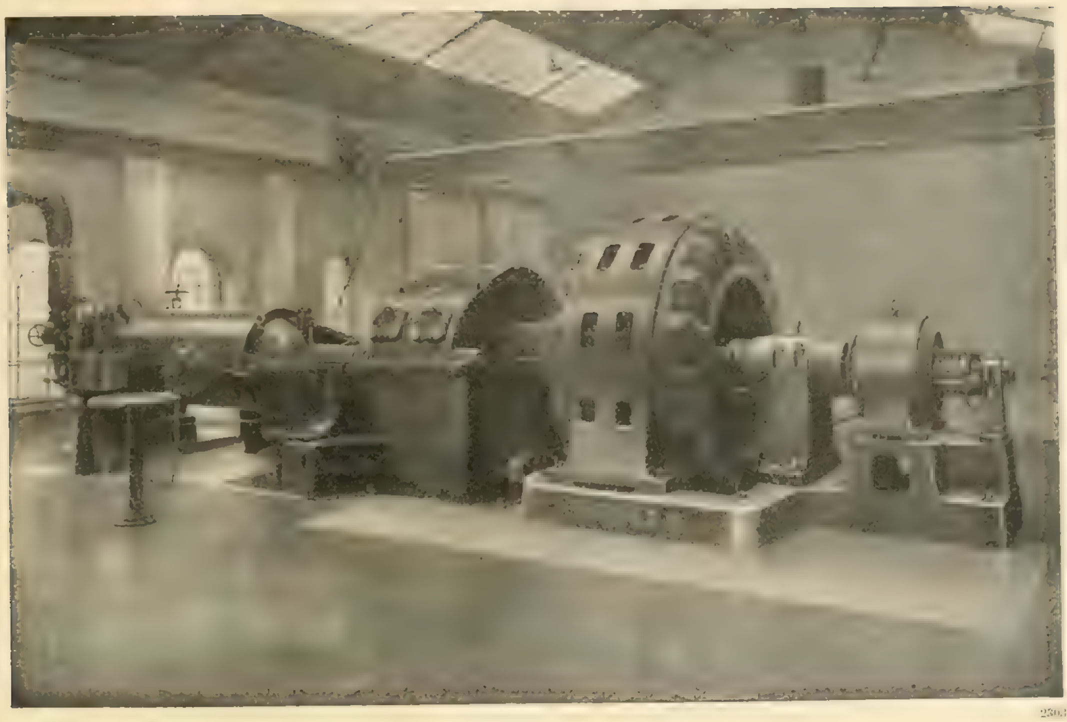

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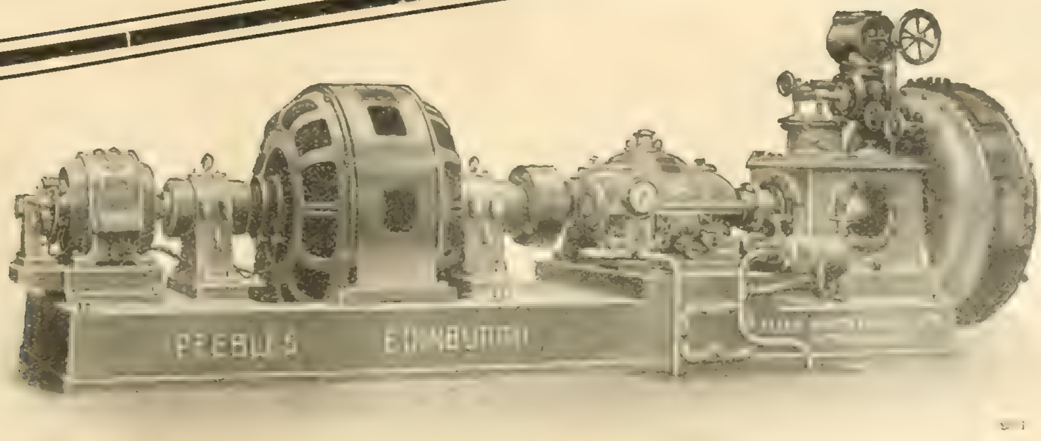

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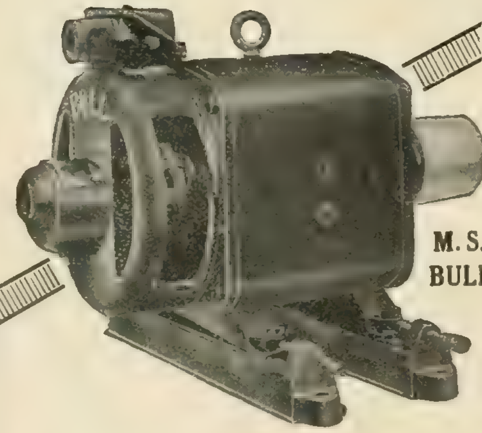

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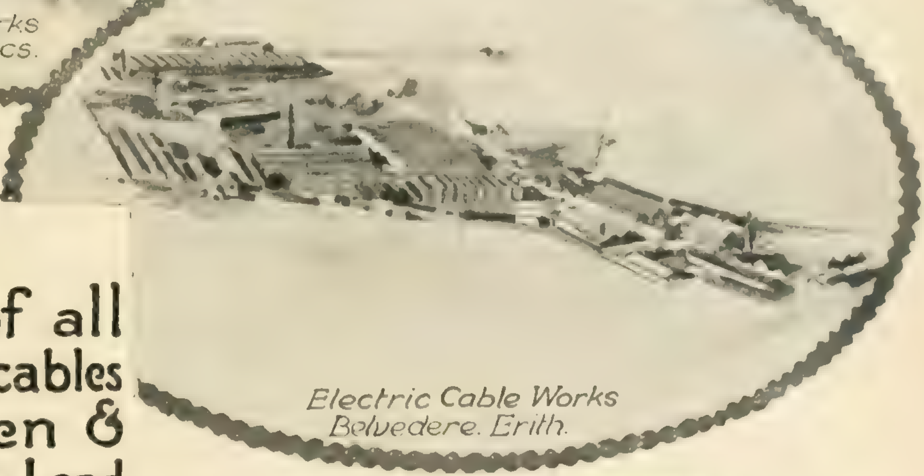

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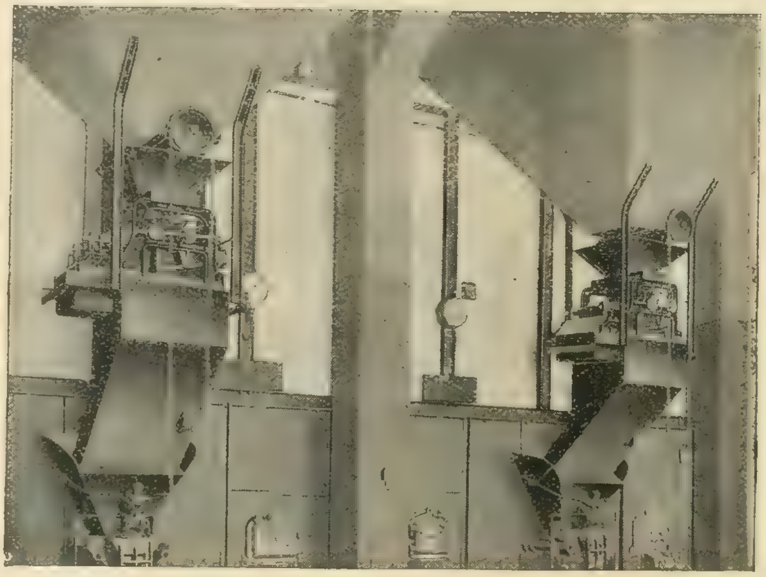

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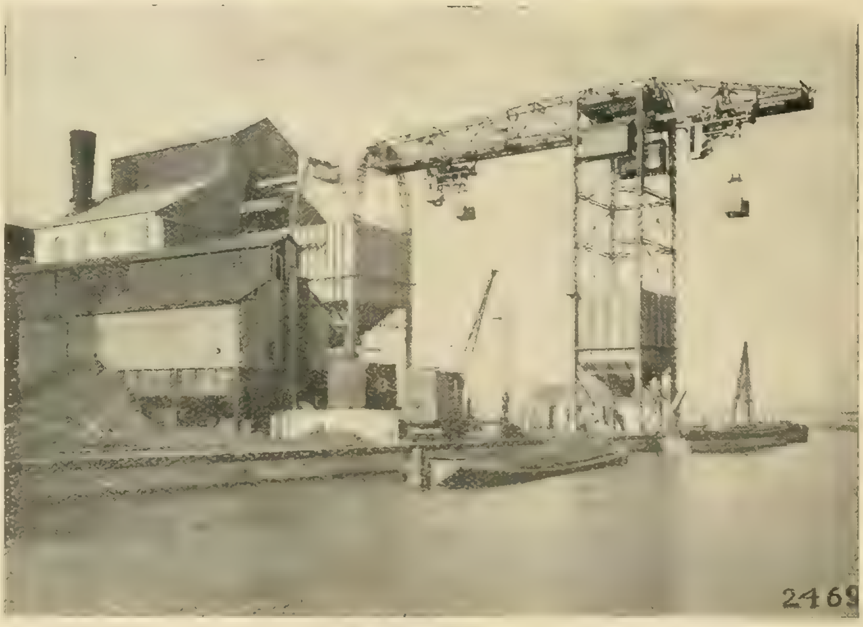

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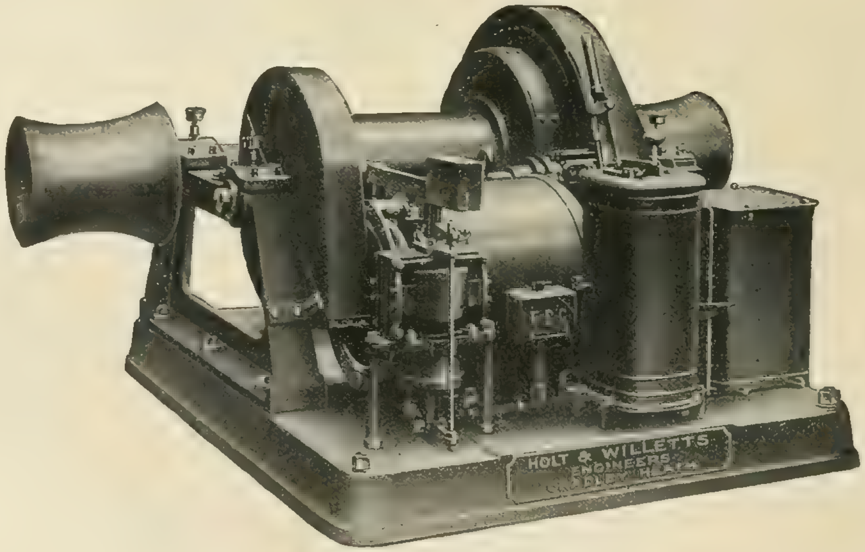

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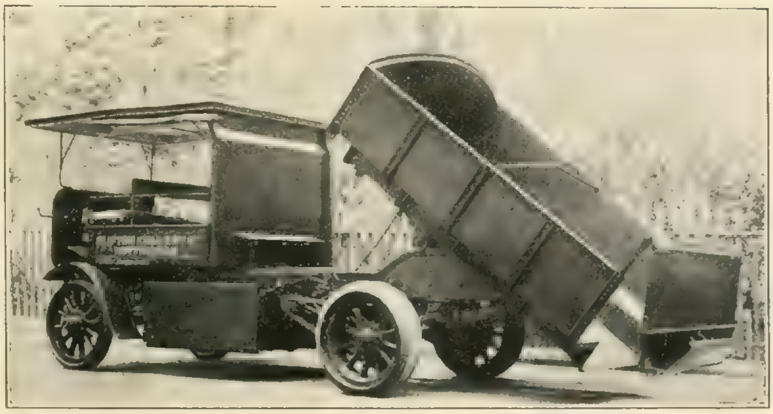

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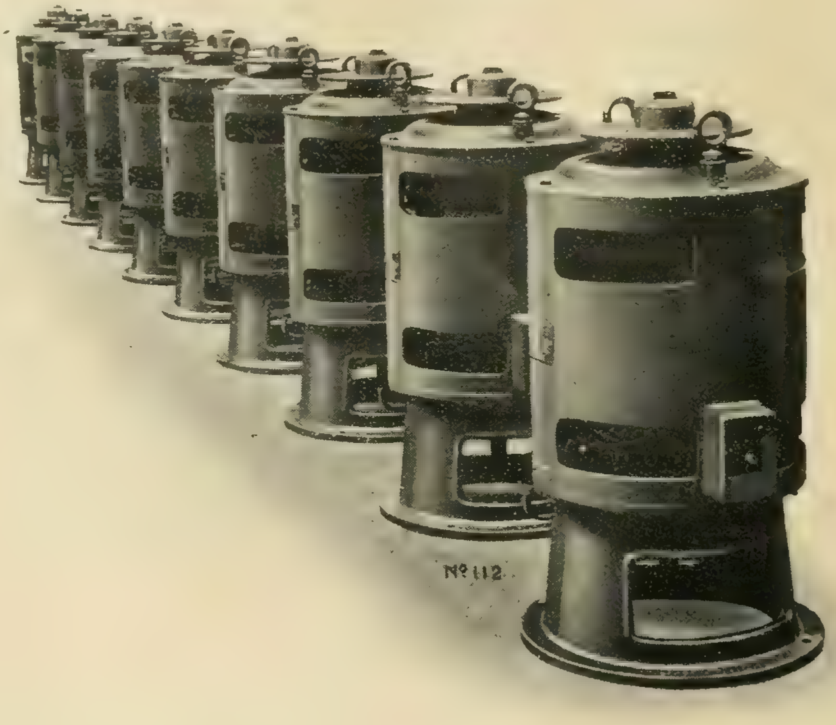

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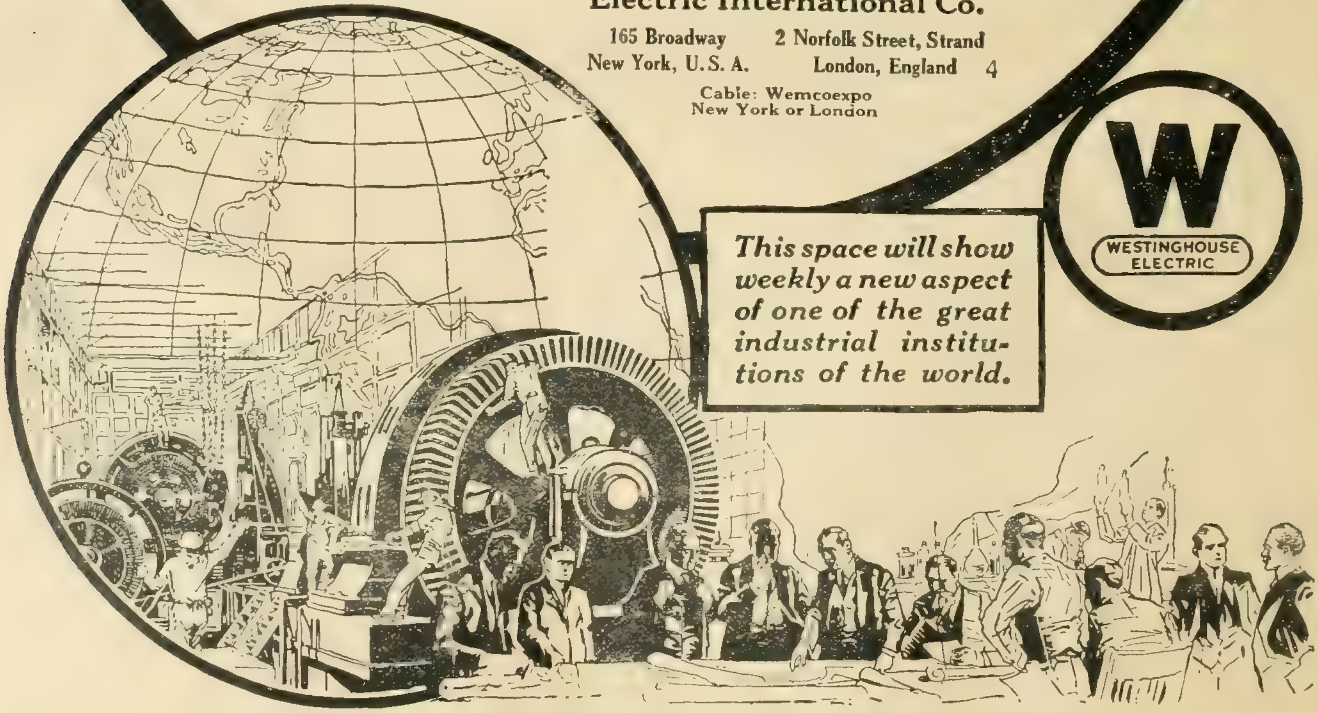

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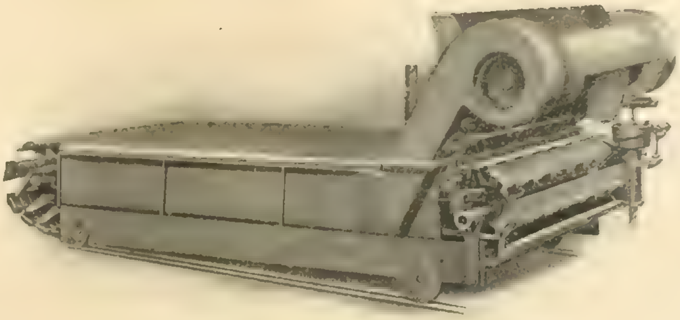
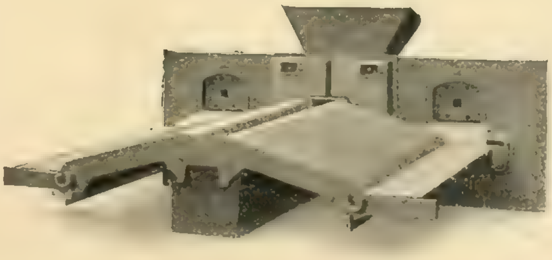
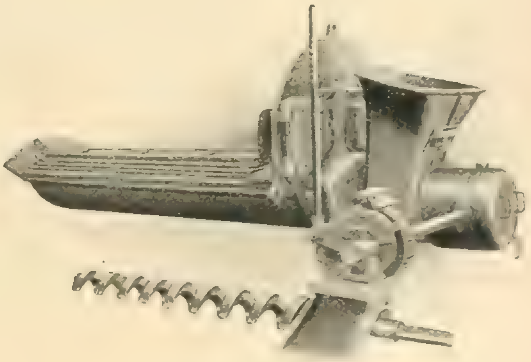


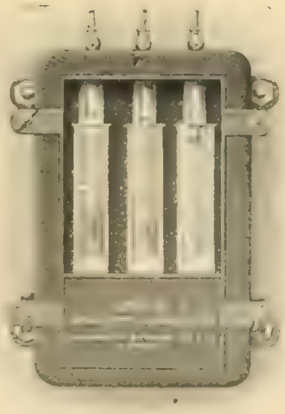
Self-Contained Forced Draught Travelling Grate Stoker.



Rear View of Class E Stoker for Water Tube Boilers.



Gear Driven Stoker for Internally Fired Boilers.



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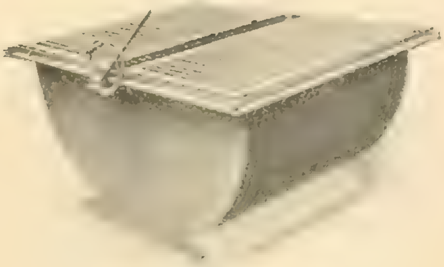

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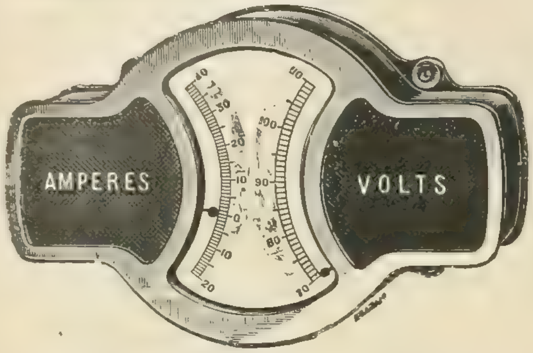

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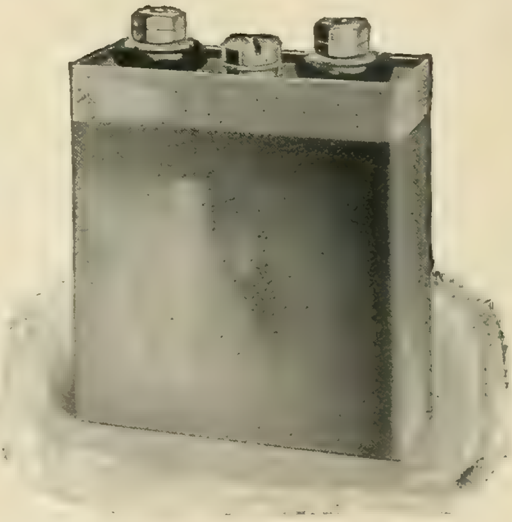

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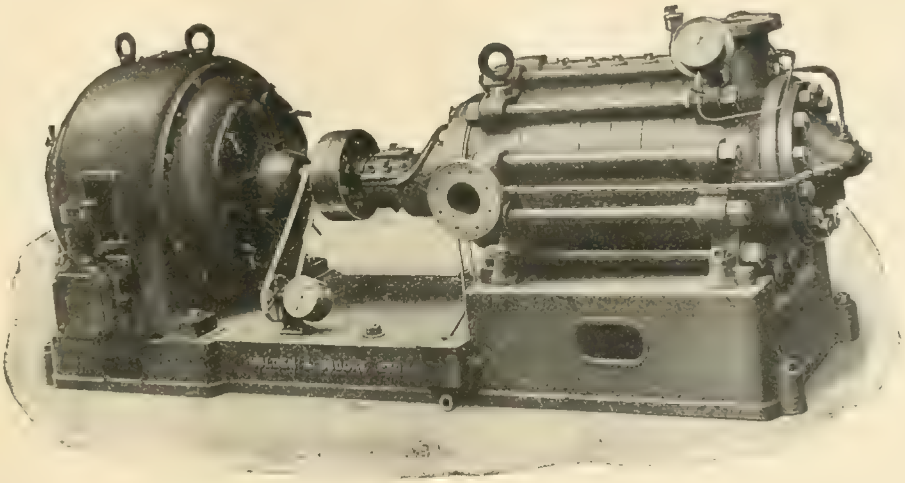

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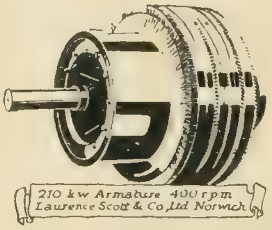
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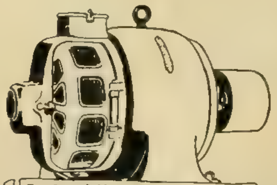
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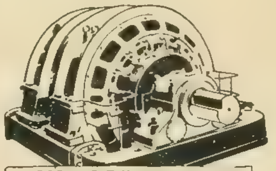
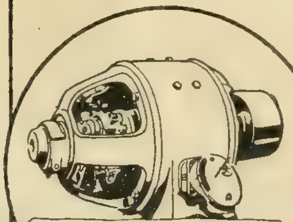
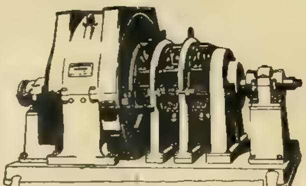

12,000 H P Rolling Mill Motor
Siemans Bros, Dynamo Works, Ltd Stafford


Protected type B T H Continuous Current Motor Type DR
British Thomson Houston Co, Ltd Rugby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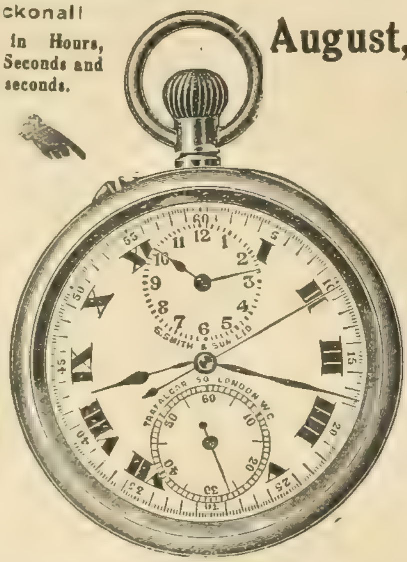

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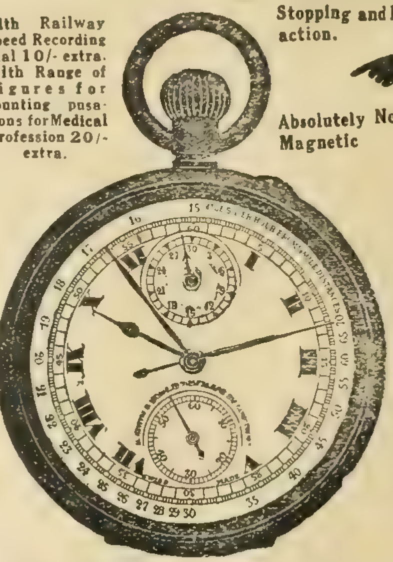

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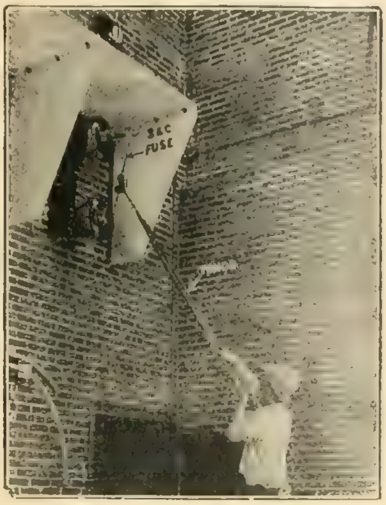

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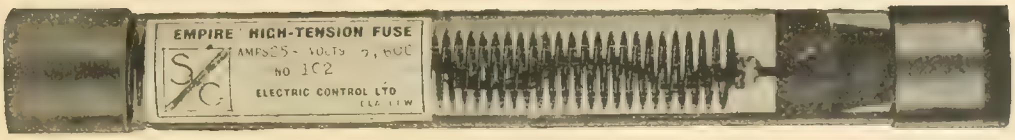

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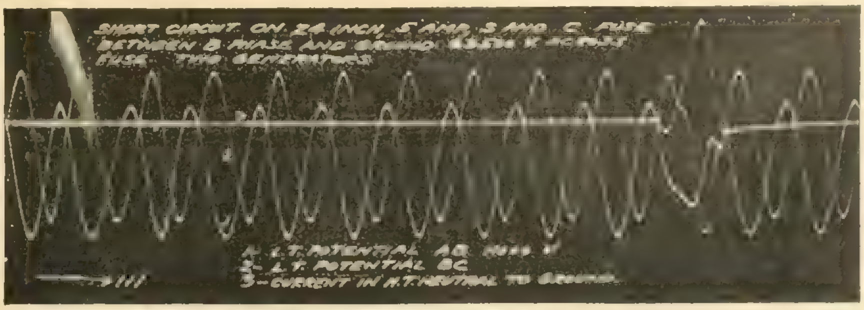

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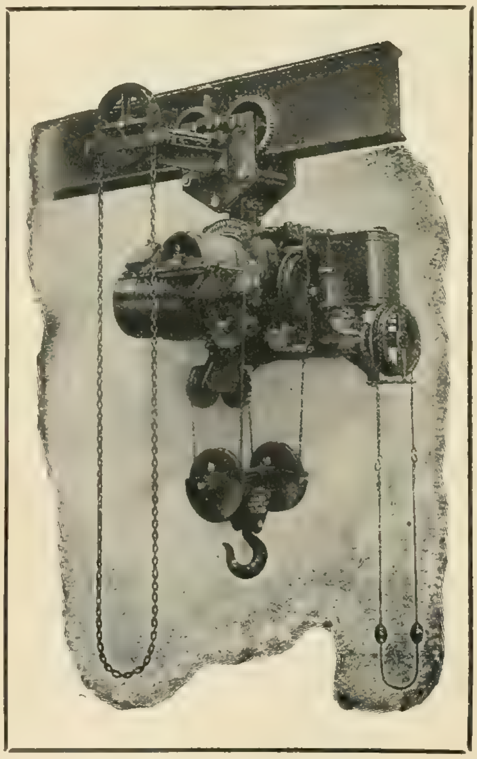

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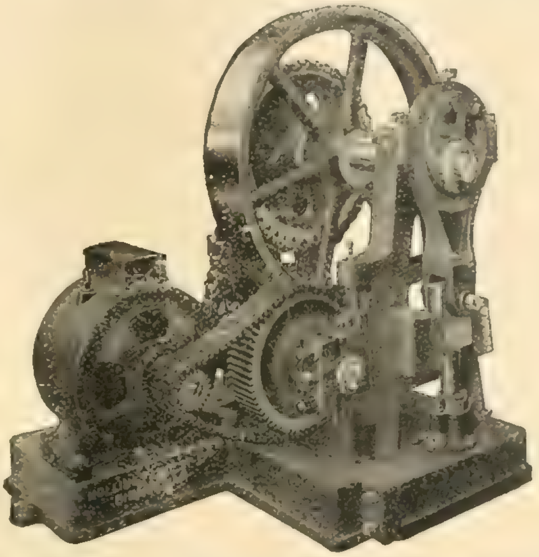

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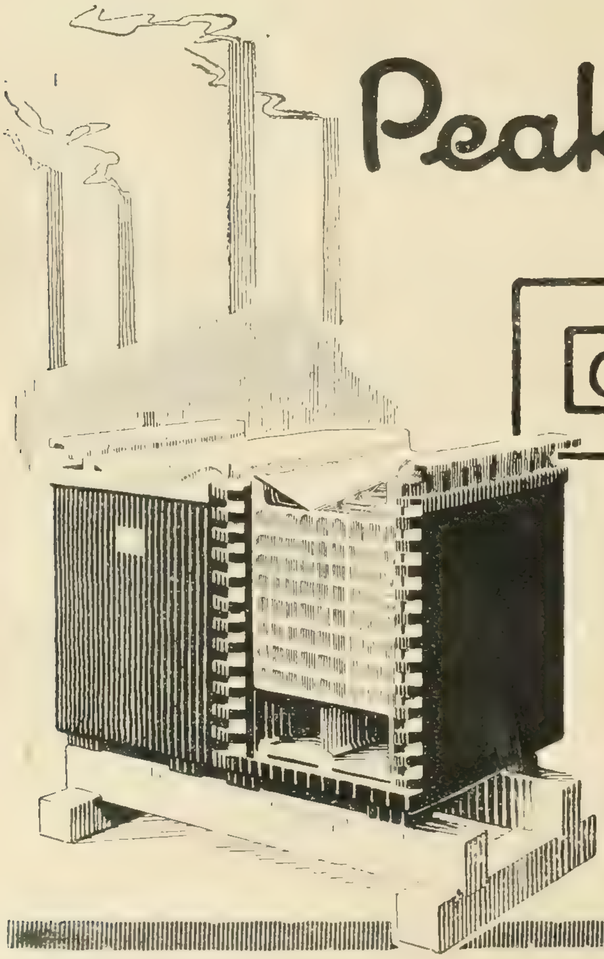

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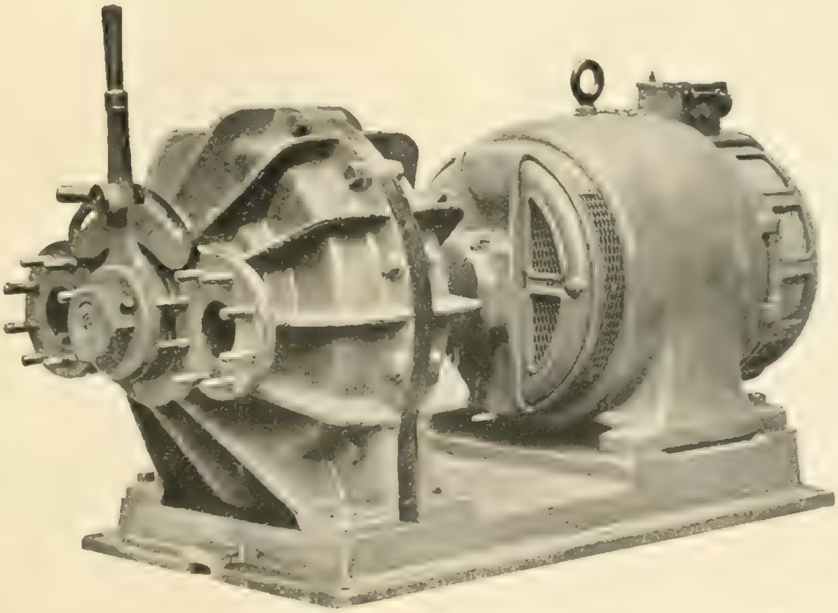

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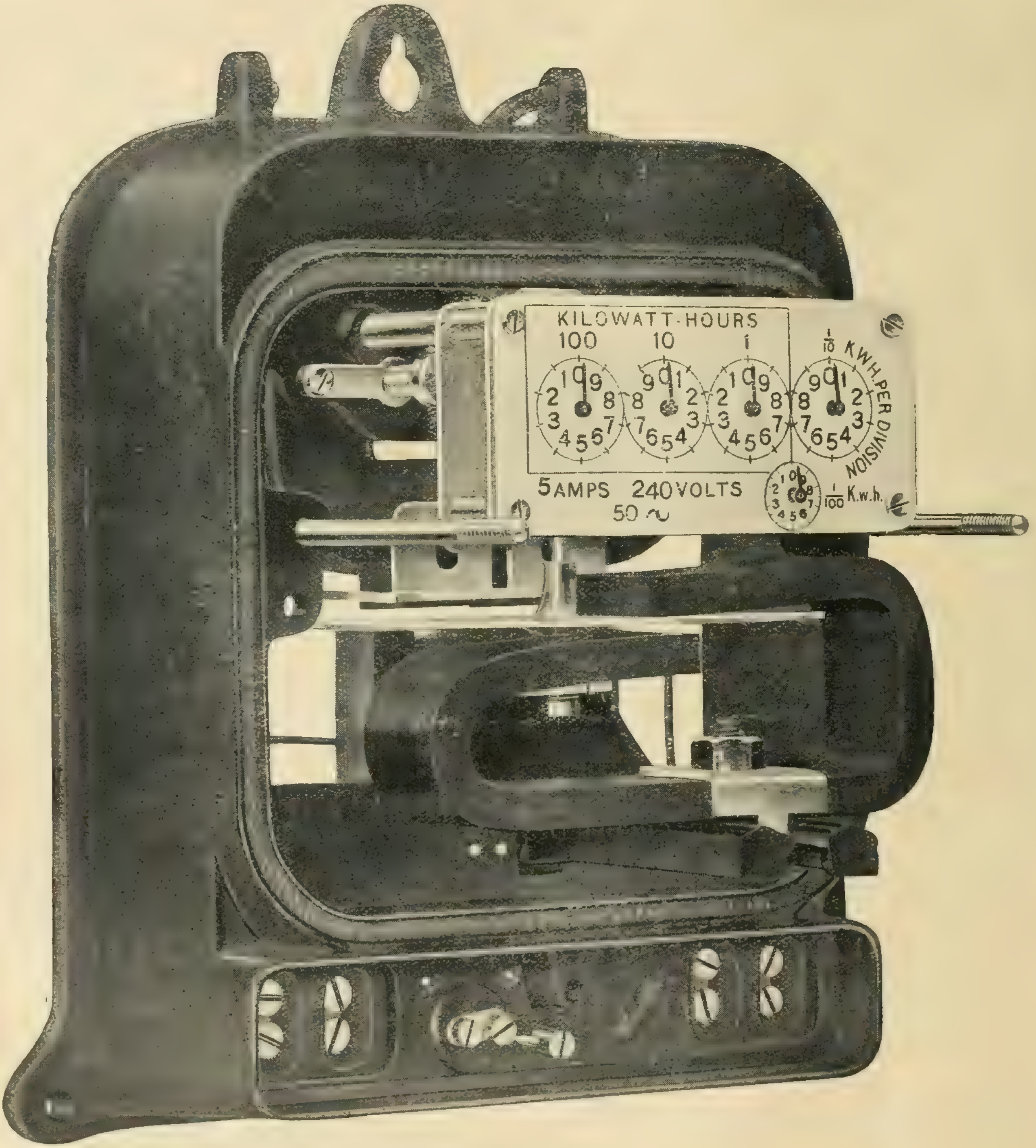

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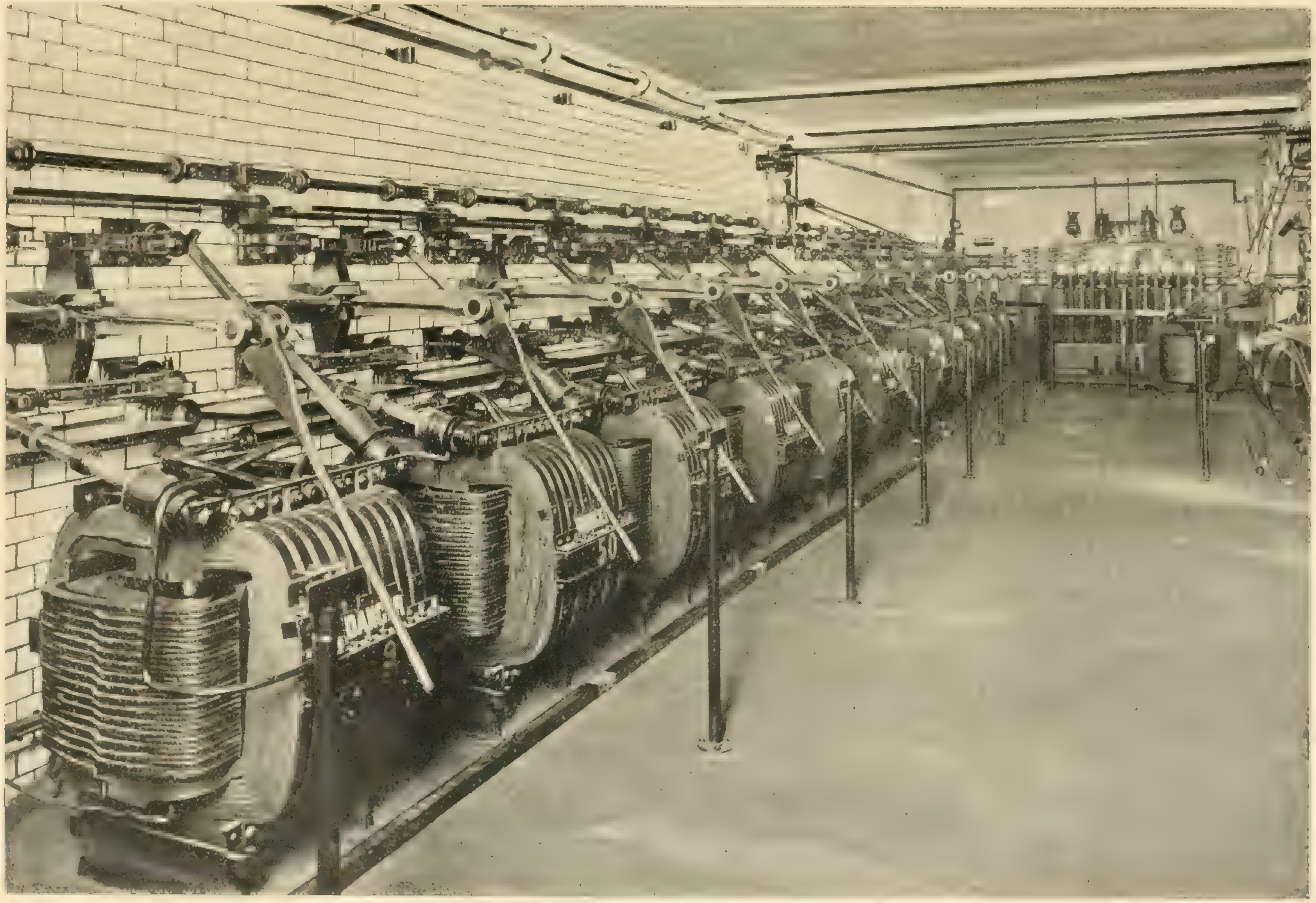

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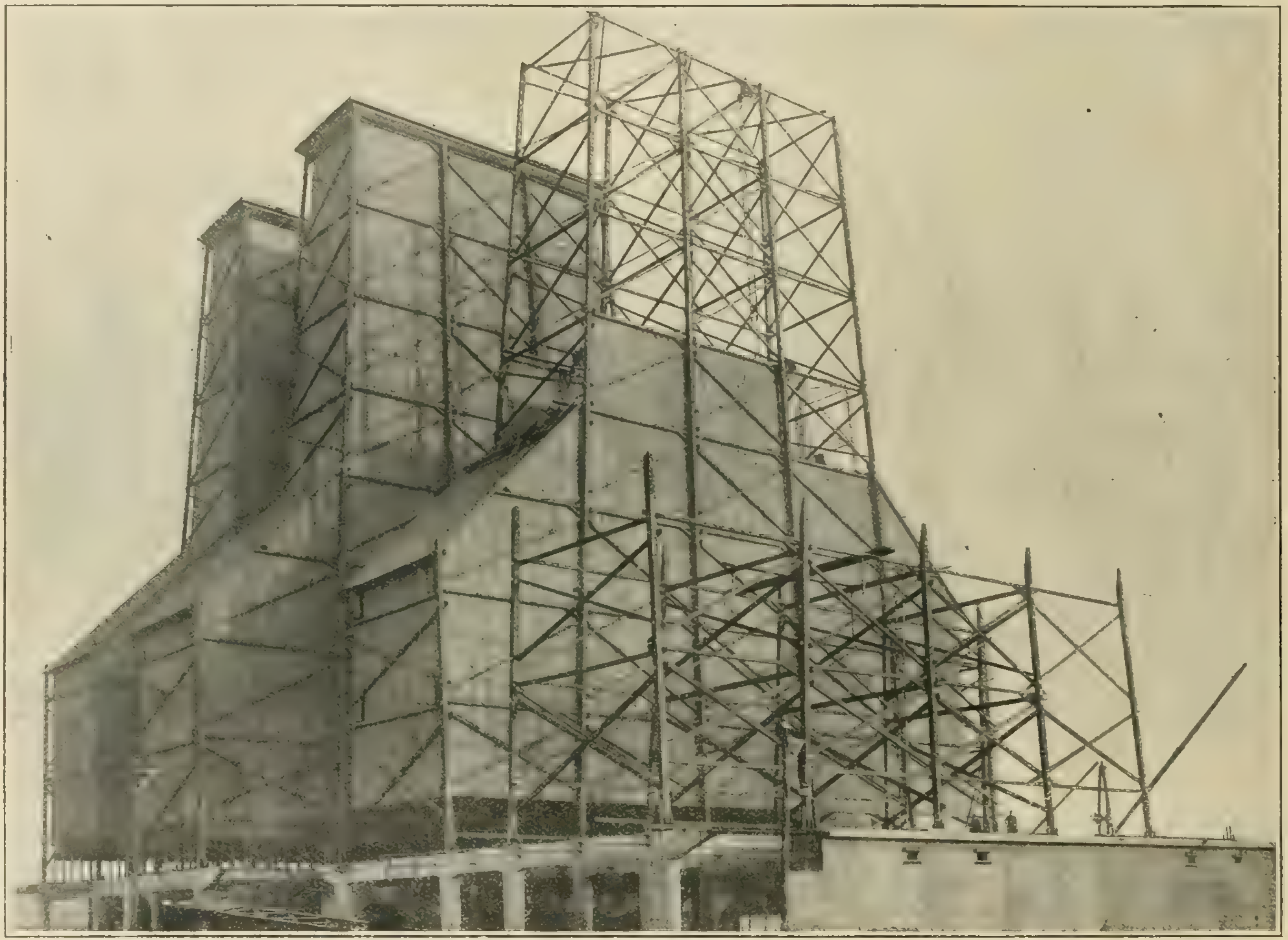

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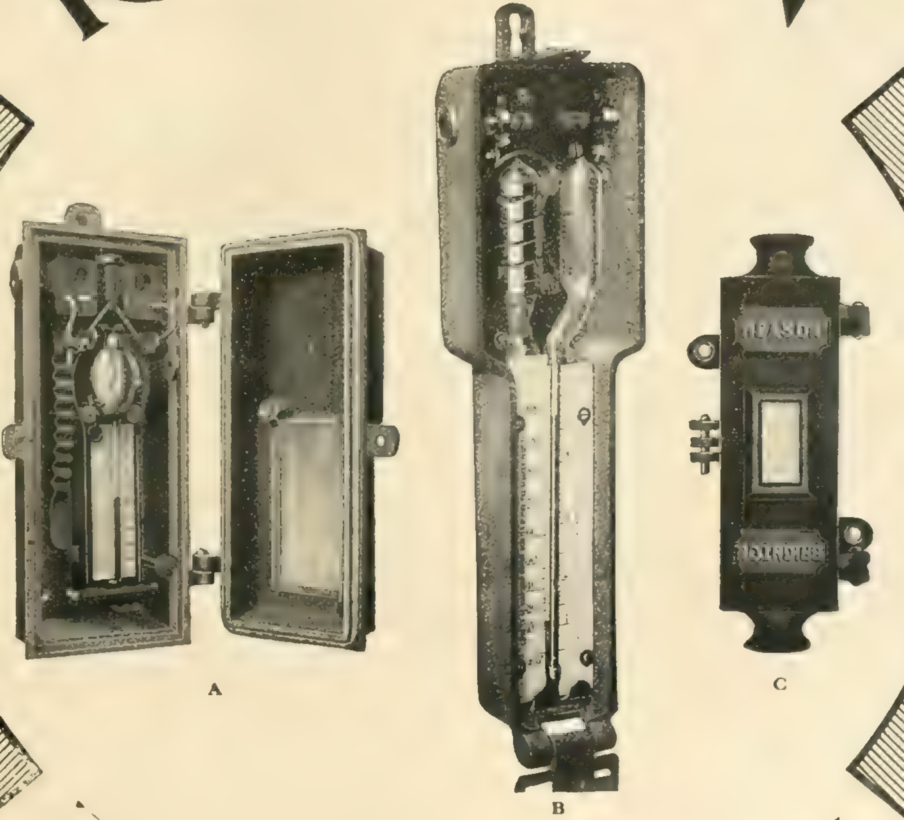

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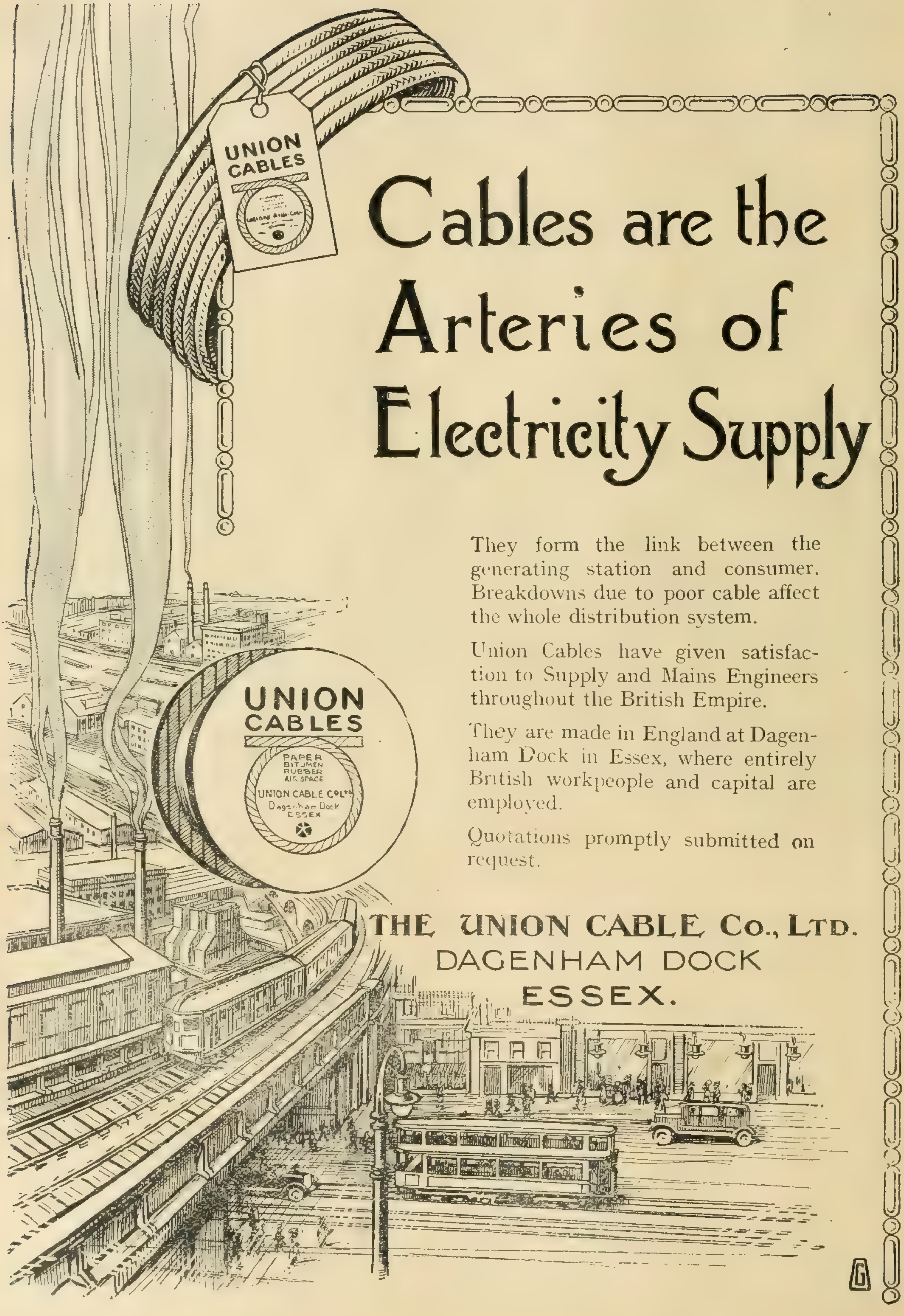

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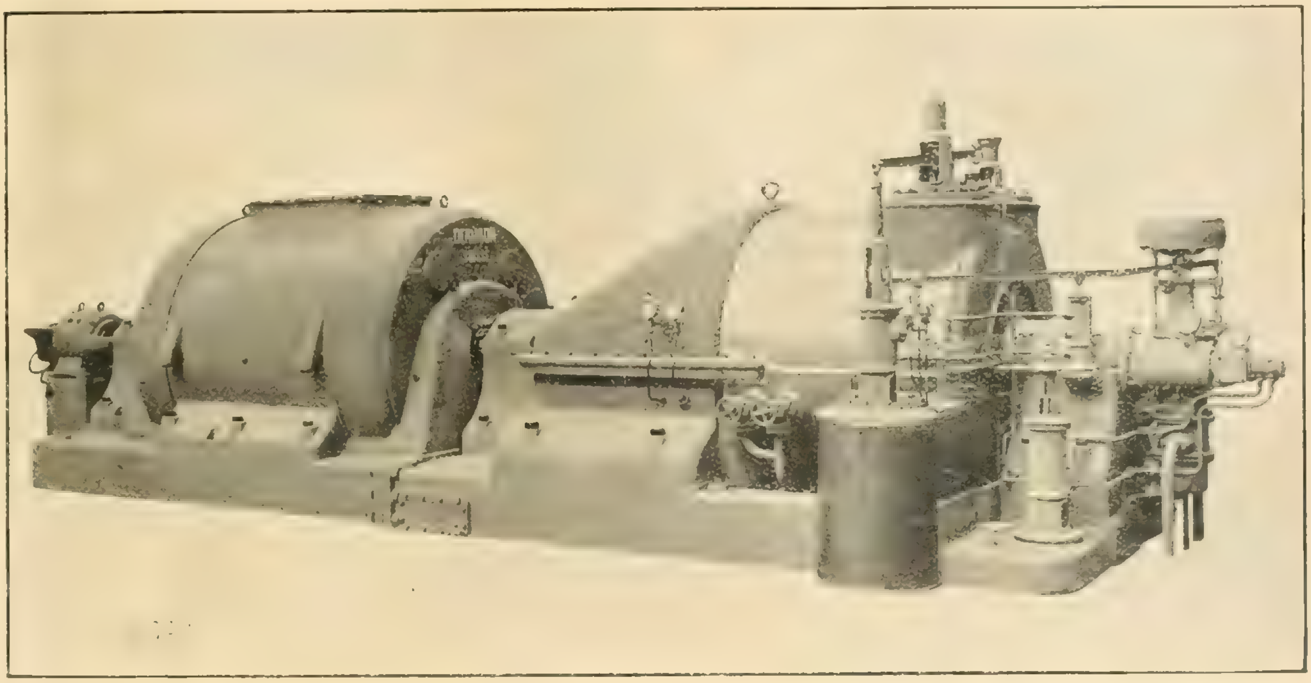

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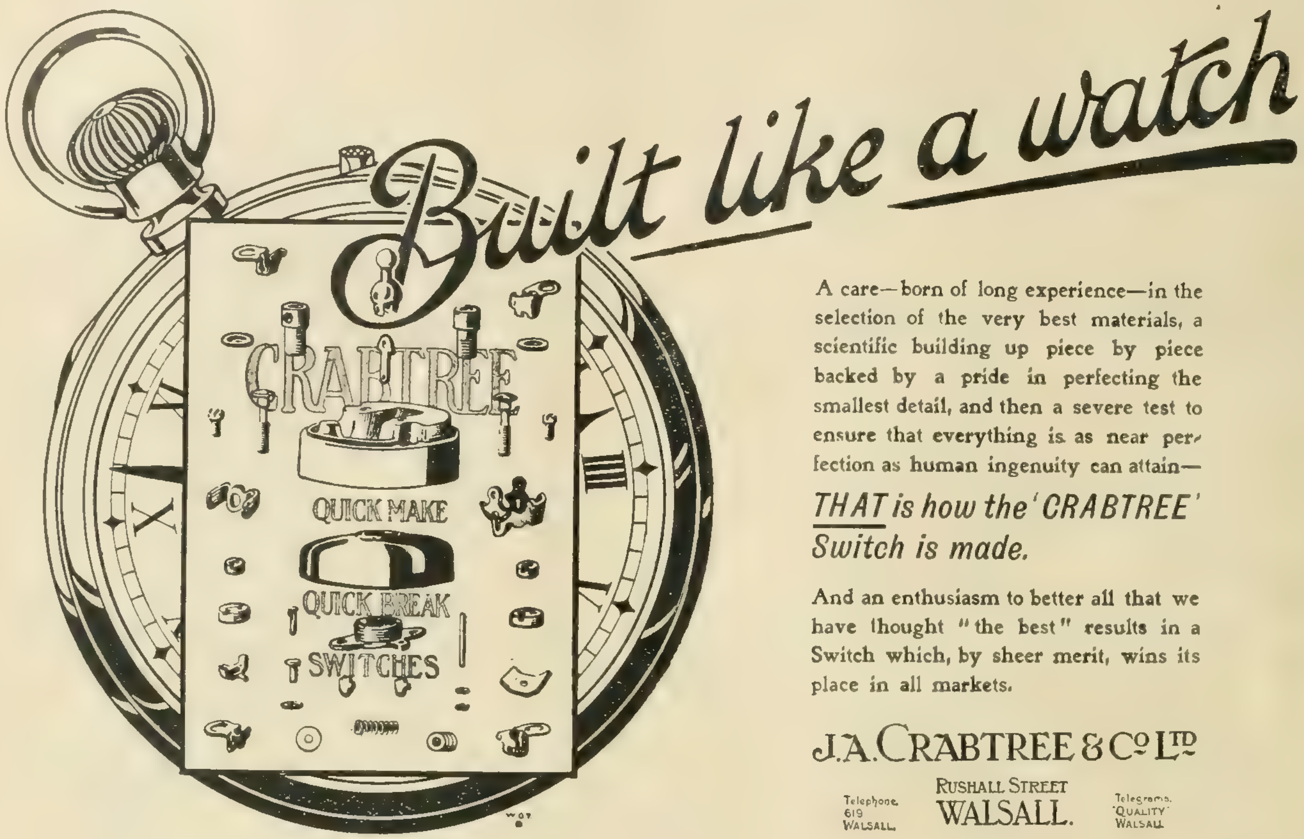

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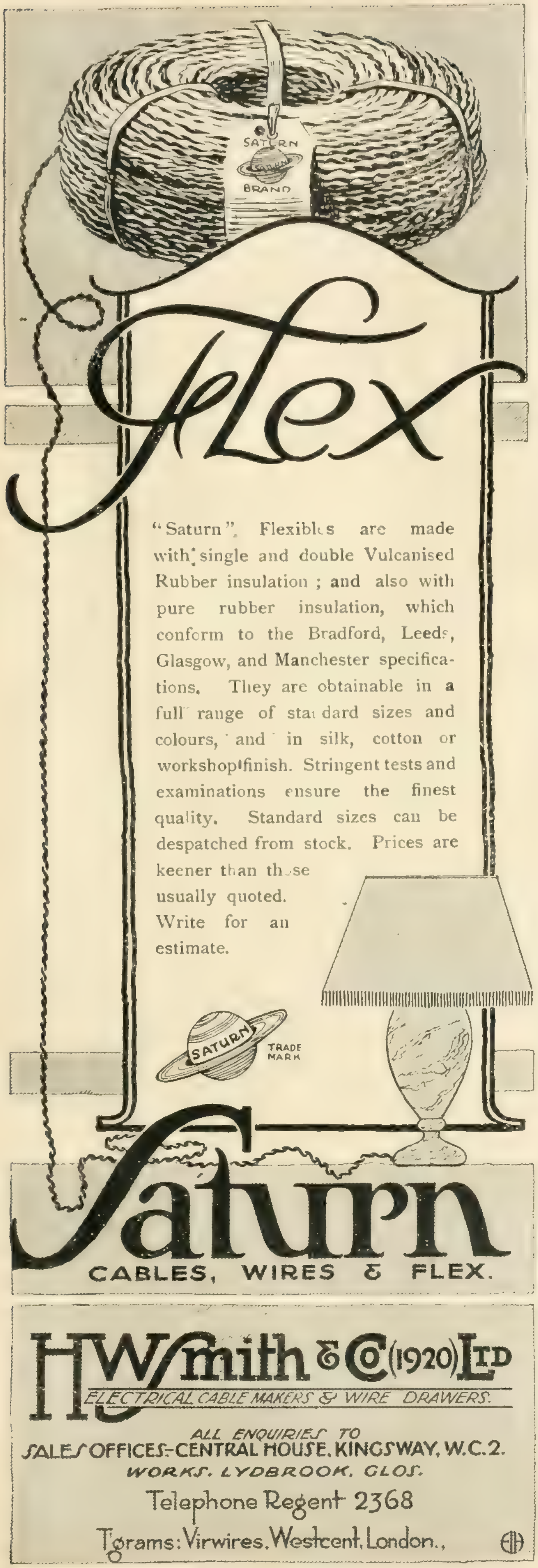

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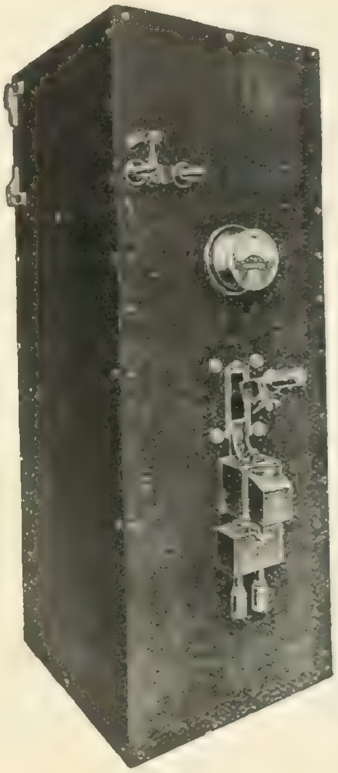

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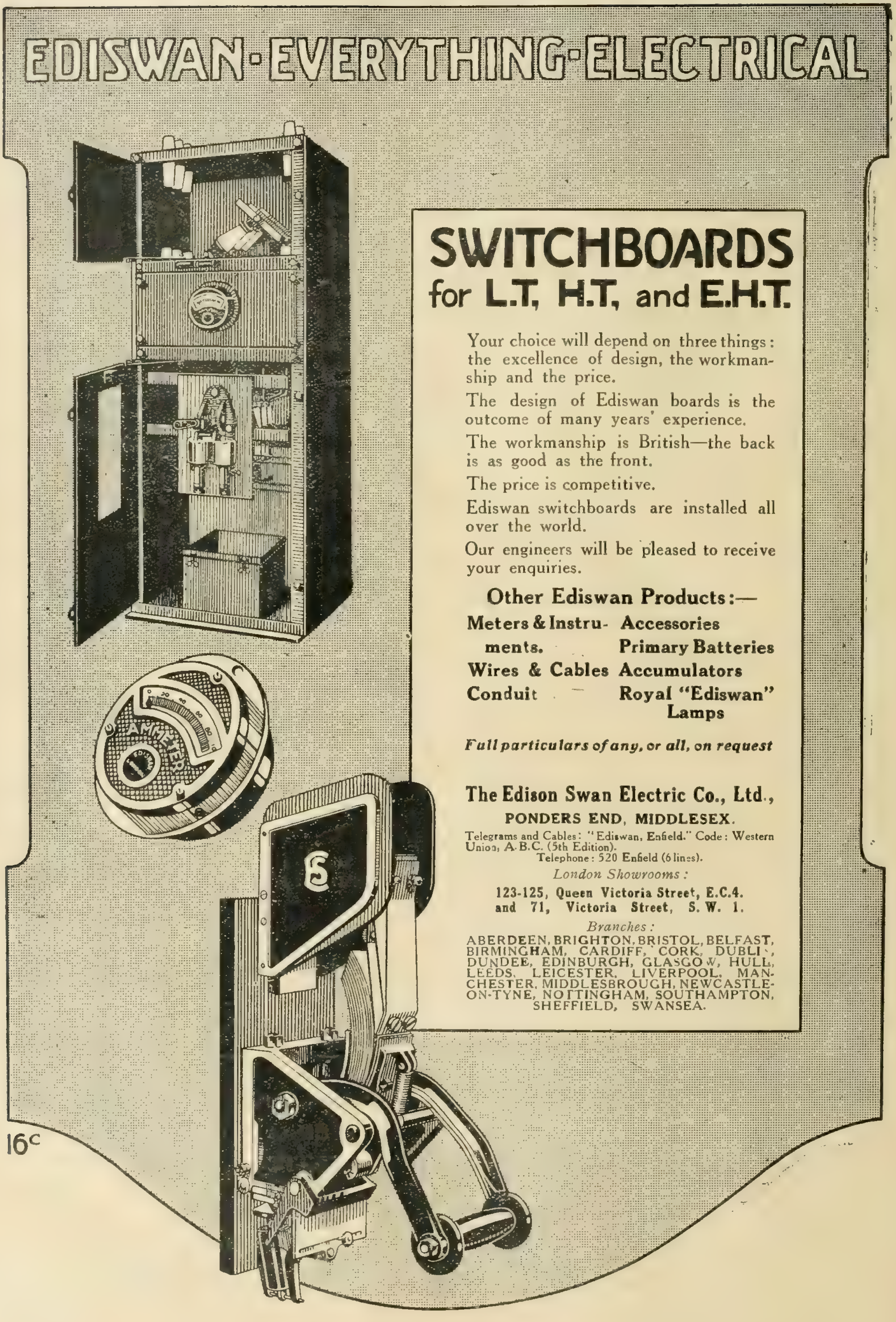

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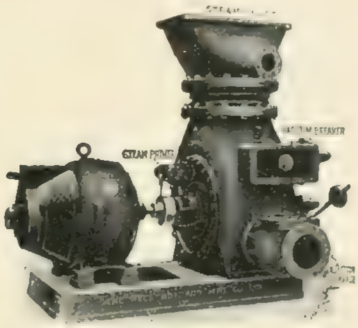

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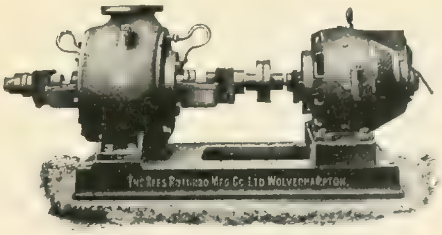

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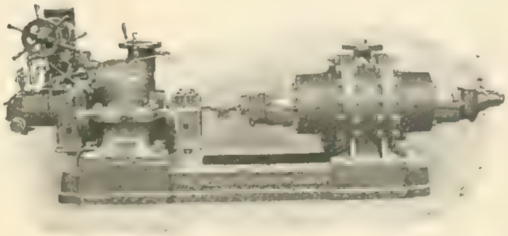

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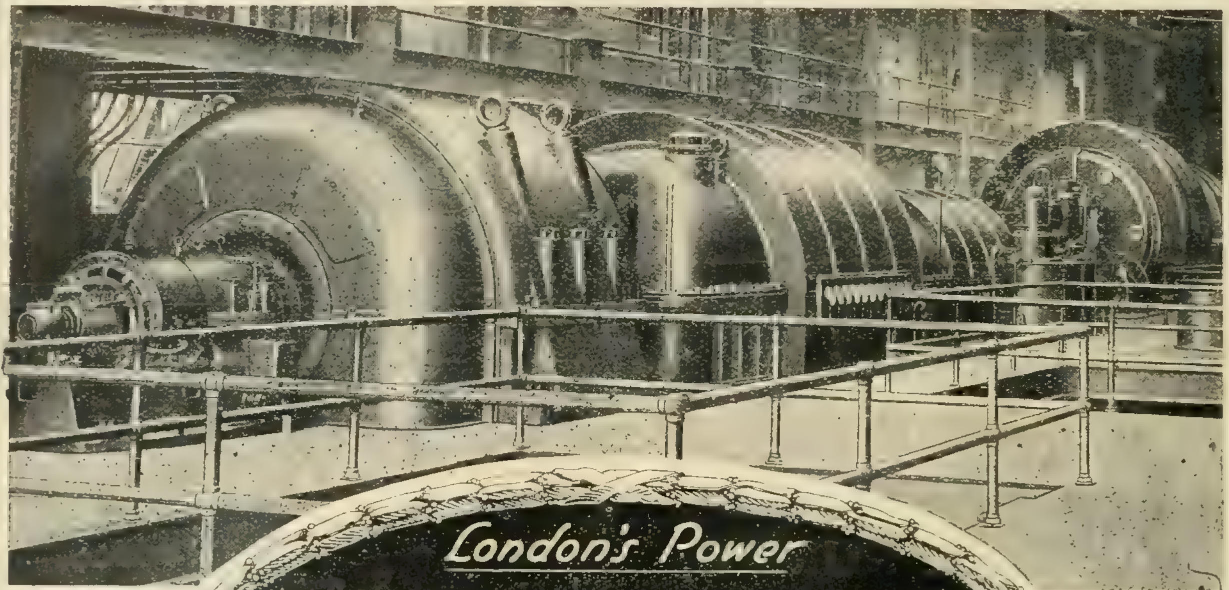

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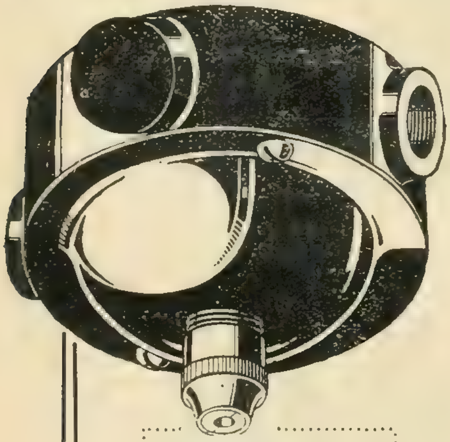

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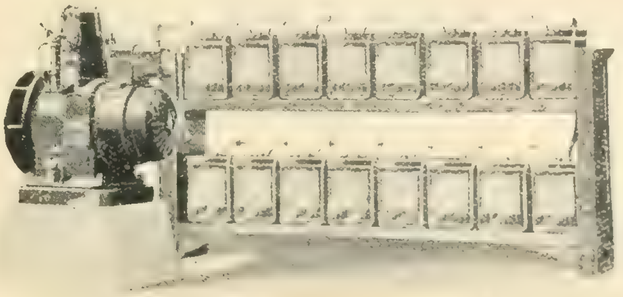

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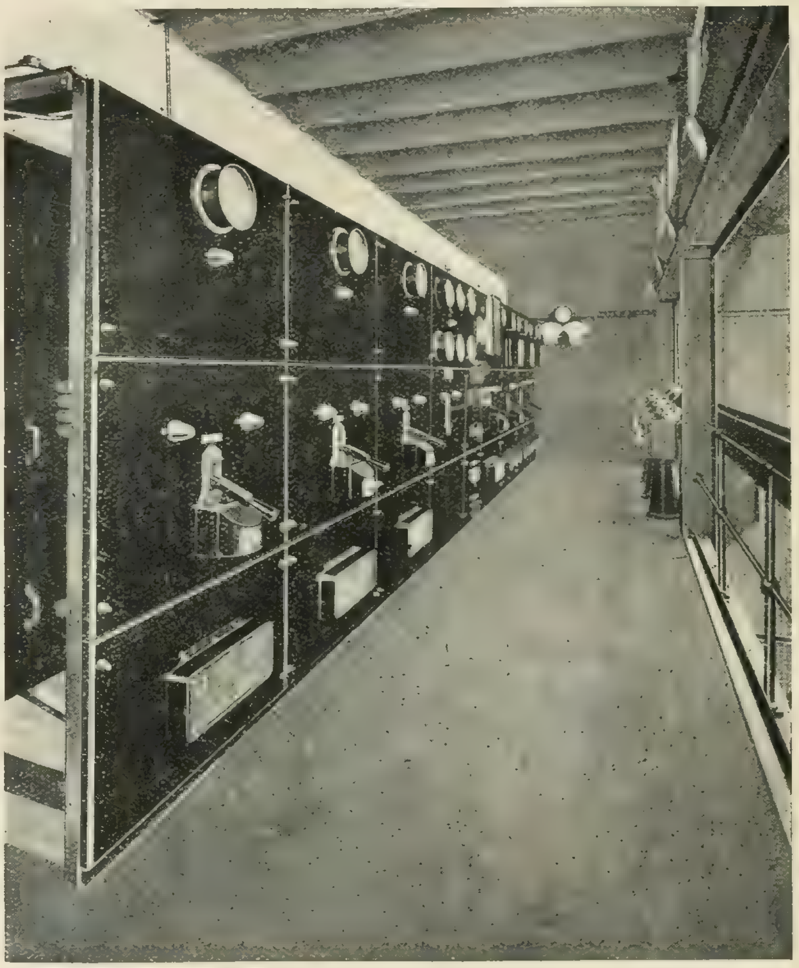

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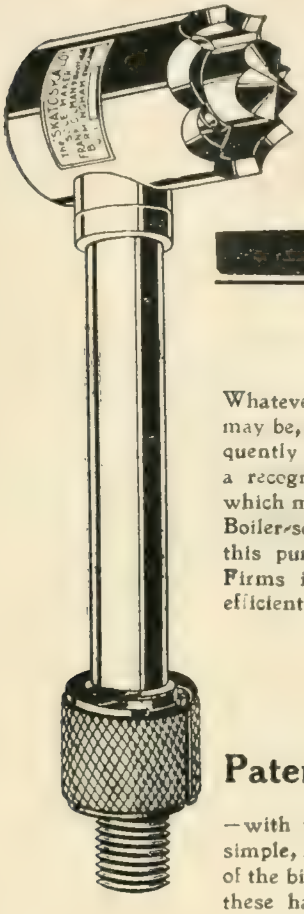

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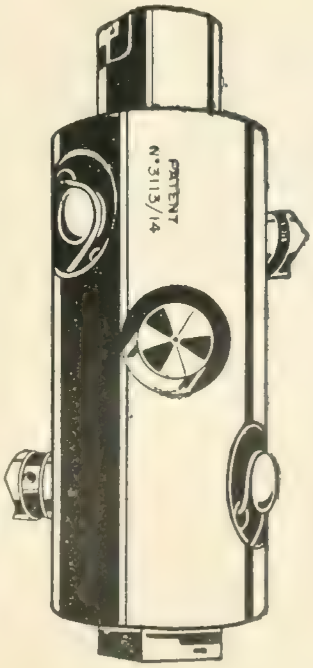

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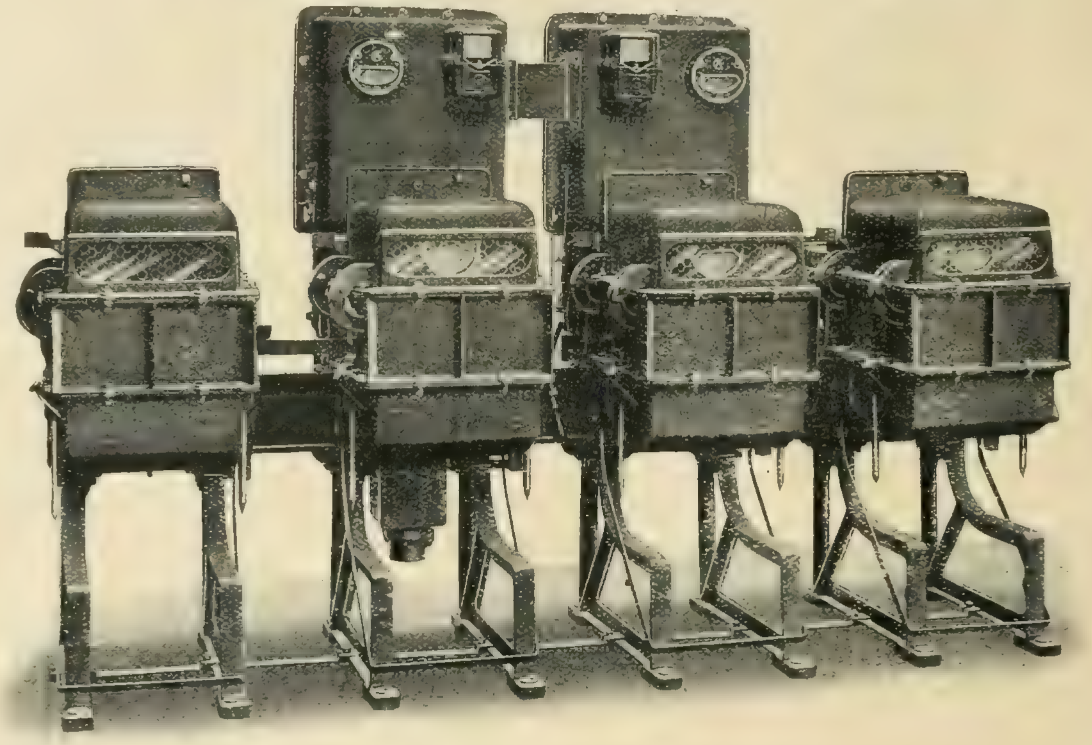

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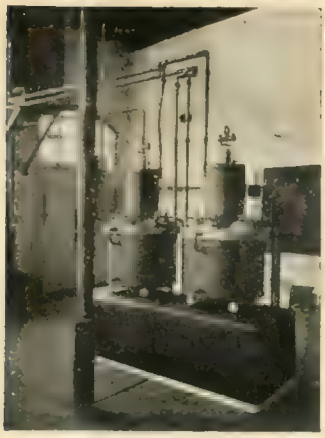

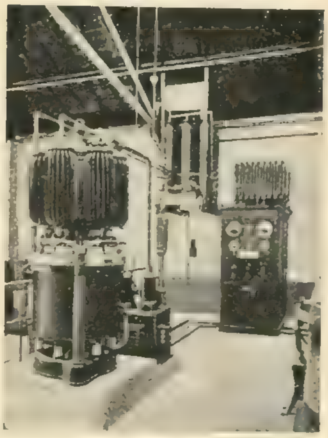

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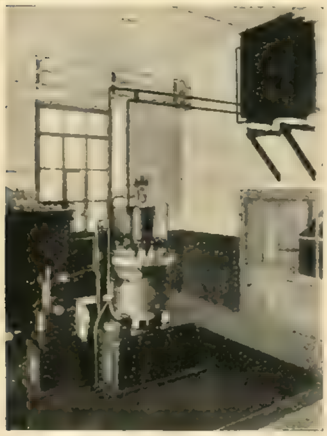

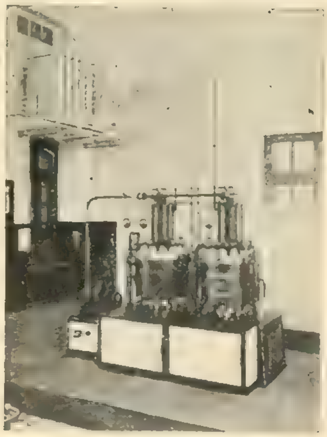

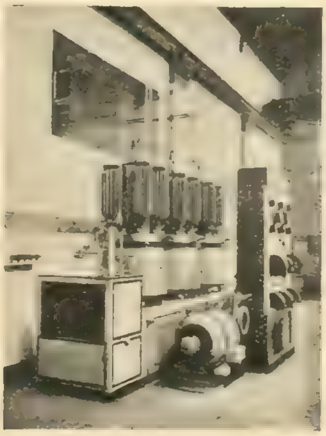

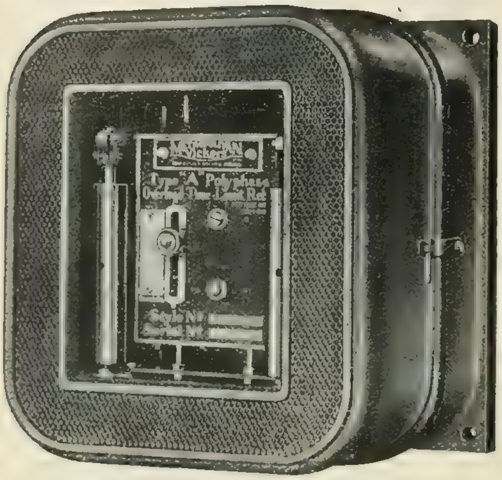

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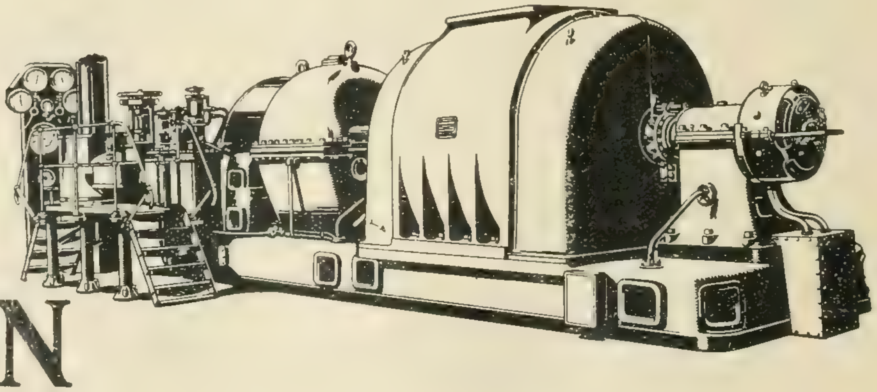

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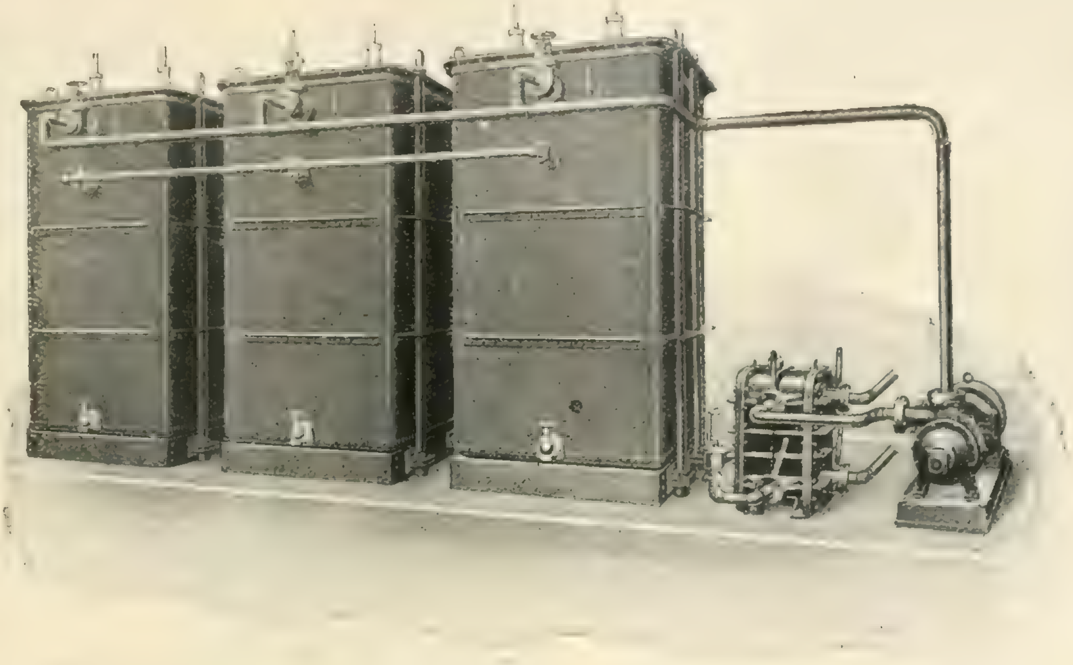

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The following list of some of the Transformers we have supplied is evidence that this reputation is well sustained among the largest buyers.

	Number Supplied	*kVA*	*Volts*
Glasgow Corporation	16	7,800	6,600/20,000
Newcastle Electric Supply Co.	6	4,000	11,000 66,000
Manchester Corporation ...	2	4,000	6,600/12,000
Wolverhampton Corporation	3	2,000	6,600 33,000
Midland Electric Power Co. ...	2	2,000	6,000/33,000
Mersey Power Co.	12	1,666	6,000/33,000
City of London Electric Supply Co	2	1,000	11,000/ 6,600
Powell Duffryn Coal Co. ...	3	2,500	3,150/10,000
Manchester Corporation—			
Barton Power Station ...	6	19,500	6,600 33,000
,, ,, ,, ...	1	2,500	6,600/50,000
,, ,, ,, ..	3	1,250	33,000 440
Sub Station	15	2,833	33,000/ 6,600

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THE Mark of Efficiency

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716

Why you should instal 'TUDORS'

Tudor Accumulators have over a quarter of a century's experience behind them.

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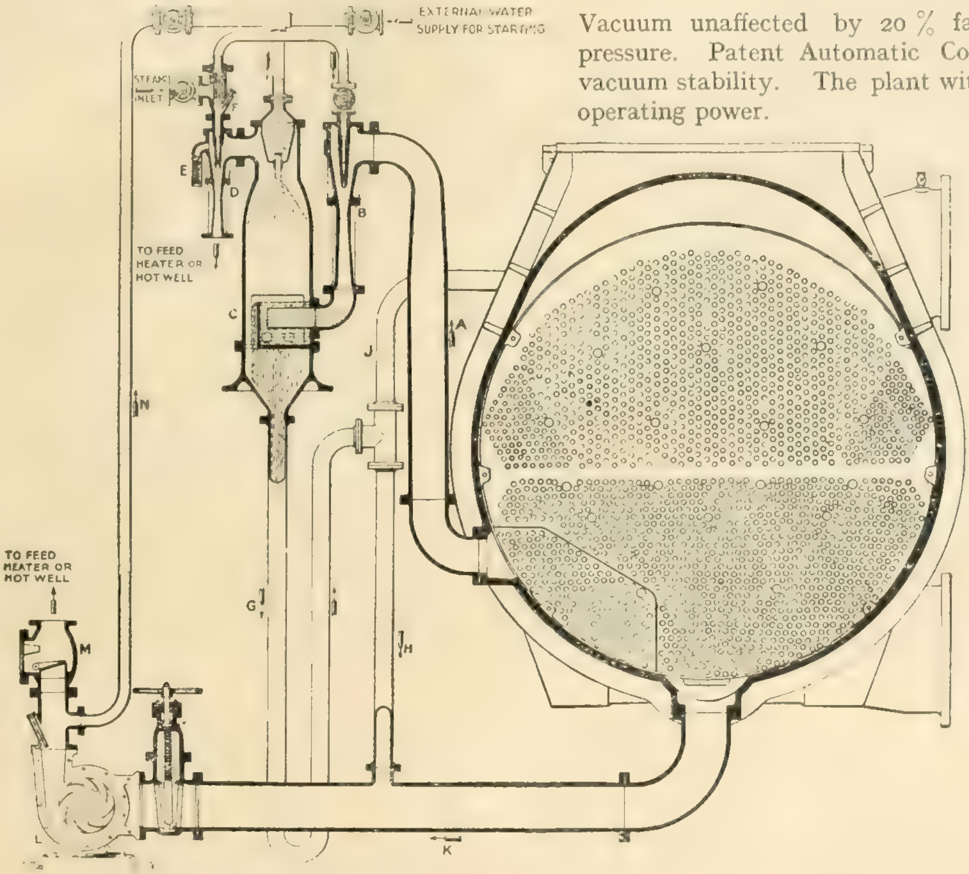
NO RECIPROCATING PARTS. GUARANTEED RELIABILITY. MINIMUM UPKEEP CHARGES.

Vacuum unaffected by 20 % fall in steam pressure. Patent Automatic Control ensures vacuum stability. The plant with the lowest operating power.


EXTERNAL WATER SUPPLY FOR STARTING
STEAM INLET
TO FEED HEATER OR HOT WELL
TO FEED HEATER OR HOT WELL
A
B
C
D
E
F
G
H
J
K
L
M
N

A	Air Suction from Main Condenser.	H	Condensate from Auxiliary Condenser.
B	Primary Ejector.	J	Vapour Pipe.
C	Auxiliary Condenser.	K	Main Condensate Suction.
D	Secondary Ejector.	L	Extraction Pump.
E	Automatic Stabilising Valve.	M	Retaining Valve.
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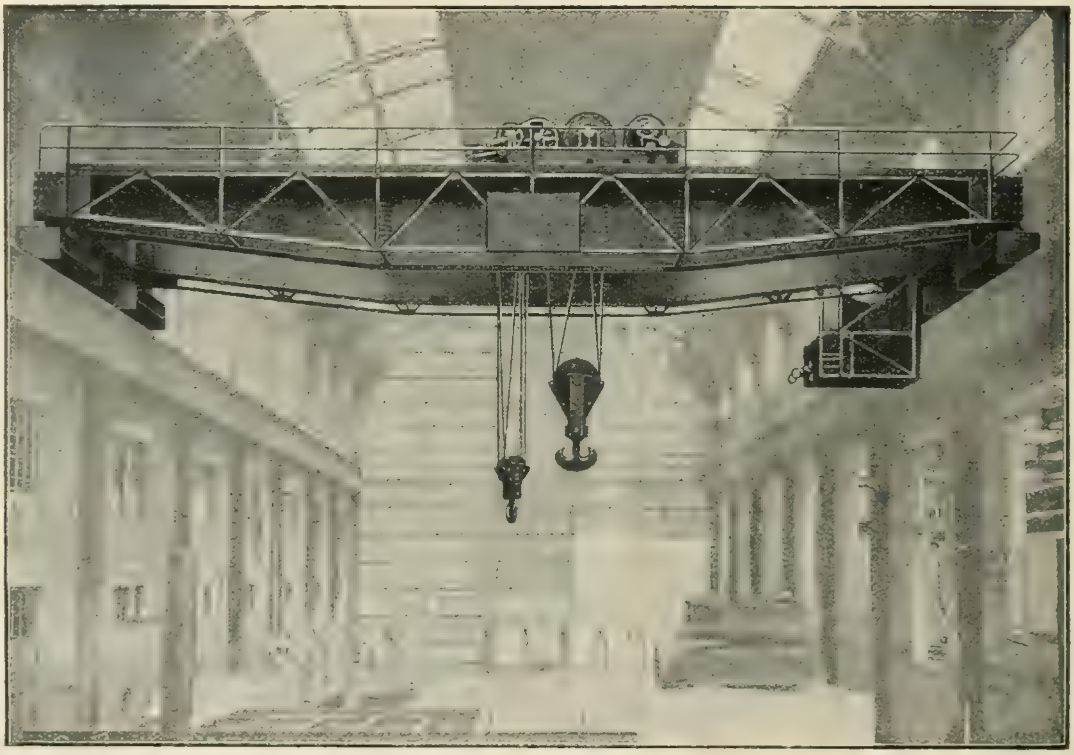

FIG. 1323.

100 TONS 62-FT. SPAN TRAVELLER AT THE NECHELLS PERMANENT STATION OF THE BIRMINGHAM ELECTRIC SUPPLY DEPT.

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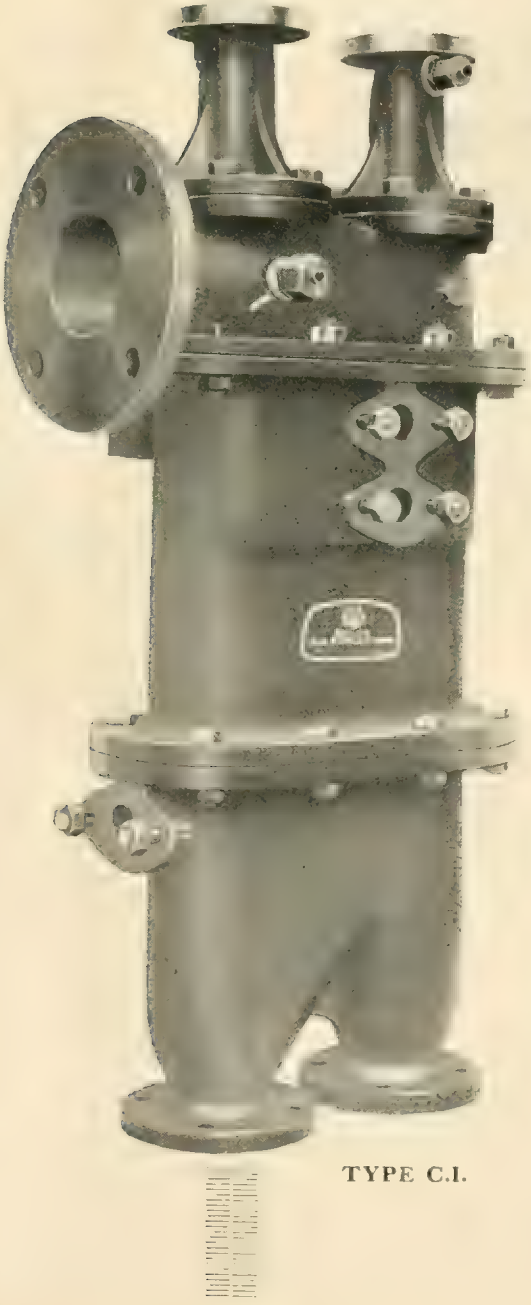

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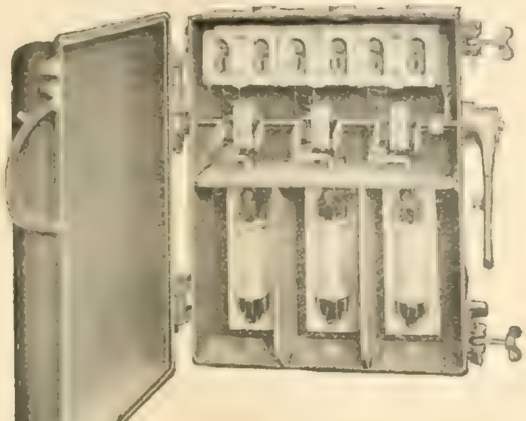
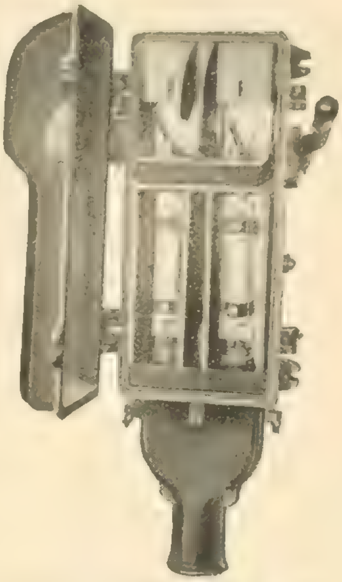


X 6312. "Twinbreak" Triple Pole Ironclad Switch with fuses. (Patent No. 26009/1910.) For circuits up to 600 volts.



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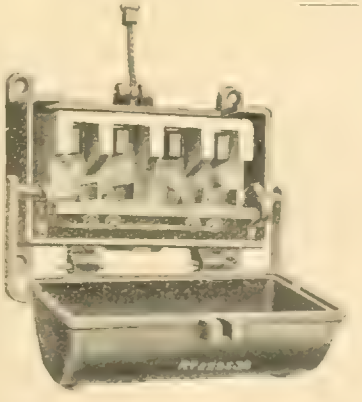

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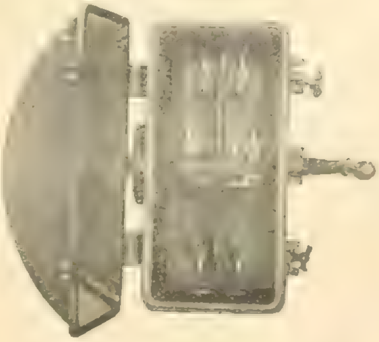

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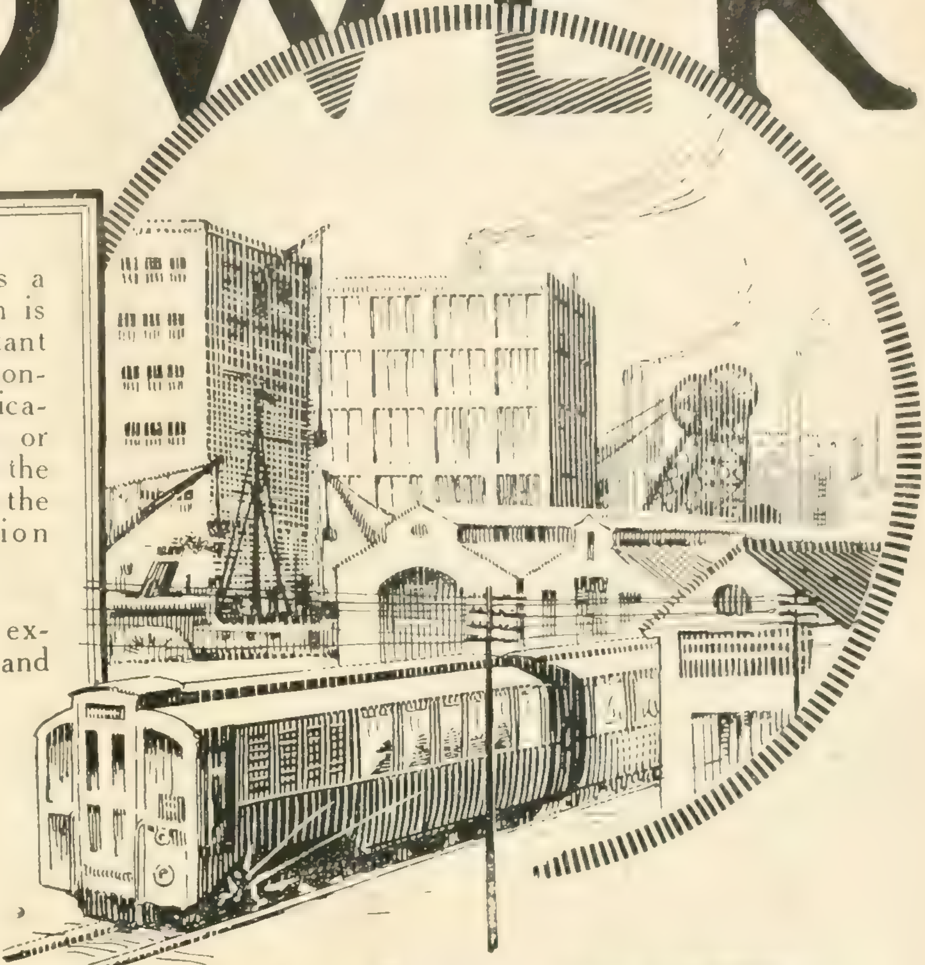

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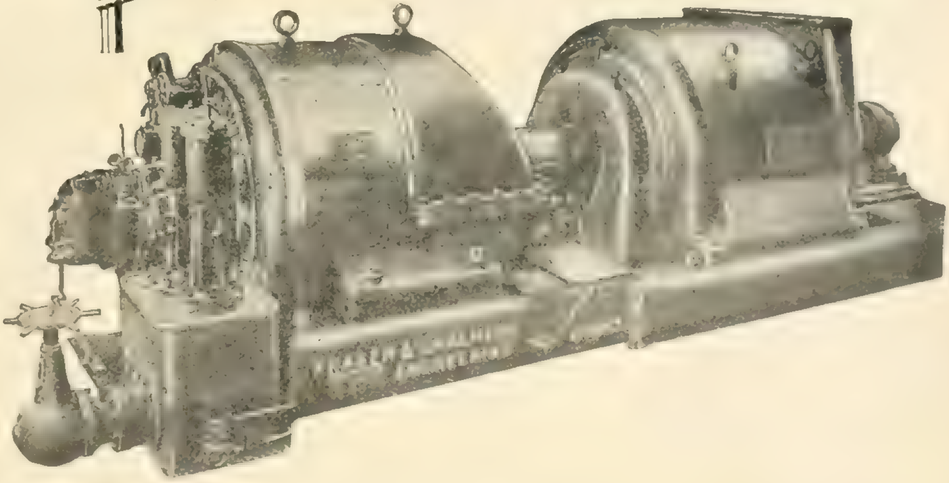

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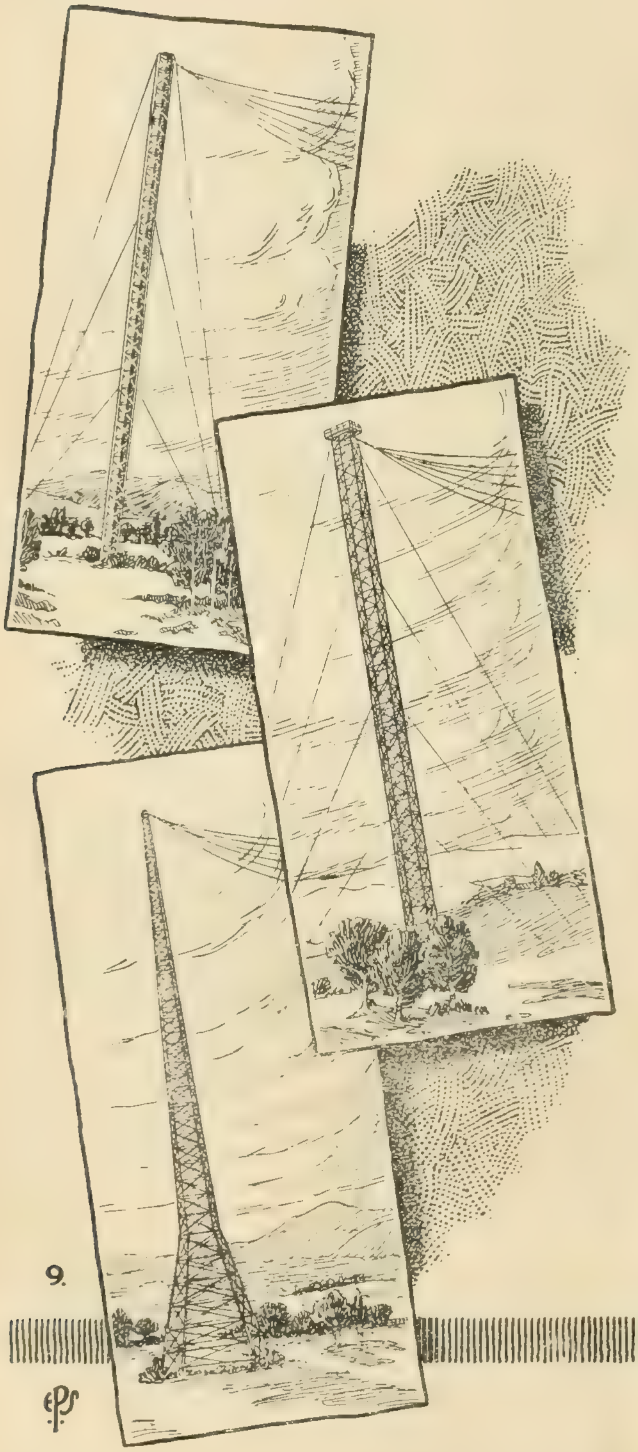

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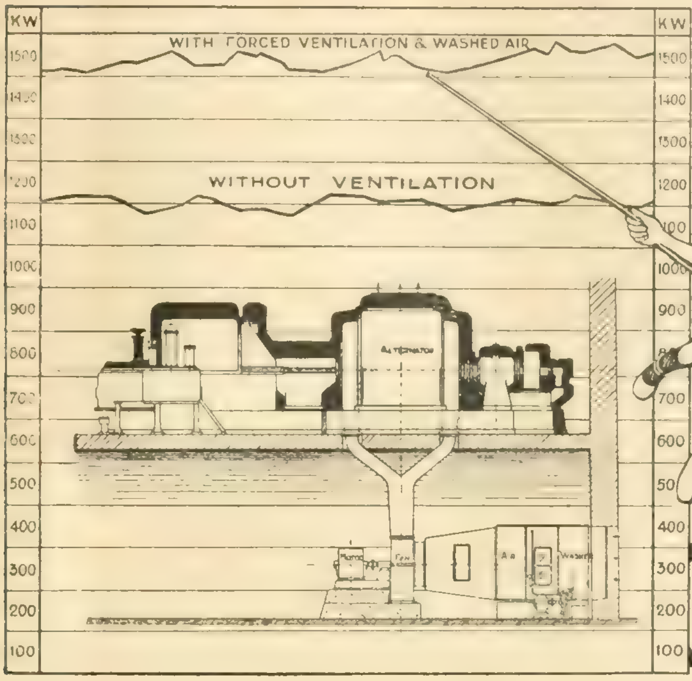

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Speed changed by Simple Controller and does not vary with Load as no resistances are used.

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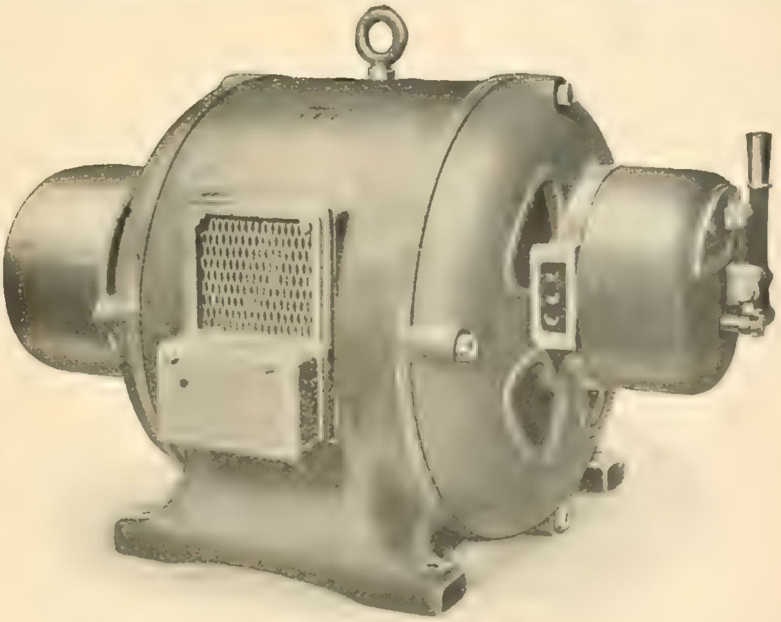

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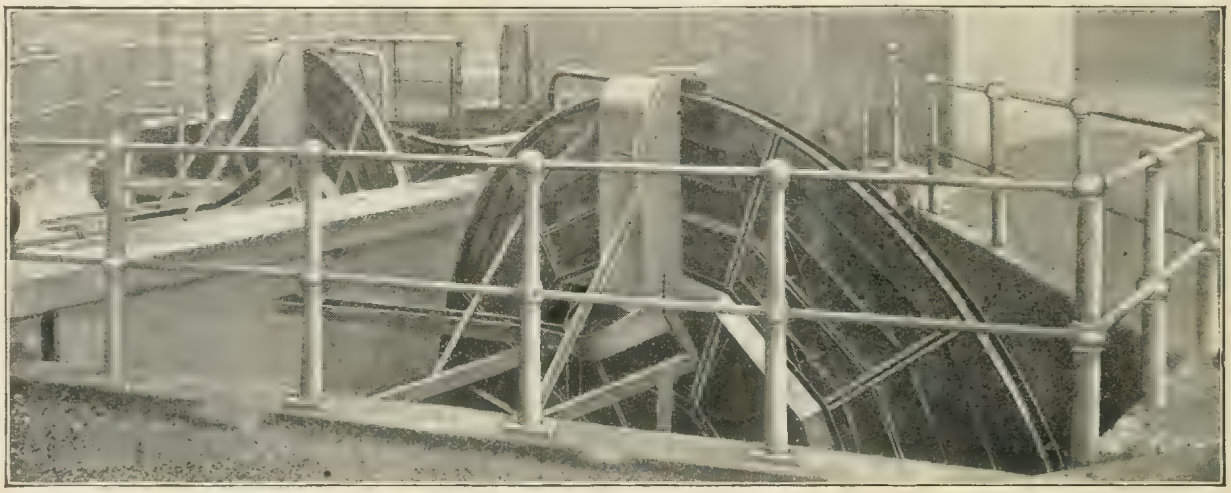
CLEAN CONDENSING WATER MEANS LOW COSTS



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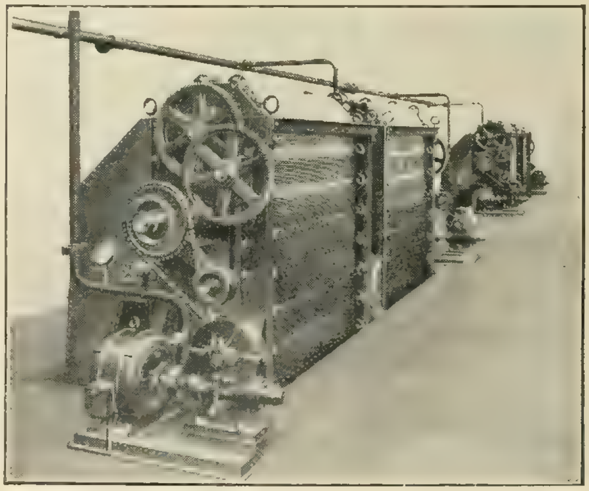

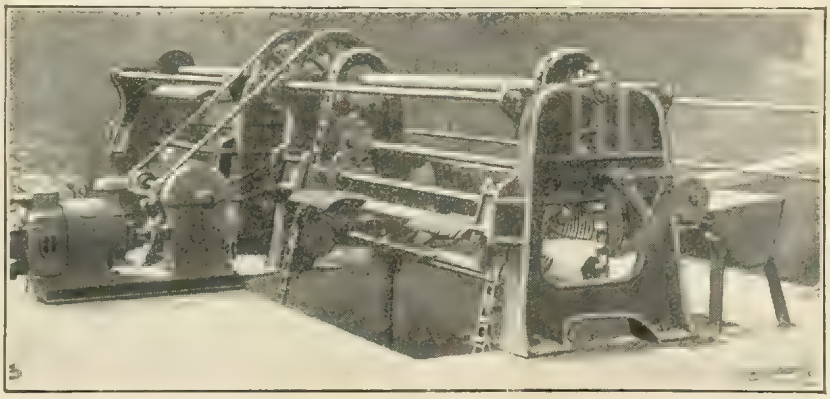

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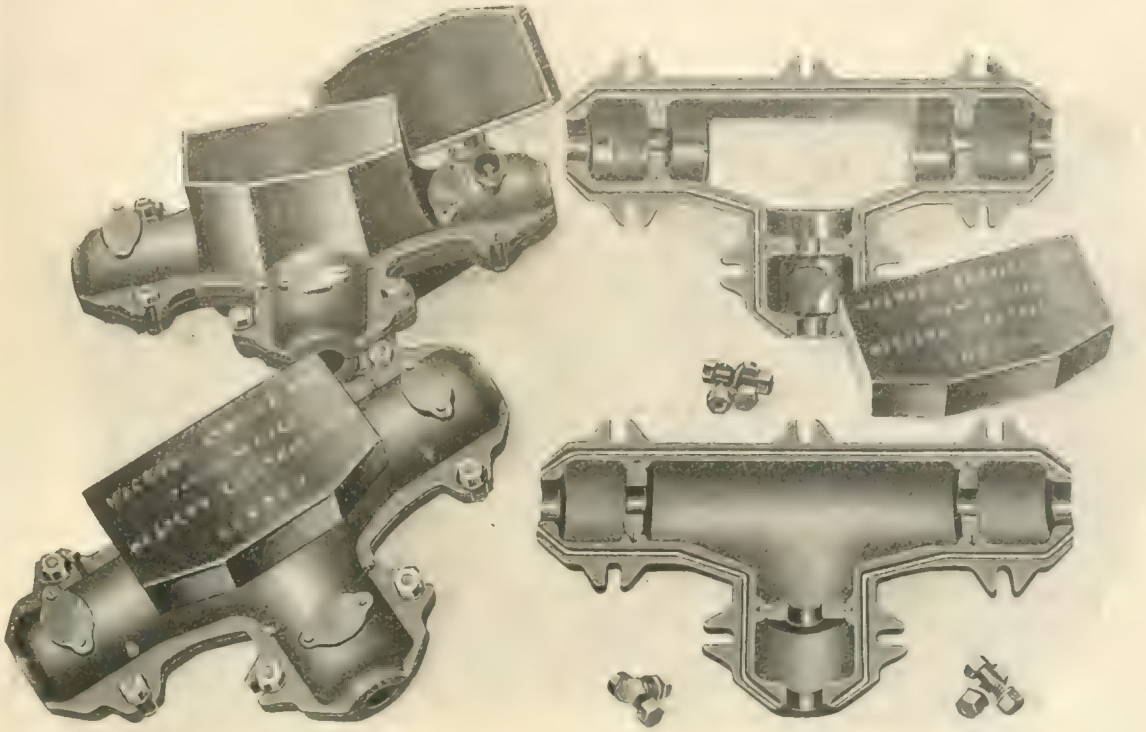

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For LAND POWER PLANTS,
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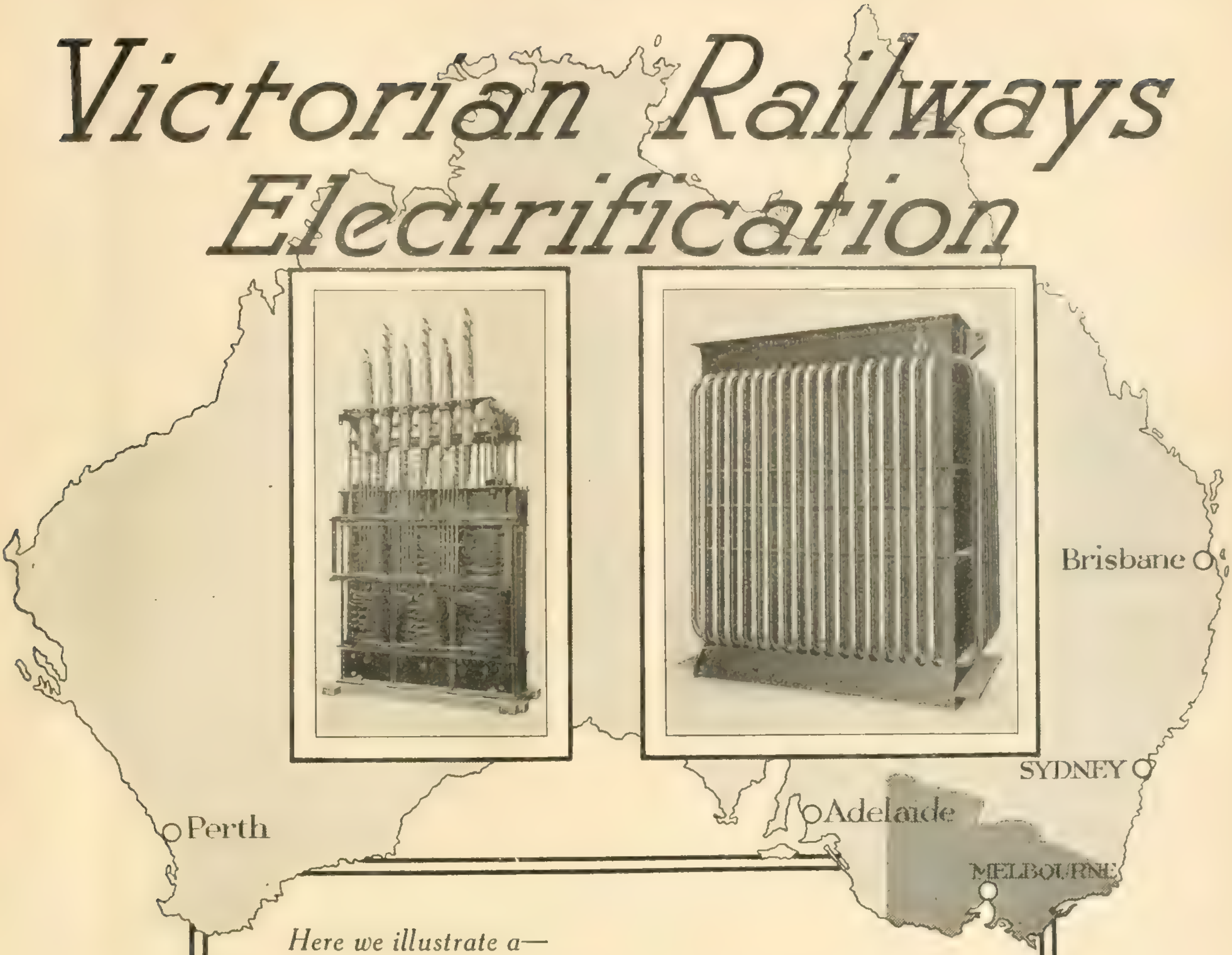

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which is one of a large number we have at present in hand, in connection with the electrification of the Victorian Railways and to the order of Messrs. Merz & McLellan, Consulting Engineers thereto.

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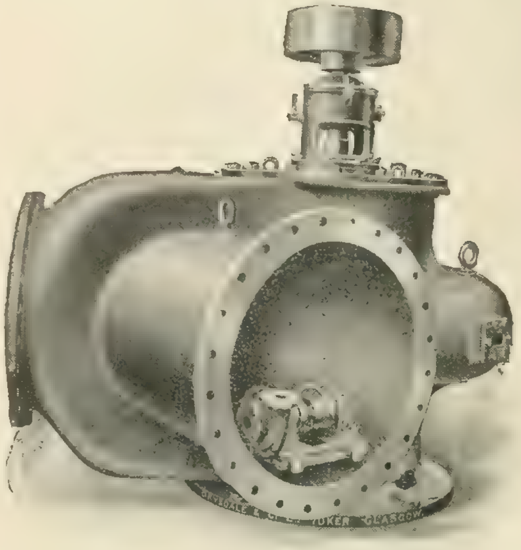

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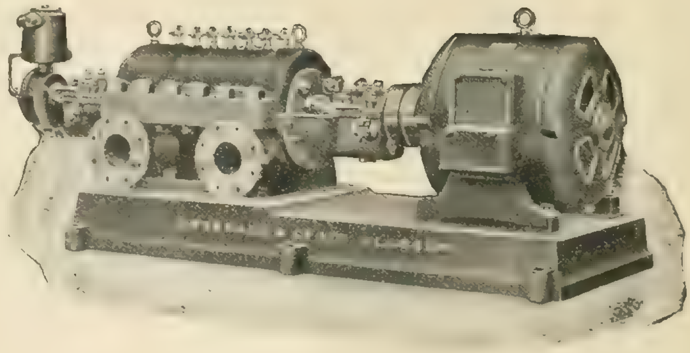

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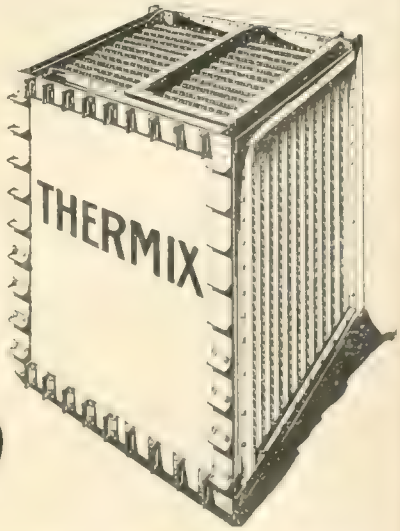

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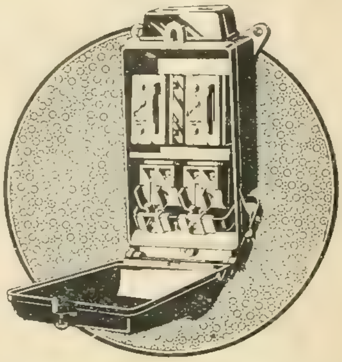

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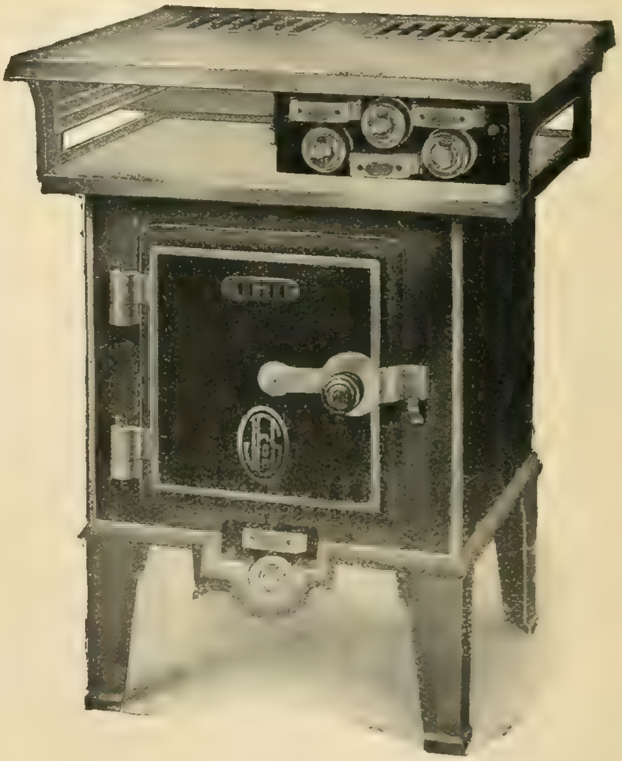

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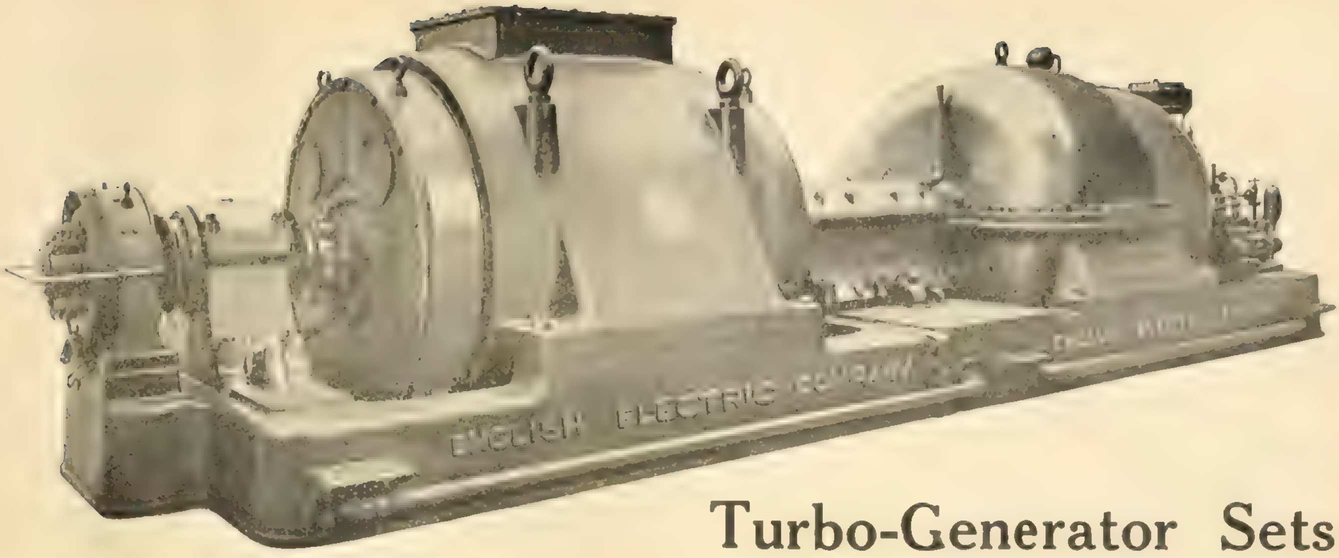

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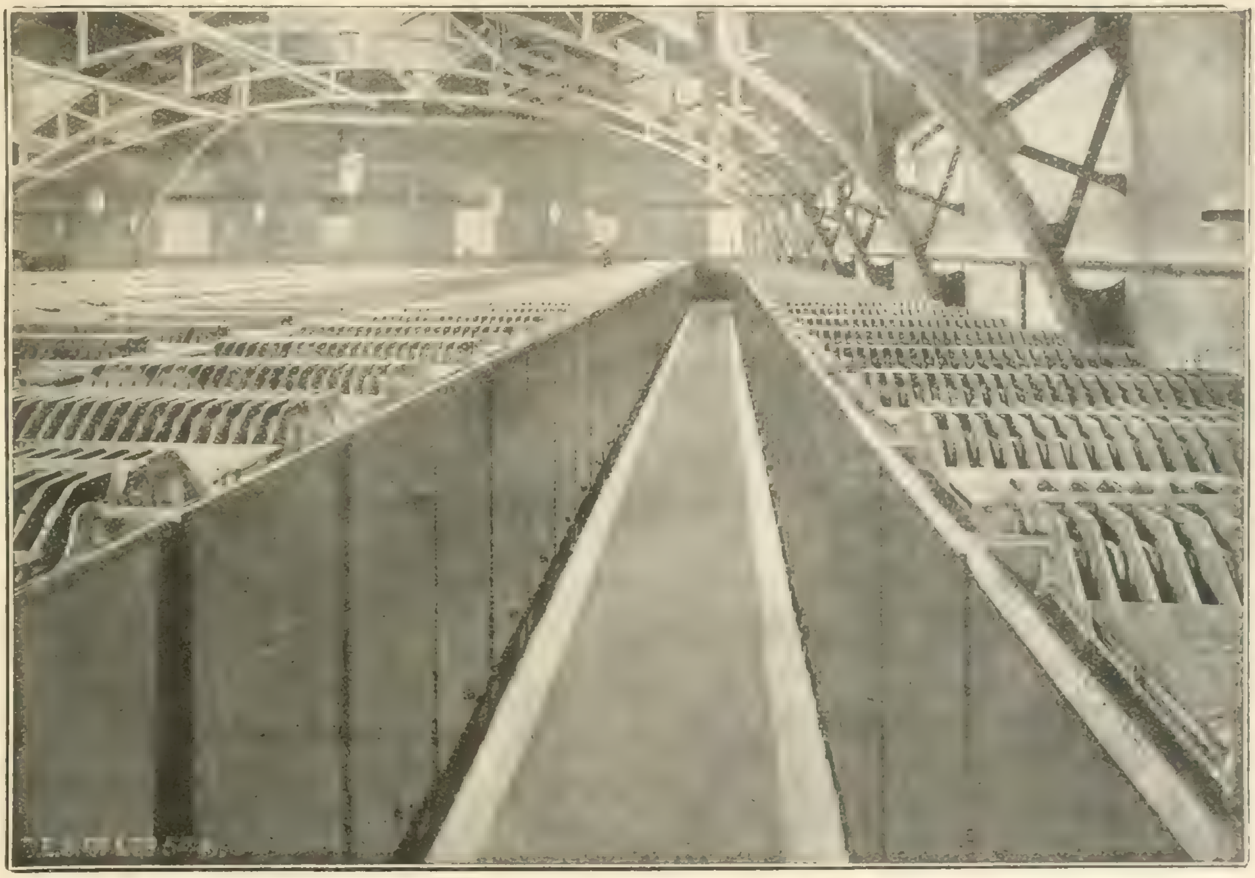

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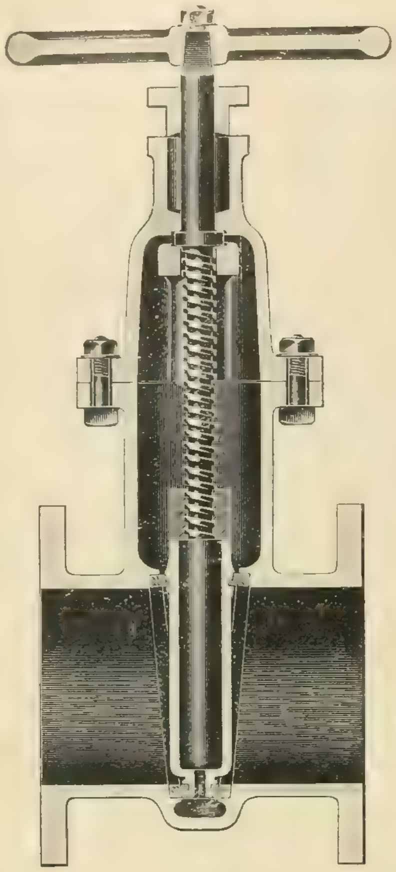

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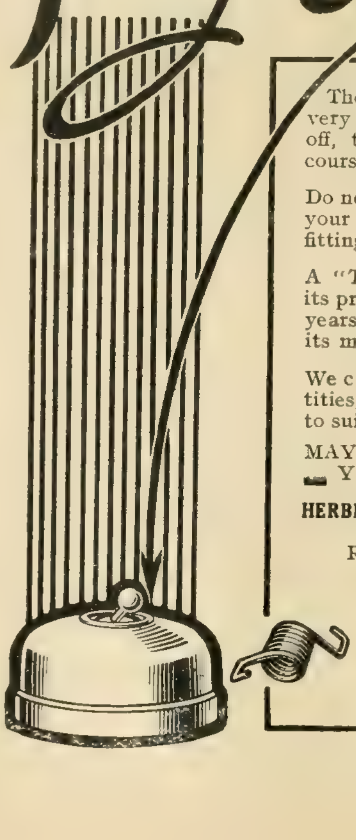

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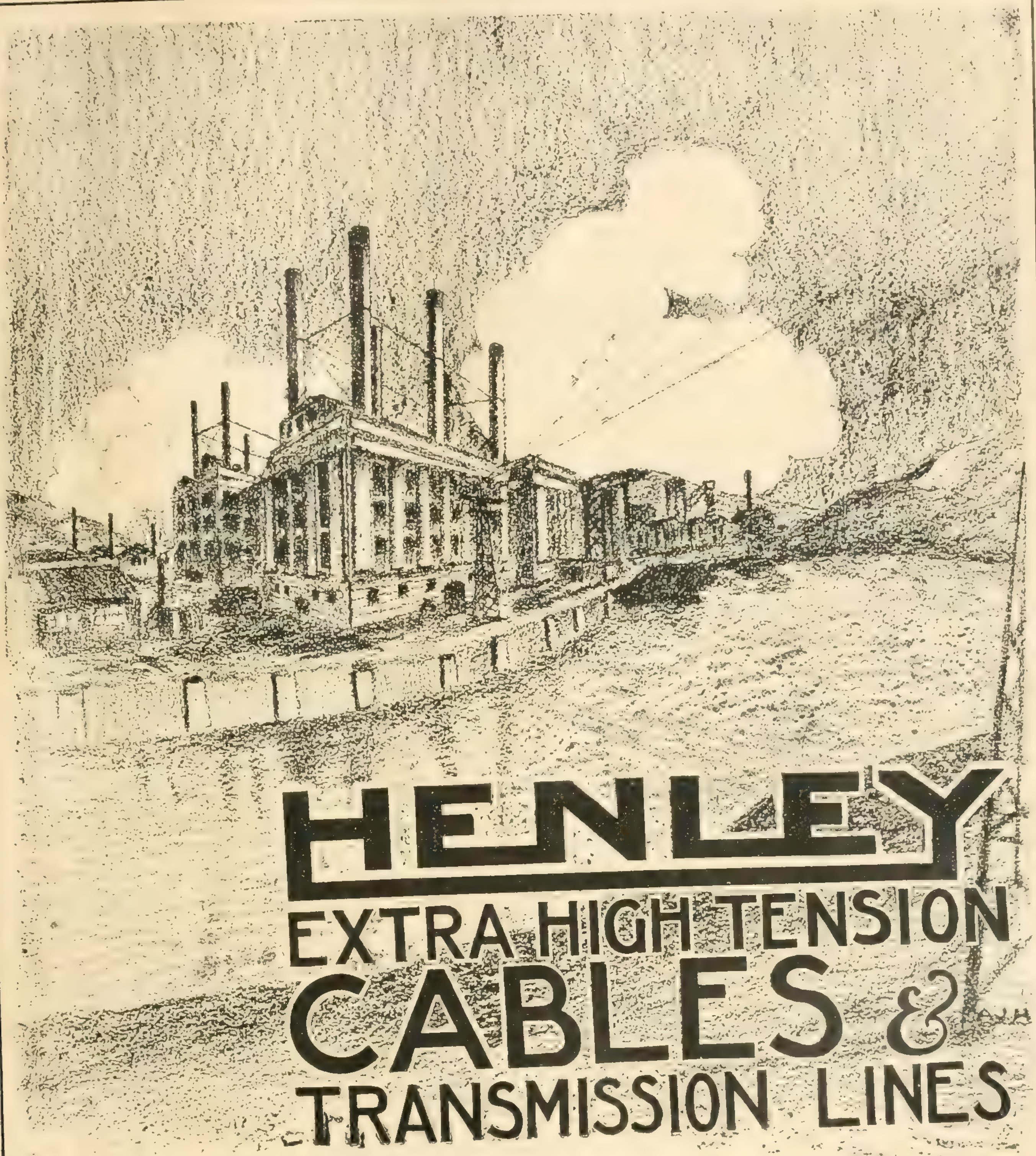

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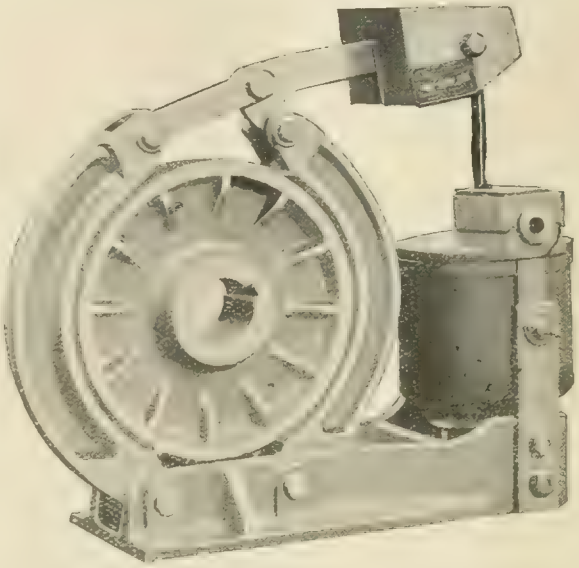

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11th June, 1921.

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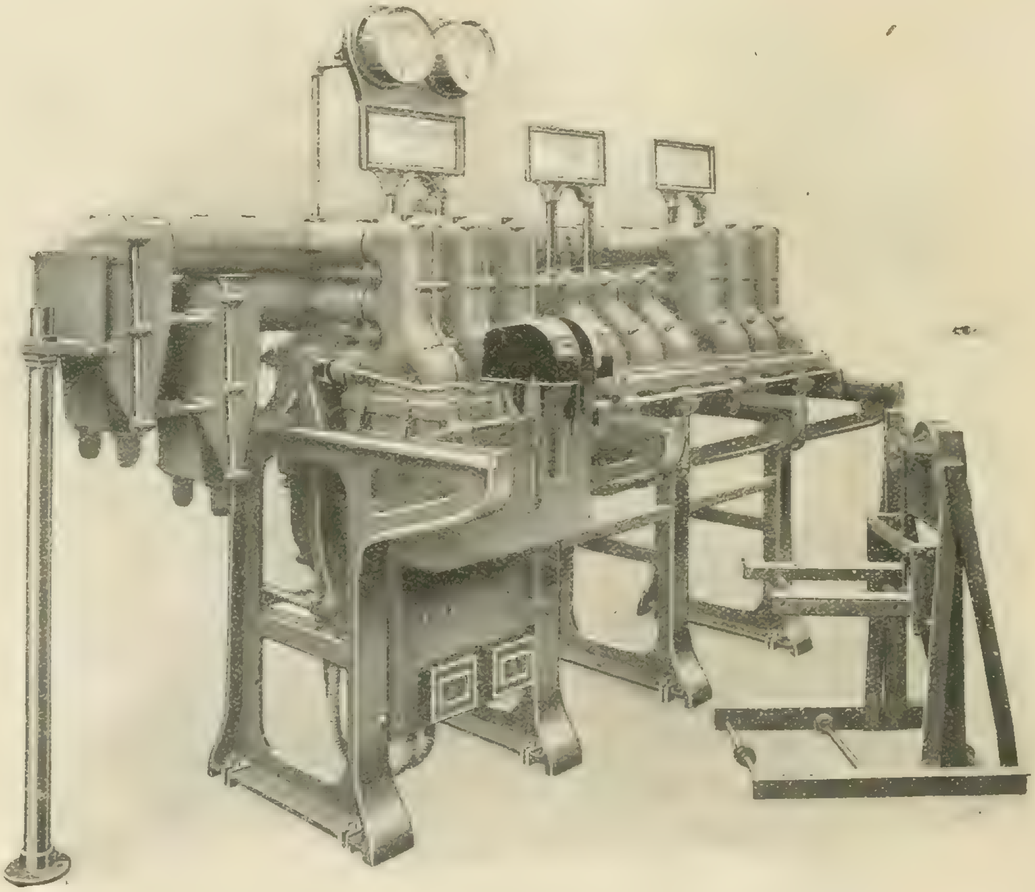

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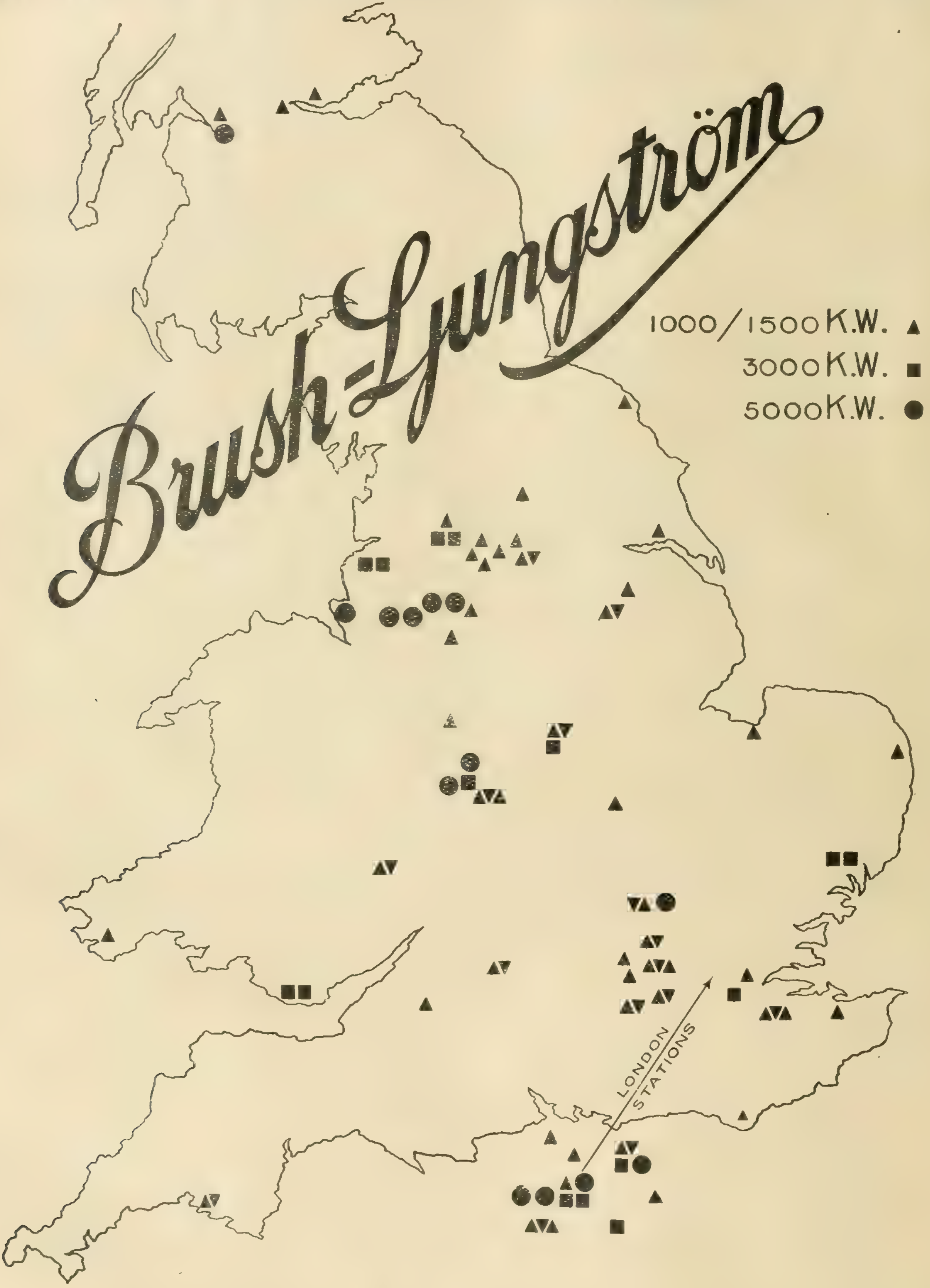

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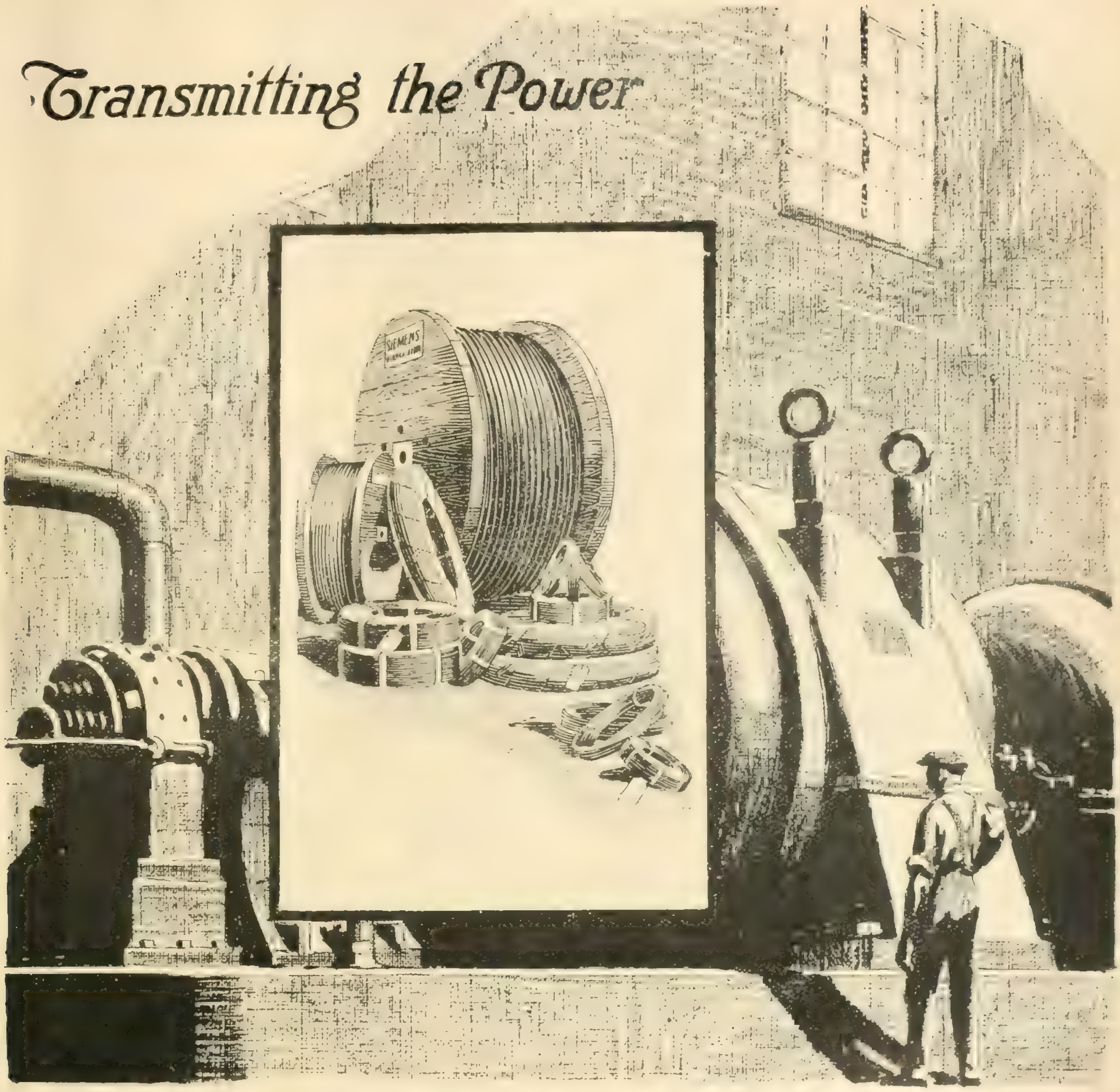

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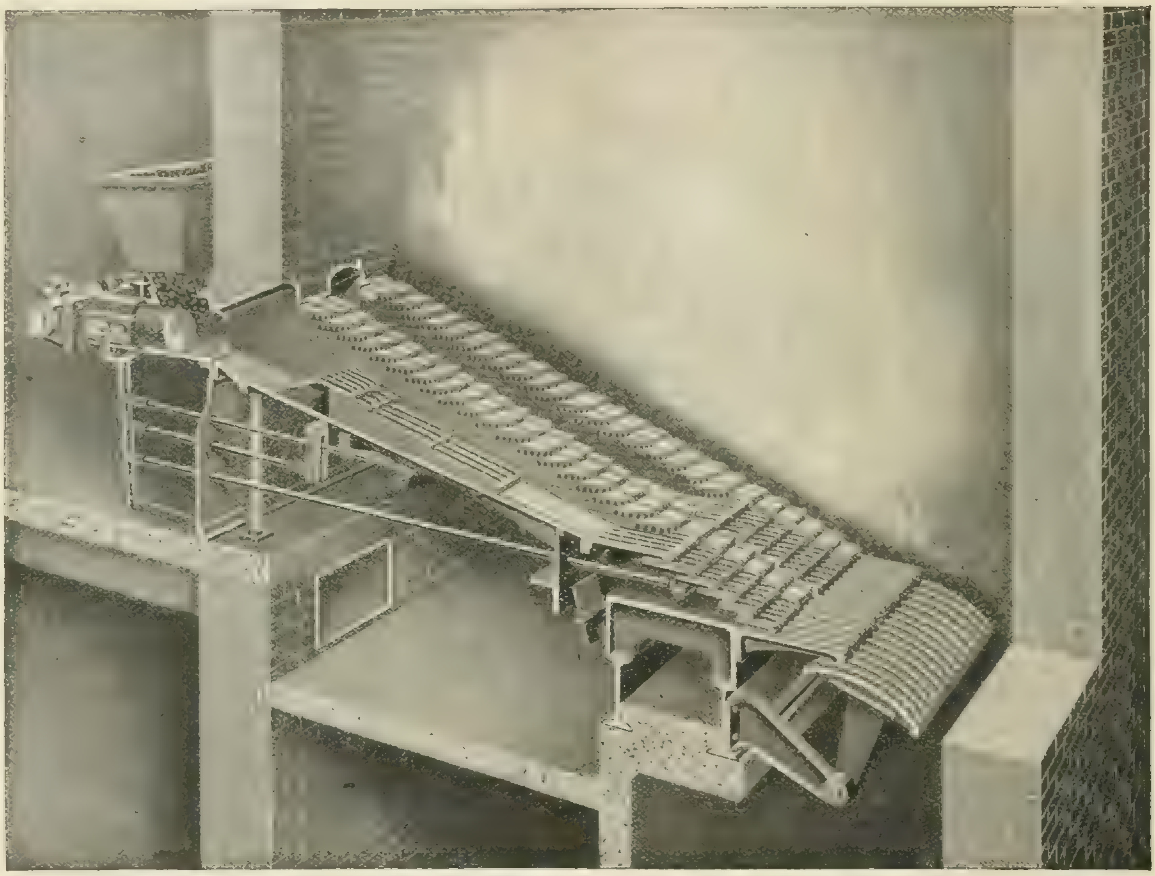

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The "Electrician" Index.

Copies of the Index to Vol. LXXXVI. of The "Electrician," which concludes to-day, will shortly be available, on receipt of postage 1d., to those desiring it. Applications should be made to the Circulation Manager, The "Electrician," 8, Bouverie Street, E.C.4.

Notes.

The American Engineers' Visit.

ENGINEERING, in the broadest sense, knows no country. Its object is the improvement of mankind's lot and it draws its inspiration indifferently from world-wide sources, irrespective of land and nationality. We can therefore watch with eyes free from envy methods that are being employed by other than British engineers to solve the problems with which they are faced and appreciate in the broadest spirit these attempts to add to our knowledge. The visit of a body of American engineers to this country to express their appreciation of the work done by their British colleagues during the war and to present the John Fritz medal to Sir ROBERT HADFIELD are sufficient assurance that these feelings are shared in the United States. Moreover, the opportunity that this visit will give for the interchange of ideas cannot fail to assist the cause of true Anglo-American friendship and to keep it unspotted from political considerations. Members of the Institution will hear with satisfaction that their American colleagues will be present at the Institution conversazione on Thursday next, when a message from the American Institute of Electrical Engineers will be conveyed by Dr. F. B. JEWETT. We have no doubt that those present will suitably mark their appreciation of the significance of the occasion.

The Engineering Conference.

THE Engineering Conference opens at the Institution of Civil Engineers on Wednesday next. This was last held in 1911, when a wide ground was covered and a large number of interesting subjects were discussed. As will be seen from the programme which we published last week, the ground on this occasion is not less wide nor is the discussion likely to be less interesting. It should, therefore, be possible to draw some useful conclusions from the ten years' progress in engineering science which has taken place since the last Conference was held. That that progress has been very great is obvious, but it is a progress which has resulted in the necessity of solving problems of greater difficulty than ever before, and not by any means entirely of an engineering character. Perhaps the greatest of these problems is that connected with the right use of fuel, and the delivery by Sir GEORGE BEILBY of the James Forrest lecture on "Fuel Problems of the Future" on the evening before the Conference commences is, therefore, most opportune, as is the Summer Meeting of the Institution of Mechanical Engineers, at which this question is to be dealt with principally from the thermal point of view.

◆

An Unfortunate Clashing of Dates.

IT is therefore more than usually unfortunate, and more than a little unnecessary, that the Engineering Conference and this Summer Meeting should both be held on the same days. Many of the questions raised at the Engineering Conference cannot fail to be of interest both to mechanical engineers and to electrical engineers, while both classes will be equally interested in the discussion on "The Means of Increasing Thermal Efficiency of Heat Power Plants" which is to form the main subject of the Summer Meeting of the "Mechanicals." During the winter, when scientific and technical societies are in "full blast," some clashing of dates is always occurring, and those who are concerned with the reporting of these functions have long ago come to regard this coincidence as one of the things that, like taxes and strikes, cannot be avoided. In the summer, however, the load is so very much less that this conflict is surely unnecessary. It seems a case where the organising committees or the secretaries of the various Institutions might have come to a mutual arrangement of dates.

The Internal Combustion Engine as a Rival.

Electricity supply engineers will read with interest the arguments in favour of the greater use of the internal-combustion engine for industrial purposes which Prof. Burstall advances in an article published on another page of this issue. He shows that the cost of running a modern form of gas engine developing some 37 H.P. on lighting gas is 1·54d., on suction gas and anthracite 1·32d., and on coke 1·09d. per horse-power hour. As far as the small consumer is concerned these figures compare favourably with those at which it is possible to obtain electricity at the present time, and are likely to compare still more favourably if Prof. Burstall's optimism on price tendencies is justified. It therefore seems at first sight that the gas engine is a formidable competitor of the electric motor in small factories. Nevertheless we are not convinced that he has presented all the facts of the case. For there are so many other considerations besides the mere cost of power. There is, for instance, labour. Labour of the quality that is essential for looking after a gas engine is both more difficult and expensive to obtain than that required for supervising an electric motor. It may be, however, that we are on the eve of further interesting developments in gas engine design and manufacture, and that gas engines may soon be made which will economically replace the prime movers now employed in our power stations. It is, therefore, a question which must not be looked entirely upon from a competitive point of view, but as a problem whose solution will be of general interest and benefit to those engaged in electricity supply.

Wood for Power Generation.

An interesting discussion of the possibilities of employing wood as a fuel for power generation is published in a recent issue of the French "Journal Official" in the form of a report by M. Kamerer, the chief engineer of the Association of Alsatian Steam Boiler Owners. This report represents part of the work of a commission recently appointed by the French Minister of Public Works to ascertain the best means of using such fuel and to suggest measures for giving effect to their findings. It appears that the space required by wood fuel to give equal calorific value is from four to seven times as great as would be necessary where coal is employed. Special attention must also be given to the design of both furnace and firebox. Fortunately, much can be done in the way of adapting present furnaces to the altered conditions and a number of instances are given by the sub-committee of wood being successfully employed in place of coal on these lines.

An Economic Question.

The questions connected with this interesting problem are naturally of great importance in France, where there are certain regions in which wood is abundant and coal correspondingly scarce. They are not, however, entirely without their interest for engineers in this country, and there may even be cases where a change-over from our present methods to those suggested by the French Committee would be an economical advantage. The whole question, as Mr. Ryecroft points out in his article on another page of this issue, is, in fact, purely one of finance, as the technical problems which have to be solved before certain "curious" fuels can be employed are generally simple.

The Neglect of the Electric Vehicle.

It is as true as it is disappointing that the electricity supply engineer has not, so far, realised the vast possibilities of the electric vehicle as a revenue earner. Few facilities are given for charging and little attempt seems to have been made by most undertakings to encourage this excellent "off peak" load. There are, we hasten to add, notable exceptions to this rule, but unfortunately they only prove the truth of what we have said. This is the greater pity in that, as Mr. Mitchell points out on another page of this issue, there is an enormous scope for the electric vehicle and great savings both in cost and worry can be obtained by its use. It is, however, obviously impossible to develop this field when the facilities for charging are so meagre, and a very promising branch of the electrical industry is therefore operating under a heavy handicap. A certain argument which is often advanced against too strenuously developing the domestic load does not apply here. For arrangements could be made, as has already been successfully done at Ipswich, for charging to be carried out at the generating stations and even at the sub-stations, so that no distributing difficulties would arise, while limiting the times at which this could be done to certain hours would not overload the generating plant. This is a matter which might well be discussed jointly by the British Electrical Development Association, the Electric Vehicle Committee and the various bodies which look after the interests of supply engineers with a view to taking joint action.

The Plight of the Small Supply Companies.

The article by Mr. A. N. Rye, which appears on another page of this issue, discloses a state of affairs whose effect on the development of the electrical industry is not generally appreciated. The burden under which most electricity supply companies labour owing to the operation of the purchase clause is well known, but this burden has been enormously augmented by the rise in working costs and the inability to impose charges which shall enable the revenue to meet those costs. Mr. Rye's arguments on this difficult problem are so cogent that they should be studied in detail. He shows that while smaller undertakings naturally suffer more than large undertakings from the effect of increased wages and rising coal costs, at the same time they have received less relief from the operation of such measures as the Temporary Increase of Charges Act than have their larger colleagues. As moreover they are obliged to give a supply to any one who demands it the net result in many cases is that the better-paying consumer has to be neglected, "other uses" cannot be developed as they should be, and many of the undertakings are fast approaching bankruptcy. To improve matters Mr. Rye suggests an abrogation of the Temporary Increase Charges Act to enable the tariff to be raised to an economic level. We fear Mr. Rye is more than a little of an idealist.

Bad for Electrical Industry.

It is, however, obvious that something must be done, and done by the electrical industry, to alter this state of affairs, or everyone will suffer. The financial position of these undertakings and the impossibility of their further development under such conditions as Mr. Rye describes must react unfavourably on other electrical activities. It may be argued that had these companies shown more enterprise in the past they would not now be suffering. And even taking into account the operation of the purchase clause as a drag on all commercial activity there is something in this argument. But, however this may be, the important point is that the industry requires their help at the present time, for it is in the areas served by these undertakings that one of the most promising fields for the development of the domestic-electric load is to be found. We hope, therefore, that before long the Commissioners will be able to give some attention to this end of the scale of electricity supply and to inaugurate a policy which will place these companies in a position not only of financial stability but where they will be able to play their part in accelerating the progress of the electrical industry.

British Firm Secures Australian Contract.

In commenting recently on the Morwell power scheme for the electricity supply of Melbourne we expressed the hope that some portion of the important contracts necessary for carrying out this work would be obtained by British manufacturers. We are glad to say that our hopes have been realised and that a large order for power-station generating plant has now been placed by the Victorian Government with the Metropolitan-Vickers Electrical Company. The contract includes the supply of five main generating units, each with a maximum continuous rating of 12 500 kW, and one auxiliary set with a rating of 600 kW. It is interesting to note that steam at this station will be obtained from brown coal with a calorific value of about 6 000 B.T.U.s per lb. It will be supplied to the turbines at a normal pressure of 250 lb. per square inch and a normal temperature of 630°F. The design of the turbines will follow the usual Metropolitan-Vickers practice, a special point being the provision of a self-contained feed heating system for which the steam is directed from the turbine at a pressure of 5 lb. per sq. inch abs. The turbines will exhaust into surface condensers which will maintain a vacuum of 28 in. at full load when supplied with cooling water at 70°F. The alternators will supply three-phase current at 11 000 V at a frequency of 50. The Company are to be congratulated on obtaining this contract, which, having in view the large amount of work which is being done in our overseas dominions, will, we hope, not be the last to be obtained by a British firm.

The End of the Big Stick.

Those who hope that sections of the miners will desert their Federation and gradually return to work will be disappointed. For the men themselves would lose too much by such a breakaway. The dispute cannot continue for ever and when it ends, though the Miners' Federation may have to alter its policy it will still continue to exercise a close control over those working in the mines. Even if such a breakaway did occur, we are not certain that it would be a good thing. Nor will it be a good thing if, as Mr. Hodges prophesies, the men are forced back by starvation. In neither case would any real settlement of the dispute be obtained and there might well be a greater state of uncertainty than exists at present. We must therefore wait and hope that before long some agreement will be reached, an essential of which will be stability and peace in the industry for a period of years. This is as necessary for the coal industry as for everyone else. For while much is being made of the effect of the dispute on the industry of the country generally, little is said about the effect of the dispute on the coal industry itself. Yet that effect must be profound. For one far-reaching result will be to show the community how both by economising in the use of coal and by the adoption of alternative methods of obtaining power they can rid themselves of the chains placed upon them by mine owners and miners alike. The more we occupy ourselves with ways and means of the economising of coal, and the electrical industry can very greatly help everyone in this, the sooner will this present dispute be concluded and the longer will the peace that follows it endure. Wielding the big stick is very amusing for the wielder until his weapon breaks; and the big stick is cracking.

The Engineering and Tramway Disputes.

Fortunately the outlook in the other industries in which wages disputes are taking place is bright and there seems little possibility of the futile idea of a general strike coming to fruition. In the engineering industry both the leaders and led are behaving sanely and we have every hope that a ballot will show a majority in favour of accepting the revised offers recently put forward by the employers. In the tramways industry the adjustment of wages is being conducted on constitutional lines, the proposal being that wages after August 1st shall be regulated in accordance with a sliding scale based on the cost of living. This is obviously not only the correct but the most beneficial procedure and in every industry it should be an aim to obtain an agreement which will allow wages to be regulated in some such way and wherever possible also to relate a man's earnings to his production. For what we require more than ever at the present time is an increased output of goods. Improvement in present conditions will surely follow.

Reaction at Dover.

The Dover Electricity Committee have done a stupid thing. Last December in common with most other undertakings they accepted the agreed schedule of salaries for the engineering staff employed in their electricity works. Now, imbued, we suppose, with a laudable desire to reduce the rates, they propose breaking this agreement by introducing a much reduced scale of payment. The chief assistant, for instance, instead of receiving a salary of £538 as at present, is to exist on £400. While we are second to none in desiring an early reduction of both national and municipal expenditure a certain judgment must be exercised and a certain procedure followed in bringing these changes about. To do otherwise is to invite trouble. For had a little less haste been employed there need have been no coal strike, a lesson that has not apparently been learned at Dover. Again, this is an age of collective bargaining, and if the Dover Electricity Committee feel they cannot continue to pay the present salaries they should have brought the matter before the appropriate District Joint Board. There is another reason why this should have been done. For employees generally, and members of the Electrical Power Engineers' Association in particular, are always being counselled to adopt constitutional methods to obtain alterations in their wages. This is good advice. But it is equally good for both sides.

Poplar and Power.

Poplar, besides distinguishing itself as a defaulting ratepayer, is now the home of a new variant of the much worn saying that electricity is still in its infancy, by laying down through the mouth of its counsel that electric light is a kind of luxury. This dictum, while put forward as one reason why the Poplar electricity works could be distrained in default of payment, is in fact singularly inapplicable. The Council's electricity department is not a luxury, but its most successful commercial enterprise, and is only incidentally a lighting and mainly a power undertaking. For of the 20 million units sold in 1919-20 over 17 millions were supplied for power, 374 000 for public lighting and only 352 000 for private lighting. Under such circumstances to say that the electricity undertaking is a luxury is absurd and like Dr. Johnson's famous mistake, may be ascribed to that ignorance of things electrical which is as prevalent in legal as in other lay circles. It is, however, an ignorance which persists in persisting and will not be removed until people generally take the trouble to make themselves more acquainted with the true facts of the case. And with polo and tennis to interest them that is not likely to be yet awhile.

The Press and the Electricity Bill.

Nor are they likely to do so while such statements as that which appeared in a well-known Sunday paper regarding the Electricity Supply Bill are given publicity. The Bill, according to our contemporary, means a great amount of Government control over electrical power and light undertakings and another big increase in the bureaucracy. This statement contains just that germ of truth which makes it so dangerous and also so false. The baleful workings of Government control have rightly determined the public to have no more of them and we yield to no one in our desire to have the electricity supply industry freed from their tentacles. At the same time we feel that this freedom and the development of the industry generally will come more easily from a well-considered system of legislation designed to remove present disabilities and giving us a chance to work out our future for ourselves than from an ill-considered opposition to all schemes for improvement engendered by one faction whose short-sighted object cannot make for the future prosperity of the industry generally.

Weird Municipal Finance.

We are not surprised to learn that more than one municipal electricity supply undertaking is faced with a deficit on the past year's working. The soaring prices of coal and stores, increased salaries and wages and the upward tendency in the price of other items have all contributed to upset the most carefully prepared estimates. Under such conditions it is obvious that the most conservative financial policy is the best and stabilisation should be the primary care. An excellent way of how not to do this is to be found in what has recently happened at Redditch, where a deficit of £5 000 on the electricity undertaking will have to be faced during the ensuing half-year. In addition, a sum of £3 000 for extensions previously undertaken has not been repaid, and there is an overdraft amounting to over £8 000 on the revenue account. Apparently no loans have been negotiated since 1911, all money expended since that date being on bank overdraft at the usual bank interest. This extraordinary catalogue is completed by the auditor refusing to allow the suspension of £6 657, representing accumulated sinking fund, &c., and ordering the amount to be transferred to the revenue account, thus reversing last year's decision when this policy was allowed. The day of reckoning has come at Redditch indeed!

A Foolish Policy.

It is not, therefore, surprising to learn that there have been heated words at the Council meetings, and we expect that the oscillations thus generated will similarly energise the ratepayers when they hear that the result of this system of managing the electricity undertaking by their elected representatives is that they will be saddled with an extra 2s. 6d. rate. This policy of not paying off the interest and sinking fund on the capital is both an irregular and foolish one, though it is frequently practised. And though it may have some shadow of an excuse in undertakings which are not doing particularly well, even this excuse cannot be employed at Redditch, where the plant is modern, there is a good demand for power and generally the nucleus for the establishment of a substantial undertaking. The best advice we can give, therefore, is that present commitments should be cleared off at the earliest possible moment and that in future the use of suspense accounts and bank overdrafts should be eschewed and attention turned to building up a proper reserve fund to deal with any contingencies that may arise.

Mr. Frank Ayton.

His many friends in the electrical industry generally will learn with interest that Mr. Frank Ayton, chief engineer and manager of the Ipswich Corporation Electricity Supply and Tramways Department, has been appointed joint managing director of the well-known firm of Messrs. Ransomes, Sims and Jefferies, filling the vacancy caused by the retirement of Mr. Victor Bone, who has taken up a position as works director to the board of Messrs. Ruston & Hornsby, Ltd. That Mr. Ayton should be leaving the appointment which he has held since 1903 will not come as a surprise to those who know the lack of recognition which the Ipswich Corporation have accorded to his services and enterprise. This is unfortunately not an unusual occurrence in the municipal electricity supply world. Almost exactly a year ago we called attention to the shabby way in which Mr. Ayton had been treated and pointed out that one result was to attract the most ambitious men from the municipal service to the more appreciative ranks of private enterprise. In making these remarks we drew the obvious moral. It has been left for Mr. Ayton, whom we heartily congratulate upon his new appointment, to adorn our tale.

Some Thoughts on the Electricity Supply Business.

The resemblance between the electricity supply industry and the atom is so close as to merit attention. Both were for long considered indivisible, but now it is known that both consist of a number of parts, each active in itself and each exerting an influence, not only on external objects, but on the other parts of the body of which they form part. When the industry was in its atomic stage, the problems with which those directing it were mainly concerned were of an engineering character, but since its division into electrons has taken place problems of this kind are seen to be only one section of a complicated whole and are, though the most interesting, not at present the most difficult that have to be dealt with. This is an aspect of affairs which is of the utmost importance in its effect on the development and management of electricity supply undertakings.

Divisions of the Electrical Industry.

Electronically speaking, the electricity supply industry may be divided into four parts, the engineering section, the administrative section, dealing with legislative questions, the managerial section, concerning itself principally with labour problems, and the business-getting section, often the most neglected of them all, upon which the health of all the others depends. All these sections are growing, the difficulties connected with their development are increasing, both in magnitude and interest, and a thorough and constant examination of their condition and of their interaction one upon the other is therefore necessary in order that there may be no check to the progress of electricity supply. To make this examination requires not only an efficient system of control, but an efficient controller, to employ a much-abused word. For the variety of the problems in each section and the differences that naturally exist between them are such as to render the best type of management a necessity. Indeed, the time has come when a reorganisation of all undertakings, except perhaps the very smallest, is essential in order that the work may be carried on efficiently in the light of a clear recognition of the many-sided character of electricity supply. This reorganisation predicates an extension of the limits of authority of municipal undertakers, including power to equip showrooms, use overhead wires and other similar matters.

Legislative Problems.

The necessity of such reorganisation is obvious when we instance the consideration that has to be given not only to the complicated legislation which is now before Parliament, but to the enquiries which are being held by the Electricity Commissioners and to such minor problems as wayleaves, agreements for supply and other similar matters.

Technical Improvements.

But important as legislation is, true development cannot be achieved unless every means is taken to ensure that on the technical side the generation, transmission and supply of electrical energy are effected in the most economical way possible. To ensure this means a constant consideration of the methods employed in designing, manufacturing and using the generating plant, the switchgear and the variety of auxiliary machinery which goes to make up the modern generating station no less than in dealing similarly with all the equipment which is part of the distribution system.

Some Points for Consideration.

For that reason no apology is necessary for once again publishing articles such as those by Prof. **Stoney** and Prof. **Burstall**, on the subject of improvements in the prime movers used for generating electricity, or such as that by Mr. **Ryecroft**, on the allied subject of the fuel employed. Such considerations are, in fact, essential on the broad grounds that it is necessary to do everything possible to ensure that each unit is generated at the minimum cost. It looks as if in some ways we have reached saturation point in this field. Nevertheless, further improvements are worth striving for not only as an end in themselves, but as opening up interesting avenues of speculation.

Similar considerations apply with equal force to a consideration of the improvements possible in switchgear, auxiliary plant and cables, and the problems which have to be solved in this direction call not for any general knowledge, but for a specialised acquaintance with the many aspects of practical and theoretical engineering.

Employment Problems.

No less important are the problems connected with the well-being of those employed in electricity supply undertakings. Fortunately disputes between employers and employed have been neither so numerous nor so heated as those in other industries, but friction has existed (and does exist) and can only be removed by a detailed and open consideration of the various points at issue, a consideration which must be undertaken in a conciliatory spirit by representatives of both sides. Except in the most reactionary circles, it is recognised that the time has past when it was possible or even good policy to pay the engineering staff of electricity supply undertakings starvation wages, and most undertakings, municipal as well as privately owned, have recognised, as Alderman **Walker** says, the weakness of spending large sums of money on efficient plant and neglecting to provide well-selected, well-remunerated and contented workpeople. The only result of such neglect is, in fact, that men of the knowledge and character the electricity supply industry most requires are either not attracted to that industry or remain in it only until they can obtain more remunerative work elsewhere. Good conditions of service, generous remuneration and favourable prospects are essential to contented workers and to the well-being of the industry as a whole. While, therefore, the employment question is not, and can perhaps never be, wholly settled, we hope that with the help of the National and District Councils outstanding points will be discussed and decisions reached not only beneficial to those concerned, but such as will act as an example to other industries.

Selling, After All, the Object.

But having put nearly all his energies into solving the legislative, technical and administrative problems of electricity supply, the manager of an undertaking finally discovers that, important as all these undoubtedly are, they are less important than the fourth emanation from the original electricity supply atom, the business-getting electron. For all legislation, all technical improvement and all efforts to improve conditions of employment are, and can be, of no value unless the business is being adequately built up with the help of the most progressive policy. This question of increasing the sale of electricity is one to which much less attention than it requires has generally been given, but it is one of such paramount importance from every point of view that the closest attention must be given to it in the future. It has been neglected partly because supply has either been in the hands of a municipality or of a private undertaking fettered by legislative restrictions. The growth in the use of electricity has, in fact, depended very little on the efforts of any sales organisation and the growth has been unstimulated and almost unfed. We flatter ourselves that the growth has been great, but in reality we have much the fringe of the vast field there is to till. Really to develop electricity supply in the way it should be developed requires the inauguration of a business-getting campaign on the most modern lines. This campaign to be successful will necessitate the co-operation of the manufacturer and the contractor, especially the latter, but it requires most a policy, a leader, and vision.

The Remedy.

It follows that the days of municipal electricity supply, as we understand it, are numbered. The enterprise and liveliness of private ownership unhampered by absurd restrictions, but responsible for their policy and operations to some body representative of the public, are necessary for bringing about that re-orientation of conditions in the electricity supply world which are necessary to its satisfactory development. It may, we hope, will, mean a greater specialisation of duties, with the result that everyone will be doing the work for which he is best suited, a condition of things which, unfortunately, does not exist at present.

Recent Advances in Steam Turbine Design.

By GERALD STONEY, D.Sc., F.R.S.

The use of steam turbines for central stations dates from the time when four 75 kW non-condensing steam turbines were installed in the Newcastle and District Electric Lighting Company's station in 1889. Since then the use of steam turbines in Power Stations has become universal, but the real start may be said to have been made when steam turbines were constructed to work condensing in 1891 and two of 150 kW were installed at Cambridge.

During the 30 years which have elapsed since that date the largest size usually installed has increased from 150 kW to 25 000 kW or over, and at the same time the steam consumption per kW hour has been reduced from about 27 lbs. to well under 10 lbs. This development has been due not only to increased efficiency in the turbine but also to there being more heat drop available due to increased steam pressure and temperature as well as increased vacuum.

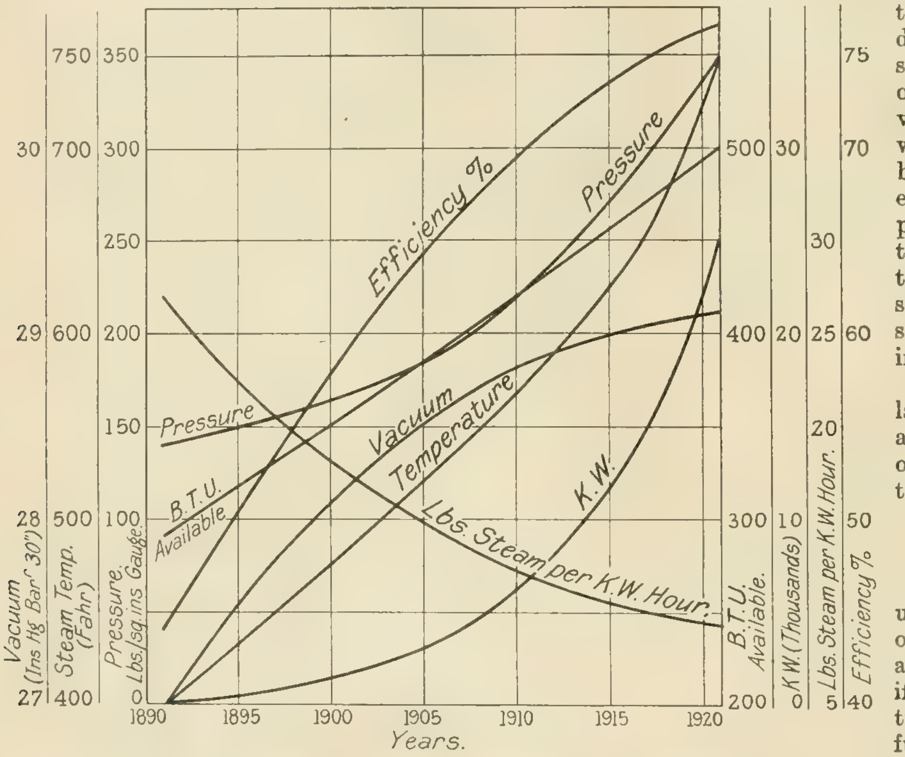

Fig. 1.—Diagram of Turbine Progress during 30 Years.

Pressure, Temperature, Vacuum and Heat Drop.

Fig. 1 gives approximately the curves for steam pressure, steam temperature, vacuum, heat drop available, size of turbine, steam consumption and efficiency for the 30 years taking the case of the most advanced practice at each date. These curves are, of course, very approximate, as there are always large variations in practice, and they are only intended to show the general tendency in central-station practice.

One noticeable point is that with the exception of the vacuum curve none of the curves seem to show signs of "saturation," and it is difficult to say what the future will bring forth.

The temperature of steam at a vacuum of 29·1 in. is 77°F., and with cooling water at 53°F. there is only a difference of 24°F. between the cooling water and the steam temperature. As it is not practical for the cooling water to be more than about 70 times the steam condensed it means that there is a rise of about 15°F. in the cooling water leaving only 9°F. difference betwen the steam temperature and the temperature of the water leaving the condenser, which latter temperature, of course, represents the highest vacuum possible. Such a small difference as 9°F. is quite possible in a good condensing plant, but there is not much prospect of it being materially reduced at present, so that with the cooling water available in this country there seems little prospect of much further increase in vacuum. To get this difference the condenser must be designed with a minimum of drop between the turbine exhaust and the air pump, so that there must be ample way through the tubes to prevent loss of pressure, which means ample area for the steam to get to the tubes and also sufficiently wide pitching to enable the steam to get between them. The area through the tubes should then gradually diminish to the air-pump suction. Another important point is that the condenser be so arranged that the whole of the tube surface is utilised and that there be no pockets in which air can collect. Even with the best arrangement the partial air pressure in the air pump will not exceed probably 1/10 in. of mercury, and so most efficient air extraction is necessary. No ordinary reciprocating air pump can deal with such low air pressures, and as a result it is universally the practice where the highest vacuum is desired to have either a valveless pump, such as the Le Blanc or its modifications, or else a steam jet to concentrate the vapour and increase the partial air pressure, when the vapour can be dealt with either by further steam jets or some form of water ejector or a reciprocating pump. The importance of getting a minimum drop between the temperature of the exhaust steam and the temperature of the cooling water is well seen when it is remembered that every 1°F. saved means about 1½ more B.T.U. available in the turbine per lb. of steam.

Of course, the drop of pressure between the last row of blades and the condenser must also be made a minimum by the provision of ample exhaust area and easy curves for the flow of the steam.

Limits of Steam Temperature and Pressure.

With regard to steam temperature the upper limit is imposed by what the material of the superheater tubes will stand. These are generally mild steel, and it is doubtful if such material will stand a steam temperature of much above 750°F., so that much further increase of temperature is not possible unless some better material, such as possibly pure nickel, is used.

Steam pressures will probably increase, as there is no fundamental difficulty in going to pressures higher than 350 lbs. per sq. in. in water tube boilers, and there are signs already of such increase of pressure. At the same time it has to be remembered that the steam turbine can more efficiently utilise low pressures and large volumes than high pressures and small volumes.

High Vacuum Difficulties.

The great difficulty in utilising high vacuum efficiently is the difficulty of providing sufficient exhaust area to prevent the terminal losses being serious. The volume of the steam at the exhaust is approximately $V=\frac{300}{p_0}$, V being the volume in cubic feet per lb. and p_0 the absolute pressure in lbs. per sq. in. in the exhaust. If Q=steam used in lbs. per hour the total volume at the exhaust will then be $\frac{Q}{3600}\times\frac{300}{p_0}=\frac{Q}{12p_0}$ cubic feet per second. If the area of the exhaust annulus of blades is A square feet then $A=\frac{\pi h d}{144}$, where h is the blade height and d the mean diameter of the blades in inches. If, then, it is assumed that the steam leaves the blades axially, as it should with properly designed blading, the leaving velocity in feet per second will be $c=\frac{Q}{12p_0A}$ and the B.T.U. lost will be B.T.U. $=\frac{c^2}{50\,000}$.

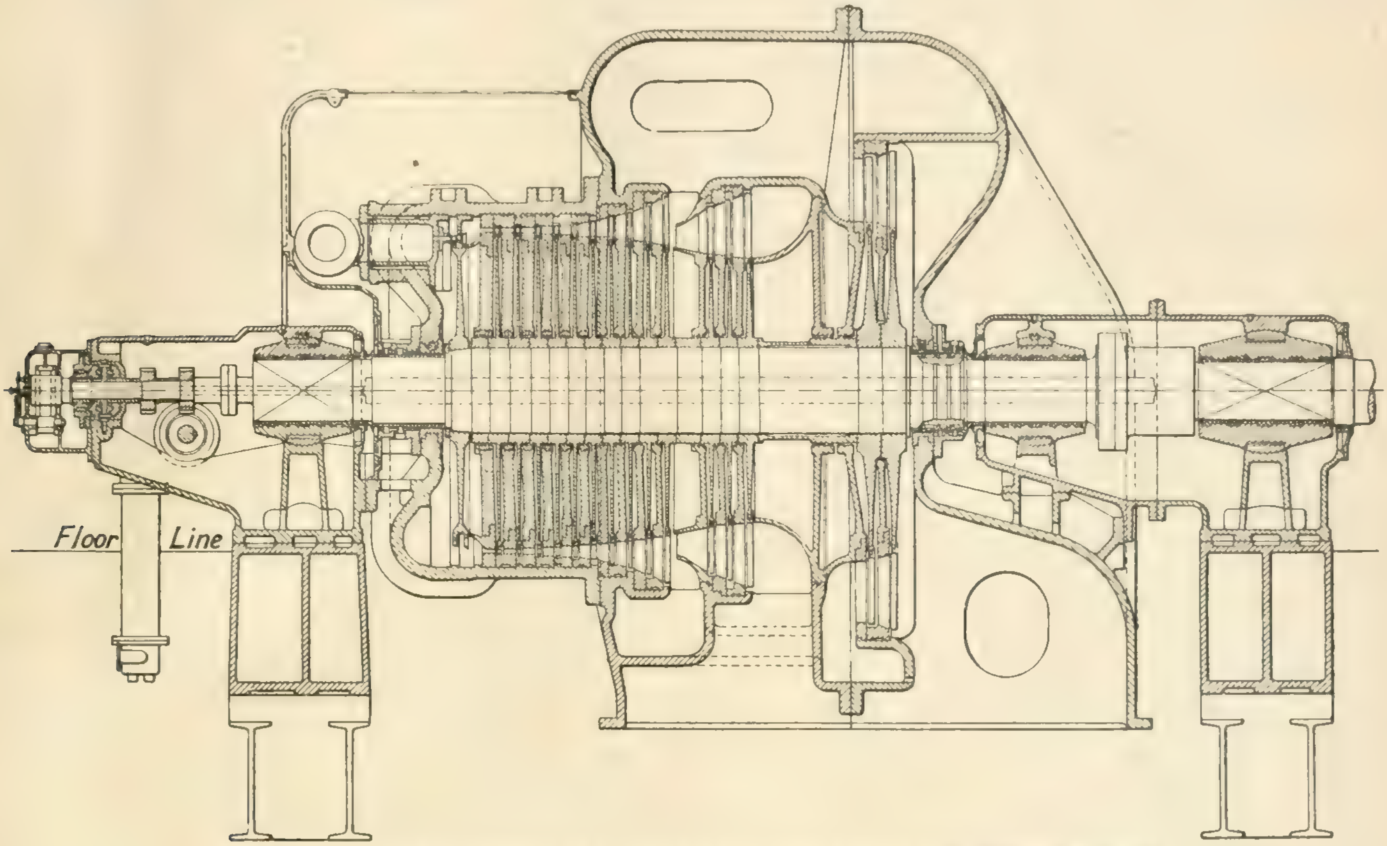

Fig. 2.—Sectional Arrangement of a Fraser & Chalmers Rateau High-pressure Turbine.

This in well-designed turbines should not exceed, say, 3 per cent. of the B.T U. available as a maximum and is generally less. It will be seen that this terminal loss varies inversely as the square of the exhaust pressure and inversely as the square of the area of the exhaust annulus. It also varies directly as the square of the quantity of steam passed or approximately as the square of the kilowatts. If the ratio of mean diameter to blade height is fixed, the loss then varies inversely as the fourth power of the blade speed with given revolutions. Formerly it was usual not to have the ratio d/h less than 5 at the exhaust end; but now, to get more area, designers are going to make $d/h=3{\cdot}5$, or even less. If the blade velocity is limited, and it is limited by consideration of the allowable stresses from centrifugal force, &c., then the output of a turbine at given revolutions is limited by this allowable terminal loss.

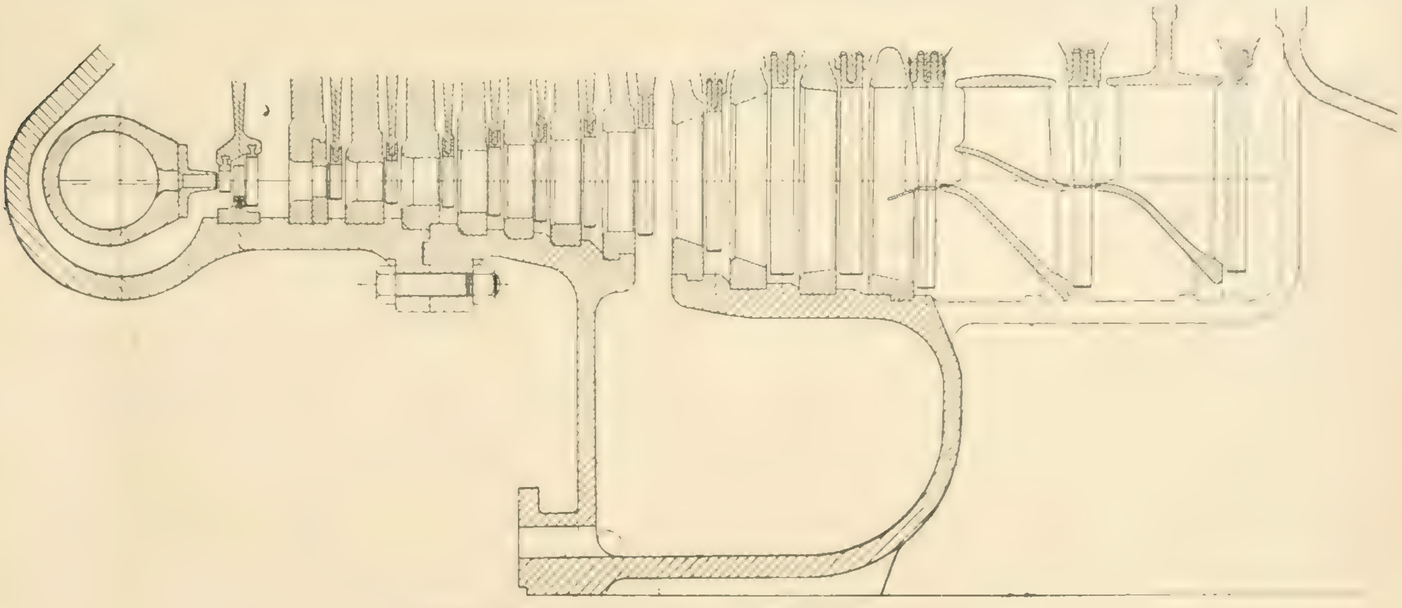

Fig. 3.—Metropolitan-Vickers Multiple Exhaust.

3 000 revs. per min. Turbine Data.

If an example of a turbine is taken running at 3 000 revs. per min. and having, with a vacuum of 29·1 in., barometer 30 in., 500 B.T.U. available giving a consumption of 9 lb. per kWh, it is easy to estimate the maximum kilowatts possible with a plain exhaust taking the blade velocity $u=600$ ft. per

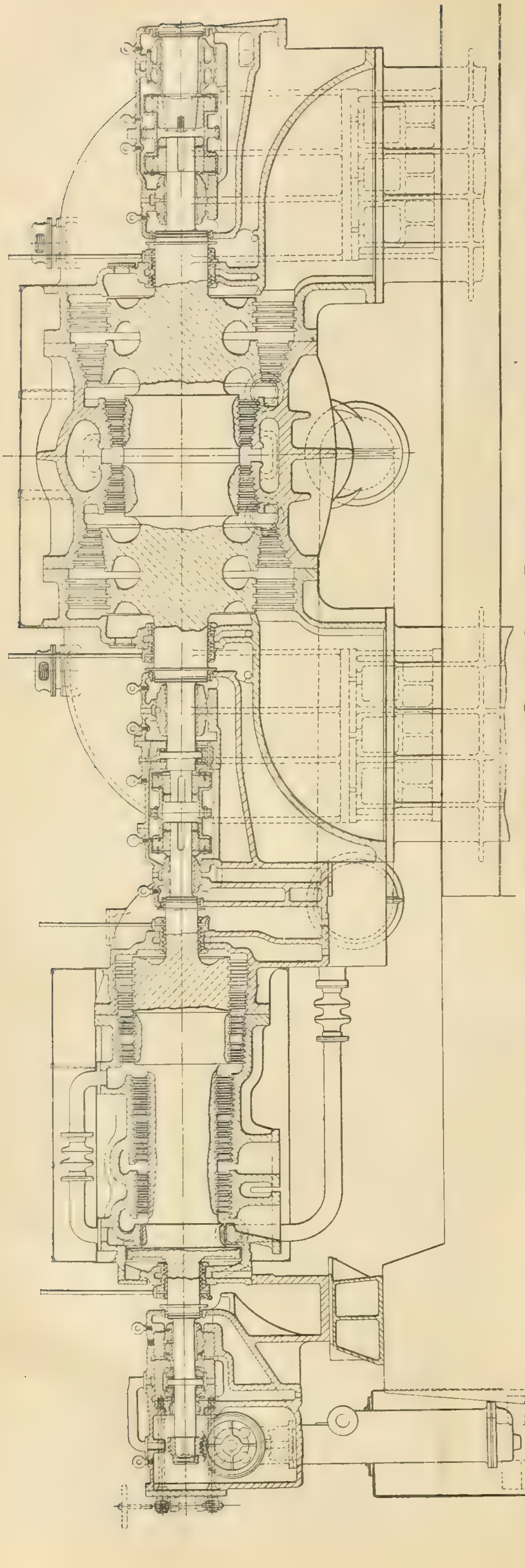

Fig. 4.—Longitudinal Section through a Parsons Tandem Turbine.

second, and the ratio $h/d=3{\cdot}5$, the terminal loss being limited to 3 per cent. or 15 B.T.U. The axial velocity of the exhaust steam will then be $c=224\sqrt{\text{B.T.U.}}=224\sqrt{15}=870$ ft. per sec. With a blade velocity of 600 ft. per sec. at 3 000 revs. per min., the mean diameter is 46 in. and the blade height 13⅛ in., so the area is 13·2 sq. ft. The pounds of steam passed per hour will then be $Q=12p_0Ac=12\times0{\cdot}45\times13{\cdot}2\times870=62\,000$ lb. per hour which, at 9 lb. per kWh, will give just on 7 000 kW.

For 28·2 in. vacuum, or $p_0=0{\cdot}9$ lb. per square inch, the limit would be double this, or 14 000 kW, showing the great effect the vacuum has on the design of the exhaust end. As the output of similar turbines is inversely as the square of the revolutions a 28 000 kW turbine could be made at 1 500 revs. per min. for 29·1 in. vacuum under the conditions assumed. As, however, turbines up to 15 000 kW at 3 000 revs. per min. and over are now being made for a vacuum of 29·1 in., and as moreover 3 per cent. is rather an excessive loss to allow, it is evident that some means must be taken to reduce the terminal loss.

Disadvantages of Higher Blade Speeds.

One way and a very tempting one is to put up the blade speed as the kilowatts vary as the fourth power of the blade speed with given terminal loss. Thus, if in our turbine the blade speed was put up to 725 ft. per sec. the terminal loss would be 3 per cent. at 15 000 kW. The difficulty is the very high stresses that such blade speeds necessitate in the blades and discs, and the difficulty of getting really reliable material to give a safe factor of safety with such stresses. Recent disasters, especially in America, are a lesson as to the danger of too high blade speeds. Another way is to have a double exhaust, and this may be arranged in one casing by having the whole of the steam passed through the high-pressure part and then splitting it for the double low-pressure part. Such an arrangement is used by Messrs. Fraser & Chalmers, and is shown in Fig. 2.

Another method is to have a tandem turbine with a double-ended low pressure, and such an arrangement is shown for a Parsons' turbine in Fig. 4, made by Messrs. C. A. Parsons & Company, Ltd. The tandem arrangement has also other special advantages which are dealt with later. Either of these, of course, doubles the output.

A third most ingenious method is that contrived by Mr. K. Baumann and used by the Metropolitan-Vickers Electrical Company, where the steam from the outer part of the blade passes direct to the exhaust while that through the inner part passes through one or more supplementary stages. Such an arrangement is shown in Fig. 3. With a two-stage exhaust the area is increased by about 1·6 times, or with a three-stage 2·2 times. By such devices as these either the output can be increased, the terminal loss reduced, or the blade velocity and consequent stresses reduced.

The Effects of High Steam Temperature.

Having dealt with the effect of high vacuum on the design of large steam turbines, the effect of high steam temperature may be considered. It is probable that nothing has given so much trouble to turbine designers, manufacturers and users as the problem of dealing with the very high temperatures now in use. There is not only the problem of materials suitable to stand such temperatures, but also the question of the design being such as to avoid injurious distortion due to differences of temperature between various parts and also distortion due to different coefficients of expansion of the materials used.

So long as saturated steam or steam with only a small amount of superheat was used, cast iron proved quite suitable for the whole of the casings, provided the design was such that the distribution of metal was fairly uniform in the top and bottom halves of the casing so as to avoid radial distortion. Where, however, a temperature of about 450°F. was exceeded a phenomenon known as the "growth" of cast iron became manifest and caused in many cases serious trouble. This growth of cast iron may be described as due to the steam, and small quantities of other gases present in it, getting into the cast iron alongside the graphite plates in the metal and causing rusting, with consequent swelling and disintegration of the metal. In some cases the linear dimensions have been increased by as much as 3 per cent. and the cast iron reduced to a substance almost like loaf sugar dipped in ink. Not only this, but cracks in ribs and flanges are liable to form owing to differences in expansion. For example, in a flange or rib on a turbine casing, there is a temperature difference between the temperature in the bore of the casing and the outer edge of the flange or rib, and a large part of the stress due to this temperature difference is manifested as tensile stress at the outer edge of the rib. That this stress can be considerable is easily seen when it is remembered that a temperature difference of 100°C. or 180°F. causes a stress of about 15 tons per square inch in steel and 8 tons per square inch in cast iron. Both these figures are well above the elastic limit of steel castings or cast iron, and in the latter case cracks are especially liable to form owing to the ductility being so small. Such a difference as 180°F. is easily attained between adjoining parts in a turbine casing where there is high superheat. As a result it is now generally the custom to make parts of casings subject to high temperature of steel, which, being a homogeneous material, does not grow, and having considerable ductility is not so liable to form cracks.

BENDING TROUBLES.

Another trouble due to high temperature is the difficulty of preventing bending of the casing, causing radial distortion. As a rule, the longitudinal distortion is fairly uniform, and the serious thing is radial distortion. On this account it has been found that, in general, much smaller clearances can be used where the clearances are longitudinal than where they are radial. All turbines of all classes in which there are two or more stages must have steam packings with fine clearances somewhere. In the Parsons or reaction turbine there are generally fine longitudinal clearances in the dummies or balancing pistons and radial at the tips of the blades. Of late years, however, what is known as "end tightening" blading has been introduced, which has enabled the clearances and consequent leakage at the blades to be reduced to about one-half. Such blading is shown in Figs. 5, 6 and 7, and consists of short sections of blading with the blades silver-soldered to deep distance pieces at the root, and to a shrouding at the tips. These sections are then fixed into the rotor or casing, and the fine longitudinal clearances are as shown in Fig. 5, between the shroudings and the deep distance pieces. These longitudinal clearances can be kept considerably less than radial clearances, because the longitudinal distortion is small and also because any vibration affects the radial clearance, and not the longitudinal.

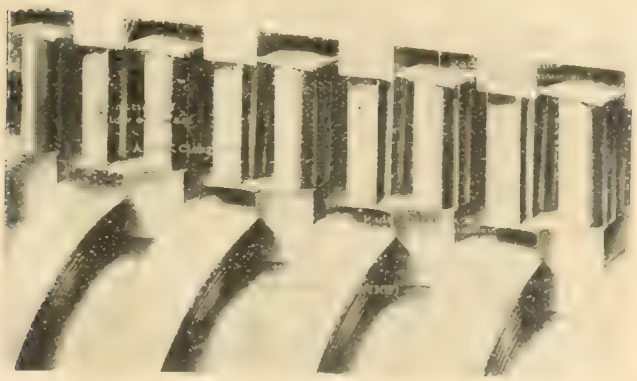

FIG. 5.—PARSONS END-TIGHTENING BLADING.

In impulse turbines the fine clearances at the diaphragms are usually radial. Longitudinal clearances would be difficult owing to the distortion of the diaphragms under the steam pressure and distortion due to temperature differences between the two sides. On the other hand, leakages at the diaphragms of impulse turbines are generally of much less account than the blade leakages of reaction turbines.

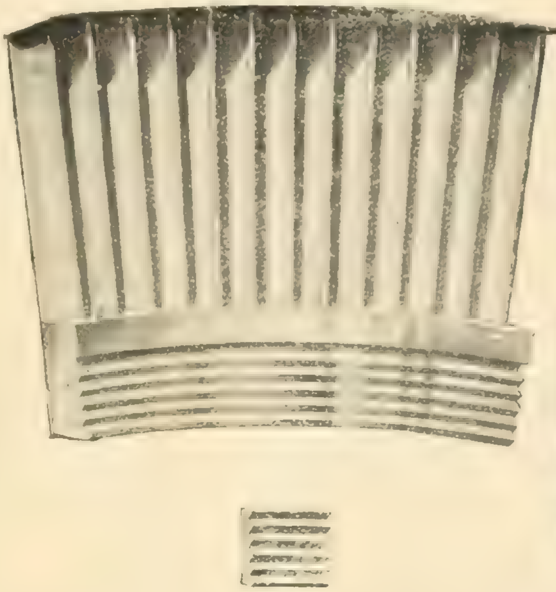

FIG. 6.

FIG. 7.

FIGS. 6 AND 7. SEGMENT AND CAULKING PIECES FOR PARSONS END-TIGHTENING BLADING.

One great improvement of late years has been that where there are fine clearances one member has a *really* fine edge, so that if touching does take place no damage will occur. Where two members have a large relative velocity and fine clearance, one of them must consist of a fine edge, or, if touching takes place, considerable heat is generated, and consequently damage occurs.

TEMPERATURE RANGE PROBLEMS.

In modern turbines there is a temperature range between the steam temperature of some 750°F., and the exhaust temperature of, say, 77°F. of between 650°F. and 700°F. The effects of such a temperature range in a single casing can be greatly reduced by carrying out the expansion in two casings instead of one, each having about equal power, and then about two-thirds of the temperature drop is in the small high-pressure turbine, of which the greater part of the casing can easily be made of steel, and only one-third in the large L.P. turbine. Further advantages are that the diameter of the high-pressure parts can be kept down, thus giving better blade heights in all classes of turbine and in impulse turbines increasing the arc of admission and reducing windage, so that in most cases it will be found that a better consumption can be obtained as well as a more reliable machine. Also it lends itself to a double-ended exhaust, thus reducing the terminal losses or the blade speed and consequent centrifugal stresses. Of course, it has the disadvantage that the whole plant is longer, but this is only a small one. At the same time, the parts to be handled are smaller and lighter as a rule. These remarks apply equally to reaction and impulse turbines, both of which can be and are made tandems. Fig. 4 is an example of such a turbine made by Messrs. C. A. Parsons & Co. It may be mentioned that the marine turbines as made in this country have invariably two turbines, a high pressure and a low pressure, and in some cases there are three—H.P., I.P. and L.P. Here, of course, in direct-coupled marine turbines, now obsolete, the question of having several screws to divide up the power and get better revolutions comes in, and in modern geared turbines the question of reducing the weight of the gears is of great importance; but the advantage gained by sub-division even where there was no superheat in the turbines was not ignored.

In the reaction turbine the casing is subjected at the high-pressure end to the full temperature and pressure of the steam. The diameters are, however, small, and with steel castings can be easily dealt with.

In the impulse turbine the only part subjected to the full temperature and pressure is the nozzle box, and this can be easily made to stand such, as it is small. Freedom for expansion of the nozzle box in the casing should be provided for, and this is well done by such a method as that used in the Metropolitan-Vickers turbine, and shown in Fig. 8. Another arrangement much used in marine turbines is shown in Fig. 9, and a similar one, used by Messrs. Fraser & Chalmers, in Fig. 10; but many other designs are also used. With a one-row wheel a temperature drop of about 70°F. to 100°F. can be obtained, or with a two-row about 150°F. to 200°F., so that not only is the casing exposed to lower temperature, but also to lower pressure.

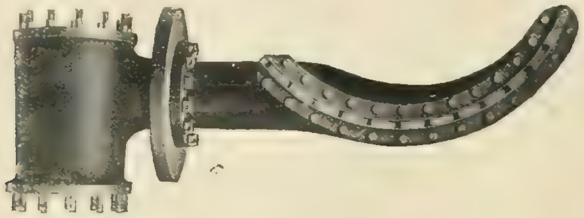

Fig. 8.—Metropolitan-Vickers Nozzle Box.

"Disc and Drum" Turbines.

The same advantage is gained in the "disc and drum" turbine as shown in Fig. 12, which is a 20 000 kW plant running at 1 500 revs. per min., made by Messrs. Richardsons, Westgarth & Company, Ltd., where, instead of a two-row impulse wheel being followed by one-row impulse wheels, the remainder of the expansion is dealt with by reaction blading. This gives a short stiff rotor for which it is easy to arrange a high critical speed. The internal steel pipe carrying the nozzles is also shown in this figure.

Radial Flow Turbines.

In the Ljungstrom turbine the whole of the high pressure and temperature is confined to the central portion of the turbine, as shown in Fig. 11, and the most ingenious methods of dealing with differences of expansion due to temperature cannot be dealt with here. In it for large sizes the rims of the wheels are provided with radial rows of blades, as shown in Figs. 13 and 14, thus getting a double-ended exhaust and increasing the exhaust area to reduce terminal losses.

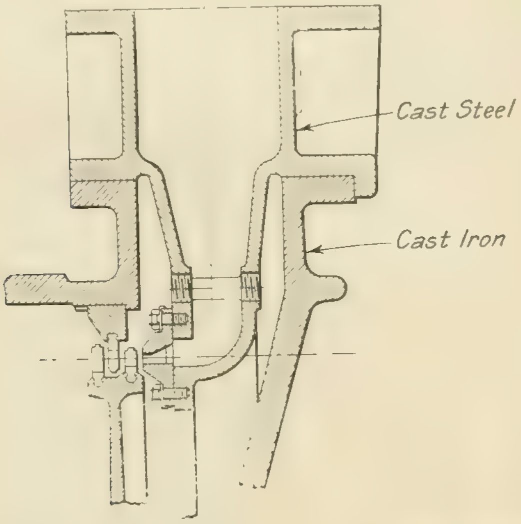

Fig. 9.—Marine Turbine Casing showing Cast Steel Nozzle Box.

Blading Material.

The problem of the most suitable material for blading is a most difficult one and up to the present has only been partially solved, although each maker claims his system of blading and material used is the best. Blade material is subjected at the high-pressure end to high temperature and therefore should be able to stand such temperature without losing its strength or ductility and should not be liable to oxidise. It should also not be liable to corrode due to impurities in the steam or due to damp when the turbine is standing, and also should be able to withstand the erosive effect of high-velocity steam. At the low-pressure end the stresses on the blading are generally much higher than at the high-pressure end, so that high tensile strength is of the first importance. The temperature is not high, but the material must be able to resist the erosive effects of high-velocity steam and also the corrosive effects. There is also often much liability to corrosion, just where the steam becomes saturated. One necessary requirement of all blading material is that it can be formed into blades without serious difficulty whether by drawing, forging or machining, or a combination of these processes. Further requirements are that the material be reliable, to be obtainable of good quality, and to maintain those qualities under the conditions which exist within a turbine.

The original material, which is still largely used in suitable cases, is brass consisting of 70 copper, 30 zinc; and one advantage of this material is that it is easy to draw into suitable sections. For saturated steam where the stresses are moderate it is most suitable, but unless free from all traces of lead, &c., it is liable to have a brittle point about 470°F., or just the temperature of moderately superheated steam. Its strength is also largely reduced at moderate temperatures and it is liable to erosion if the steam velocities are high. On the other hand, except with some bad feed waters, it does not corrode. Similar remarks apply to phosphor bronze, which is also largely used, especially in marine turbines. Another non-ferrous alloy is manganese copper containing from 3 to 5 per cent. of manganese, a material which has been largely used for locomotive fireboxes in France. It has high tensile strength which is maintained up to high temperatures, but has a rather low elastic limit, so that it is not suitable for highly stressed blades. It is not liable to corrode.

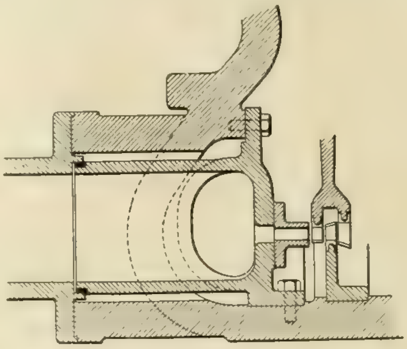

Fig. 10.—Fraser & Chalmers Nozzle Box.

The Advantages of Monel Metal.

A good material when of satisfactory quality is Monel metal, which is a natural alloy of copper and nickel with small quantities of iron and generally contains about 35-65 per cent. of nickel. It has high tensile strength and ductility which are well maintained at high temperatures, and is not liable to corrosion or erosion. Among the ferrous metals mild steel and nickel steel with 3 to 5 per cent. of nickel are prominent, and they have high tensile strength which is well maintained up to the temperatures used in turbines, but although they are comparatively free from erosion, there is often much trouble with corrosion. Various ferrous alloys are being tried, such as the high chromium steels known as "rustless," but little is known as yet as to their behaviour under prolonged and various conditions of working. Great care is necessary in the case of nickel alloys, both ferrous and non-ferrous, as many of them are not stable and liable to become brittle, notably 25 per cent. nickel steel and 20 per

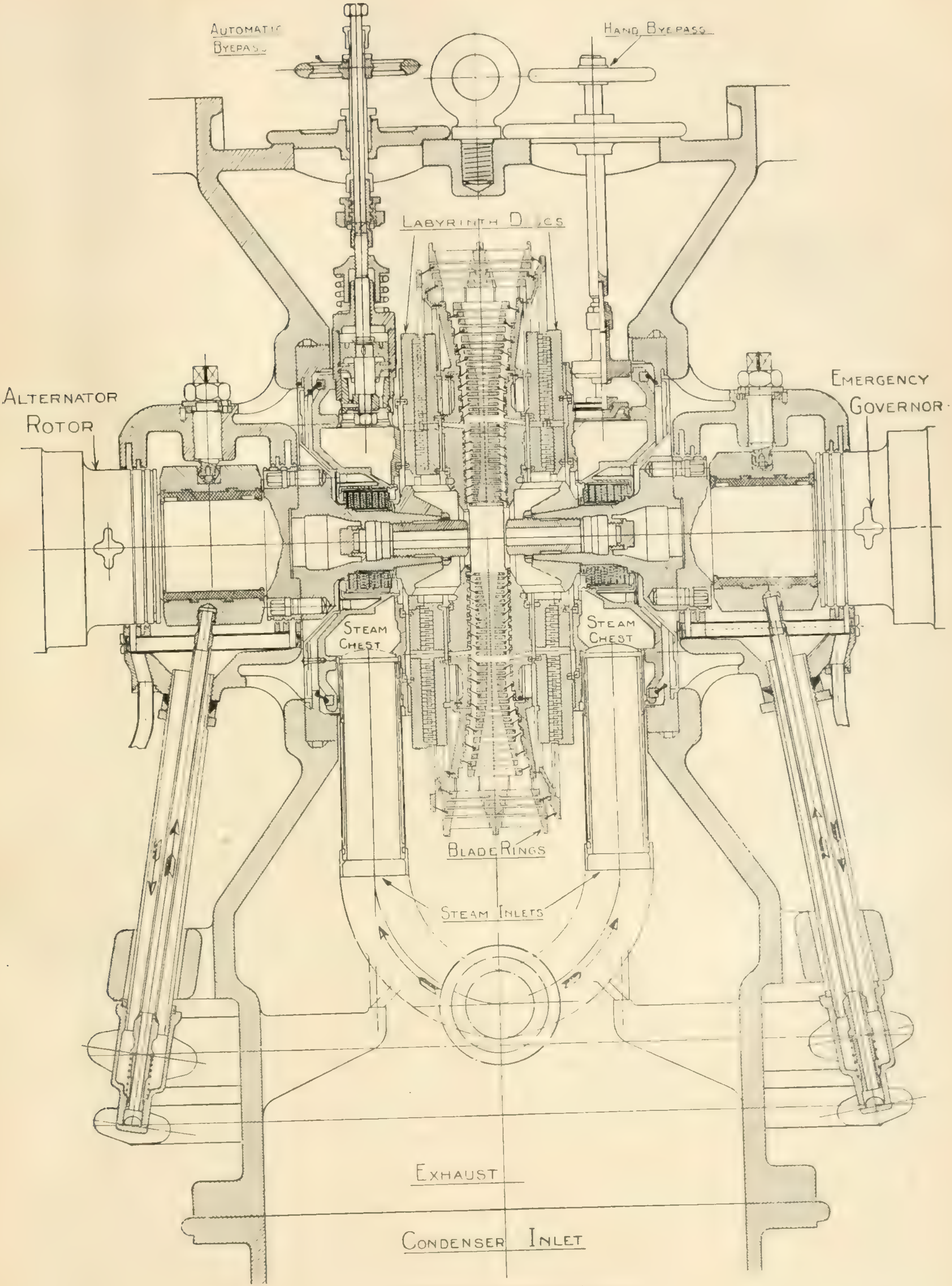

Fig. 11.—Section of Ljungstrom Turbine.

cent. cupro nickel, both of which have been used with disastrous results. Nickel-coated steel blades have been tried but do not seem to have come into use, and also various coatings to protect steel blades are being tried, but at present little information is available as to the benefits of such coatings.

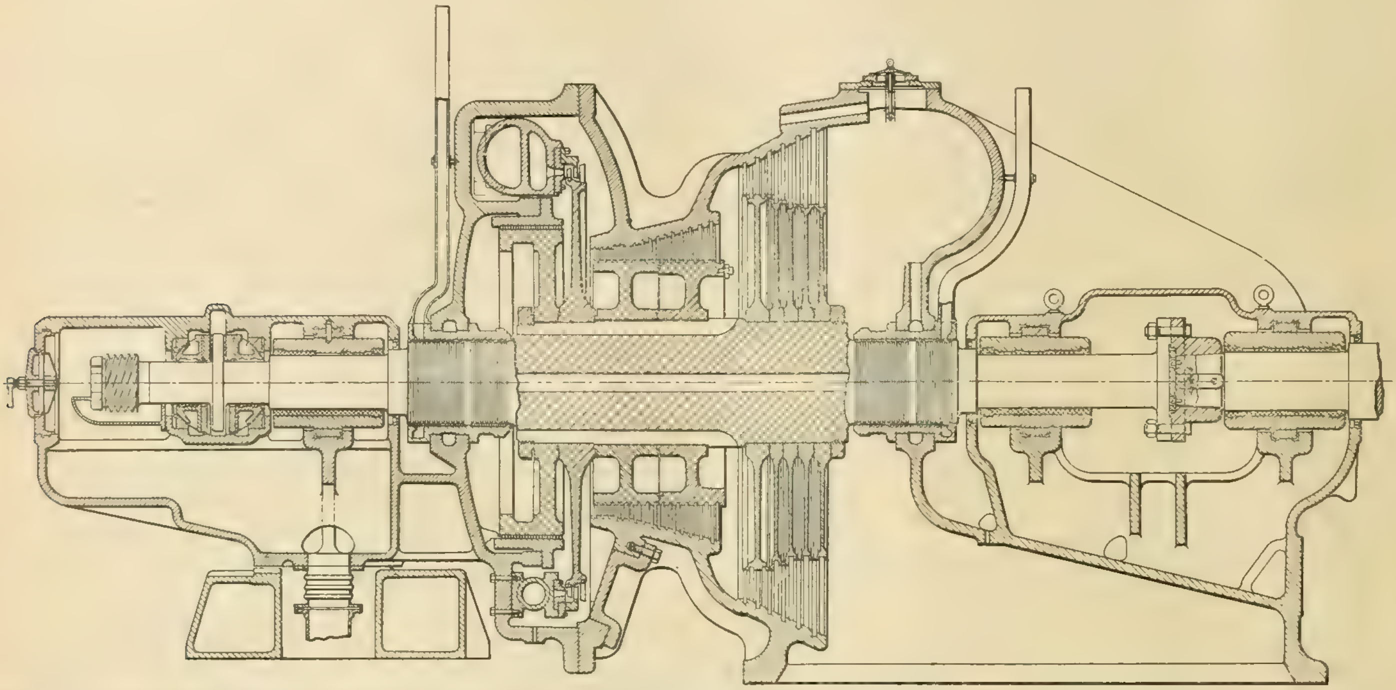

Fig. 12.—Longitudinal Section through Turbine of 20 000 kW Turbo-Alternator, 1 500 r.p.m. (Richardsons, Westgarth & Company, Ltd.)

All blading is liable to have deposit on the surface if the feed water is bad, but the material of the blade does not affect this deposit.

Effect of Blade Deterioration on Efficiency.

With regard to the effect on the efficiency of deterioration of the blade and surface of the blade, there are two conditions to be considered, firstly the nozzle and secondly the blade. In the reaction turbine, as it is all nozzles, the deterioration is at parts of the blade where the steam velocity is low, so that the effect in the efficiency is small. In the impulse turbine there is, besides the deterioration of the nozzles, the roughening of the surface of the blades, causing the skin friction to be increased and thus increasing the loss of velocity of the steam as it passes through the blade. This causes a serious loss of efficiency, more particularly in two and three-row blading, and may be so serious as to cause the steam to strike the back of the last rows of the moving blades and thus actually retard the revolution of the wheel.

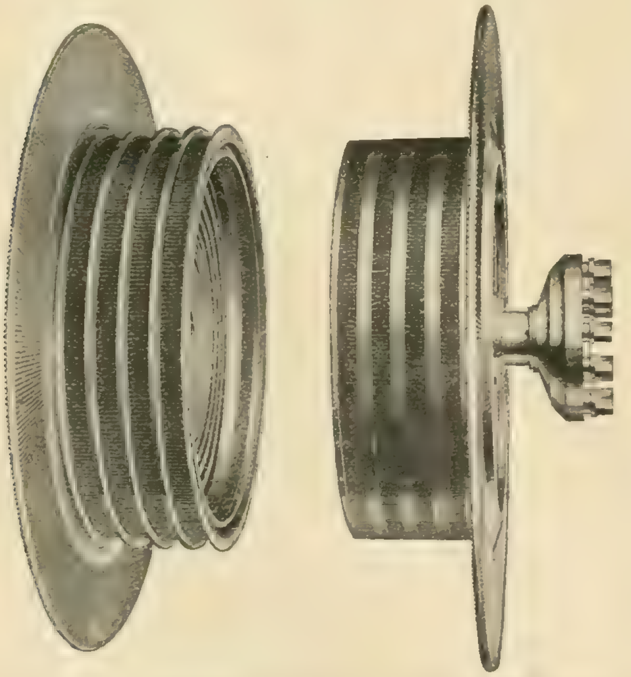

Fig. 13.—Large Ljungstrom Turbine, the Two Halfs Separate.

Effect of High Pressure on Design.

The effect of high pressure on the design of turbines hardly requires to be dealt with here as it is only a question of mechanical strength, and such stresses as are met with can in general be provided for without serious difficulty. An important advance in economy has been effected by having tappings from the turbine leading to one or more feed heaters and thus raising the feed water to boiler temperature, but this subject has been fully dealt with by various authors elsewhere.

The author must thank various firms for the assistance they have given him in compiling this article and would wish to say the opinions he expresses, many of them controversial, are ones for which he alone is responsible. In the space available only a brief and admittedly imperfect account can be given of some few of the problems to be dealt with in a modern turbine of large size and some of the methods of dealing with them.

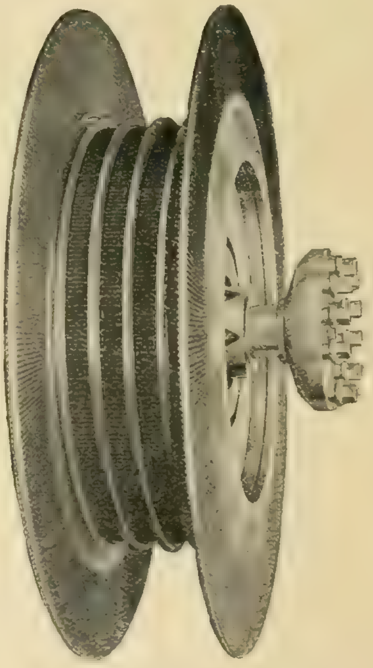

Fig. 14.—Large Ljungstrom Turbine.

The Production of Power from Internal-combustion Engines.

By Prof. F. W. BURSTALL.
(Dean of the Faculty of Science, University of Birmingham.)

THE cheap production of motive power is admitted on all sides to be an imperative necessity for the future progress of this country. The days of the small wasteful steam engine are already over, although unfortunately there are still too many uneconomical steam plants at work in various parts of the country. The last two years have seen a remarkable extension of electrical power schemes, and it appears to be almost generally accepted that electric current for motive power distributed from large power stations must be the most economical method of obtaining power.

The assumption which lies at the base of the distribution of power was first enunciated by Lord Kelvin, namely, that power distribution is economical when the saving in wholesale production is greater than the interest and depreciation and loss of efficiency in the distributing mains. No one will doubt that this is the case when comparison is drawn between the turbo-generator and the small engine, but that it is true when the much more economical internal-combustion engine is employed is a matter for investigation.

THE ECONOMICS OF INTERNAL-COMBUSTION ENGINES.

For the purpose of economical power production from internal-combustion engines, it is only necessary to consider a few forms. The gas engine on town's gas, the gas engine on producer gas and the oil engine working with crude heavy oil are some of them. The light spirit oil engine need not be taken into account, as the high cost of petrol precludes the high-speed engine from being considered as a source of motive power. The present form of gas engine as made by firms such as Messrs. Crossley Bros., Manchester, and the National Gas Engine Company, has long passed the stage in which there can be any doubt of its reliability for continuous working. The larger engine has had, unfortunately, a very chequered career.

Large engines up to 5 000 or 6 000 H.P. will undoubtedly come into use under certain conditions for industrial purposes where large supplies of blast furnace gas and even coke are available as by-products; but for general purposes, working on producer gas, the large gas engine is still passing through an experimental period and it is not proposed here to discuss the possibilities of such engines, but rather to call attention to the power obtained from small engines used for factory driving.

THE GAS ENGINE FOR FACTORY DRIVING.

The first case that may be considered is a gas engine supplied with town's gas, the size of engine being one which will continuously develop 37 B.H.P. The most important element in the power costs of such an engine is naturally the price of gas and it is most convenient to estimate the price according to the now legalised unit, the therm, which is 100 000 British Thermal Units. The price per thousand cubic feet can, of course, be expressed in costs per therm when the calorific value of the gas is known. The generally employed figure for town's gas to-day is 500 B.T.U.s per cub. ft., the heat being estimated on the higher value. The costs per therm appear to vary through very wide limits, from as low as 6d. in certain towns in the north of England, to as high as 1s. 2d. in London. The average value in Birmingham may be taken as 11d. per therm. The consumption per brake horse power of a gas engine varies considerably with the load, more especially with the modern engines in which the governing is effected by throttling the mixture. This method, universally adopted at present, gives extremely good running, but is rather less economical at light loads than the old method of hit and miss governing. Taking these facts into account, the figure of 10 000 B.T.U.s per brake horse power per hour is quite usual in ordinary normal working.

THE COST OF POWER.

In estimating the cost of power it is manifestly unfair to consider only the fuel and other running costs. A figure must be taken for interest on the capital expended and for a sinking fund which will include repairs.

Gas Engine on Lighting Gas.

Cost of engine, 37 B.H.P., and delivered and fixed at Birmingham	£800
Fuel cost of ditto, 50 hours per week and 50 weeks per year on lighting gas at 11d. per therm	424
Interest on capital at 7½ per cent.	60
Repairs, renewals and sinking fund at 10 per cent.	80
Lubrication and waste	20
Cooling water at 9d. per thousand gallons	10
Total cost of power per annum	£594

Total horse power hours, 92 500.
Cost per brake horse power per hour, 1·54d.

It will be noticed here that the cost of fuel is the most important item and that its cost is materially increased because gas under the present conditions is abnormally expensive.

GAS ENGINE WORKING WITH SUCTION GAS.

In this case there will be two fuel alternatives, the first being anthracite coal and the second gas-works coke. It is difficult to lay down any figure with regard to the cost of coal which can be looked upon as not at all definite under present conditions. The prices given are those communicated to me by Messrs. Crossley Bros., to whom I am indebted for a good deal of information as to current prices.

Suction-gas Engine on Anthracite Coal.

Cost of engine and producer delivered and fixed B'ham	£1 204
Interest on capital at 7½ per cent.	91
Coal cost at £3 18s. 6d. per ton	161
Labour, half one man's time	75
Repairs and renewal, sinking fund, at 10 per cent.	120
Lubrication and waste	18
Water at 9d. per thousand	10
Total cost per annum	£475

Cost per brake horse power per hour, 1·32d.

The consumption per brake horse power in this case is taken as 1 lb. of anthracite; a liberal figure, which will include lighting up and stand by losses. The price of anthracite makes this figure materially higher than it should be, as the fuel cost in this case amounts to nearly 0·42d.

The same plant working on coke as fuel in which the consumption is taken as 1·25 lbs. of coke per brake horse power per hour and the price of coke taken as £2 3s. 0d. per ton will give the following figures:

Cost of engine	£1 204
Interest	91
Fuel cost	108
Repairs and renewal and depreciation	120
Lubrication	18
Water	10
Labour	75
Total cost per annum	£422

Cost per brake horse power hour, 1·09d.

There is very little difference in the working of a producer plant on anthracite and coke, as regards cleanliness. Coke naturally contains a higher percentage of ash and there is more labour in cleaning the producer and poking down, but otherwise the second plant may be looked upon as identical.

THE USE OF CRUDE OIL.

A quite different source of power arises from the developments which have taken place in the use of crude oil. By crude oil is meant an impure kerosene generally having a boiling point rather greater than 180°C. and of a viscous nature. Such an oil consists mainly of the paraffin series. Crude oils which are sometimes used are those which are derived from the tar oils having a high boiling point and which will be referred to here under the general term of tar oil.

The best-known engine for heavy oil is the Diesel engine, in which a very remarkable efficiency is reached. For the purpose of the small consumer up to about 100 H.P., the Diesel engine need hardly be considered, first, because of its high capital cost, which under present conditions are somewhere in the nature of £30 per horse-power, and, secondly, owing to the high blast pressure used to inject the oil, *i.e.*, 60 atmospheres and above.

Diesel engines require rather more attendance than can generally be obtained in the ordinary commercial establishment.

Many other crude oil engines have been brought out, generally under the misleading term of semi-Diesel, that is, an engine in which fairly high compression is employed and the charge ignited by a hot bulb which is kept at a high temperature by the burning of the charge. These engines, while a considerable improvement on the older crude-oil engines, are by no means to be compared with the Diesel engine itself. The most recent development of the crude-oil engine is the solid-injection engine of Messrs. Crossley Bros. This engine is of the high-compression type and the charge is ignited by the mixture itself at the end of compression, thus agreeing with the principles laid down by that great master of internal-combustion economy, Beau-de-Rochas, whose work, dated 1869, contains all the essential requisites for economical working of internal-combustion machines.

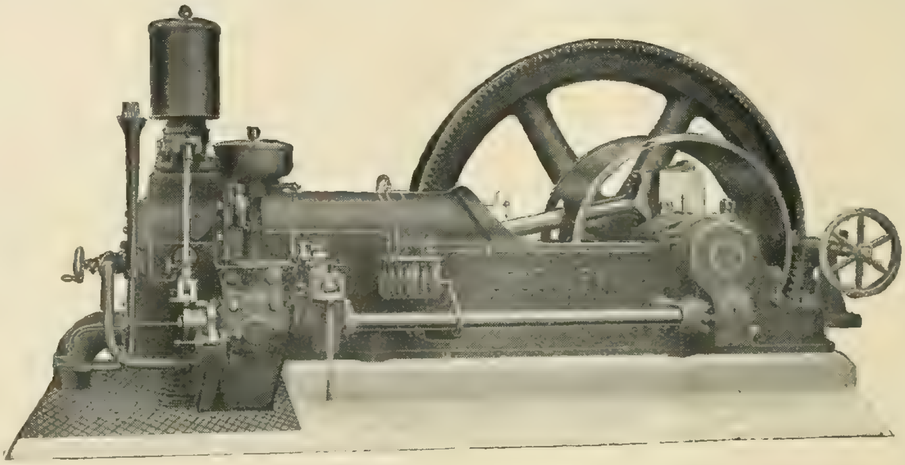

Fig. 1.—Crossley Solid Injection Heavy Oil Engine.

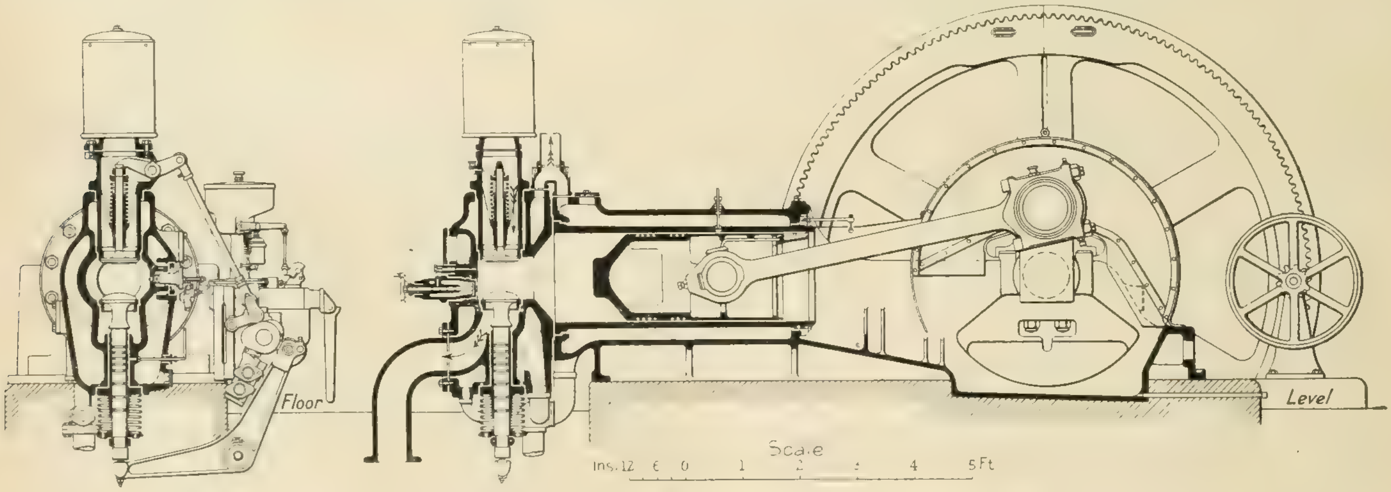

Fig. 2.—Sectional Arrangement of Size 28 Crossley Oil Engine.

The Crossley Crude-oil Engine.

The method of injection of oil adopted by Messrs. Crossley and the form of the combustion chamber differ entirely from the Diesel engine or any other crude-oil engine. The oil supply, which is controlled by the governor, is forced by means of a pump through jets at right angles to the axis of the cylinder, the pressure of oil employed being in the neighbourhood of 3 000 lb. per square inch, and it ignites with regularity and smoothness. Tests of this engine over a prolonged period show that the ignition is quite steady, even with the very lightest loads, and by introducing a charge of pure kerosene in front of tar oil it is possible to use the commonest grades of tar oil. This remarkable engine has shown itself to be very well adapted for positions where unskilled labour in attendance is essential. The engine starts readily and works without any difficulty as pumping oil against a high pressure is very much less liable to derangement than any air-compressing system. Illustrations of this engine are given herewith.

If crude oil is to be the engine fuel of the future, Messrs. Crossley will have the simplest engine for the purpose. Its economy figures are very remarkable as the consumption per brake horse-power varies very little from one-third of the full load to the full load itself and then increases rather sharply to the overload, which is about 20 per cent. greater than full load of the engine. The full-load consumption working on crude American oil having a calorific value of 18 000 B.T.U. per pound was 0·425 lb., and I am informed that since that date figures as low as 0·38 lb. have been obtained, which makes it nearly as economical as the Diesel engine itself on a compression materially lower than that generally employed in that motor

The solid injection is naturally materially cheaper in capital cost than in injection, and the cost figures with regard to this engine are those supplied by Messrs. Crossley, and the consumptions are those which have been obtained by myself.

Crude Oil Engine.

Cost of Engine, 37 B.H.P., and delivered and fixed Birmingham...	£1 171
Interest on capital, 7½ per cent.	88
Crude oil at £5 5s. per ton	165
Labour	50
Lubrication	20
Water	10
Repairs and depreciation	117
Total per annum...	£450

corresponding to 1·16d. per brake horse-power per hour. In all cases the total number of brake horse-power hours is the same, 92 500 hours.

The Economics of the Question.

These figures will enable electrical engineers, those interested in power production and the small user to judge for themselves how far electrical current is more economical than gas or oil engines, and such figures must be taken with regard to present costs as they are based upon capital figures which are abnormally high, as also are the costs of the special fuels for these particular engines. Under the more favourable conditions the prices per unit of power produced would be materially lower.

It may not be out of place here to consider the possible increased economies which are likely to be obtained in the near future from gas and oil engines. As regards their fuel consumption in the oil engine, the compression upon which economy depends has very nearly reached its economical limit. Any increase will mean very considerable additional capital cost.

The utilisation of the heat thrown away to exhaust in the oil engine is difficult, and hence it may be reasonably asserted that the oil engine will not materially increase in efficiency for the present. With producer gas, however, one can see material improvement in the use of the exhaust heat to improve the efficiency of the producer. The exhaust heat of the gas engine contains about 45 per cent. of the original heat in the gas, and it is discharged into the exhaust pipe at a measured temperature of about 500°C.; there is therefore a considerable amount of fairly high-temperature heat which could be utilised. The raising of steam from exhaust boilers is familiar, but as a source of power it is of little value owing to the inefficiency of the steam engine.

If a portion of the heat mentioned above could be employed to super-heat the steam and air supply to the producer, the material gain and efficiency in the combined plant would be considerable. I have been experimenting in this direction for a considerable period, using a form of regenerator, and have in this way affected very material economies in the combined plants. It would appear that in place of the consumption of the combined suction producer and gas engine being 1 lb. of anthracite per brake horse-power hour, it is quite possible to reduce it to 0·75 lb. and possibly slightly better.

The Still engine is attempting to utilise the exhaust heat on a Diesel engine for steam raising, and it is, of course, a good method of procedure and is likely to be developed in the near future.

The principle of regeneration does not appear to have received the attention which it deserves in the development of the internal-combustion engine. It is the most obvious way of obtaining increased efficiency and one which is perfectly practical.

Alternatives to Coal for Power Production.

By **PERCY E. RYCROFT, M.B.E., M.I.E.E.**

THE high price of coal during recent years, especially when coupled with an actual shortage of supplies, naturally encourages all fuel consumers and particularly steam raisers closely to consider the question of substitute fuels. At the outset it must be admitted that the governing factor in the use of alternative fuels to coal is whether they will prove a commercial proposition or, in other words, whether they will pay. The answer to this question must depend on the following considerations :—

1. The ruling price of coal.
2. The cost of the "substitute."
3. The period over which adequate supplies of the substitute, at staple prices, can reasonably be expected.

The Importance of Adequate Supplies.

This latter consideration is of the utmost importance, as it is of little use installing special plant for burning particular fuels unless adequate and regular supplies of such fuels at more or less firm prices over extended periods can be assured. Engineers will have many cases in mind where, after making special alterations to their plant or installing particular apparatus to burn a given fuel more or less valueless—take coke breeze as an example—the price of the commodity, after its usability had been established, soared to such heights as to make its continued use financially impossible. It is necessary, therefore, to set up some standard figure of cost, in order that reliable comparisons can be made, before deciding on the merits of any particular fuel.

So far as steam generation is concerned, the data required may be summarised as follows :—

1. The fuel cost of evaporating 1 000 lbs. of water.
2. Labour costs for the same work (including cost of handling fuel, firing, and removal of ash or residue).
3. Maintenance costs for evaporating 1 000 lbs. of water (including cleaning, renewals and repairs).
4. The capital cost of the plant.

No Technical Difficulties.

It may be said at once that there are no *technical* difficulties in connection with the utilisation of *any* kind of fuel for steam-raising purposes—with the possible exception of anthracite duff—which have not already been surmounted, but so far as electric power stations in this country are concerned, there is little evidence to show that "substitutes" for coal are gaining in favour.

Analysis of Methods Employed.

For the year ending March 31, 1919, nearly 5 000 million units were generated by the Electricity Supply Authorities in Great Britain. A reliable analysis of this figure shows that the method of generation was approximately proportioned as follows :—

By coal and coke	4 623	million units.
By waste heat	68	,, ,,
By exhaust steam	58	,, ,,
By refuse	28	,, ,,
By tar fuel	4	,, ,,
By gas and suction gas	61	,, ,,
By oil engines	23	,, ,,
By water power	11	,, ,,

It will be noted that the principal rival to coal is "waste heat," and the use of this "substitute" fuel is practically confined to the north-east of England, where steel and blast furnaces and similar sources of waste heat are most readily available. Boiler firing by means of waste heat offers no difficulty, providing a sufficient quantity of such heat is available. It is important to remember, however, that the term "waste heat" is apt to be incorrectly used, as under this description both incombustible and "live" gases are often included.

Definition of "True" Waste Heat.

A true definition of "waste heat" would be that it is *the heat from gases the combustion of which has been* ENTIRELY COMPLETED. The gases leaving heating, puddling and smelting furnaces, copper reverberatory furnaces and glass furnaces all correctly answer to this description, and where coke ovens are not externally fired, the gases given off from these may be added to the list. In the case of *externally* fired coke ovens, the gases given off, of course, contain a quantity of combustible matter, and if these were used under boilers, they would strictly come under the heading of "gas firing," and not "waste heat."

It is important to keep this distinction well in mind, as in every case where true waste heat is used, no furnace material, burners or combustion chambers—as such—are required, it being only necessary to feed the gases under the boiler through suitable flues.

To determine the practical possibilities of utilising any supply of true waste heat, it has to be remembered that the amount of steam evaporated by any boiler depends on the mean boiler furnace temperature. The temperature of the gases at the boiler flue *outlet* should not vary very considerably, and may be set down at about 550°F. The temperature of the inlet gases will, of course, vary according to the nature of work done in the primary furnace from which they are drawn, but it is likely to average somewhere about 1 100 to 1 200°F.

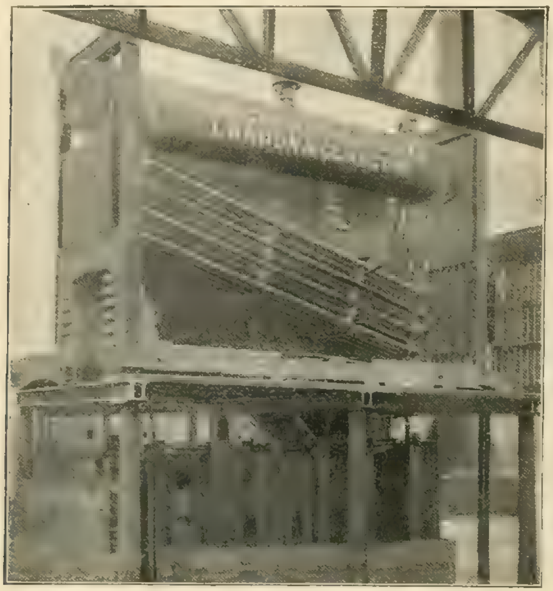

Fig. 1.—Waste Heat Boiler Utilising Gases from Re-heating Furnace.

As a coal-fired furnace, working under reasonable conditions, will have a temperature of about 2 200°F., it follows that with waste heat the mean temperature available for water evaporation will be much less than is the case with coal firing. This means that with waste heat the evaporation per square foot of heating surface and therefore the total evaporation of a boiler of given size, will be less than under coal-fired conditions.

The Capital Question.

It has thus always to be determined whether the additional capital involved in installing boilers to deal with waste heat can be compensated for by lower fuel costs. An actual example of the working of a "waste heat" boiler, such as is shown in Fig. 1, is set out below :—

Type of boiler	Water tube.
Heating surface Boiler	4 696 sq. ft.
Economiser	960 sq. ft.
Duration of test	1 week.
Temperature of gas boiler inlet	1 173 F.
outlet	567°F.
Water evaporated per hour (average)	10 897 lb.
Weight of gas at boiler inlet	75 222 lb. per hour.
Steam pressure	88 lb. per sq. in.
Evaporation per square foot heating surface	1·93 lb.

Primary heat taken from Siemens-Martin open-hearth tilting furnace fed with Durham coal.

Destructors as Alternatives.

Refuse destructors are, of course, a well-known example of "alternative fuel," and there are some forty-eight power stations in this country where a proportion of the load is carried by this means. It is extremely difficult to collect any reliable data relating to the working of these plants, as they are almost invariably run in conjunction with coal-fired or other units, and although isolated instances may be put forward showing an evaporation up to 1½ lb. of water per lb. of refuse, it is not safe to estimate on a greater average than ¾ lb. Practically all these refuse destructors are owned by Municipal Authorities who are at the same time the owners of the electricity works. The adjustment of fuel values, therefore, varies considerably according to the predilections of the engineer or committee concerned, and little or no reliable financial data on this point is available. It is, of course, also true that the heating value of refuse in one part of the country is altogether different from that in another. As a case in point, it may be mentioned that in some of the mining centres the household "refuse" largely consists of coal dust, so that it is not surprising if destructor results are exceptionally good.

There is no doubt that from the public health point of view, refuse destructors are in every sense desirable, but as primary power producers involving a considerable expenditure their limits of usefulness are well known to station engineers generally and need not be further enlarged upon.

Oil as a Competitor to Coal.

A more serious competitor to coal firing is undoubtedly to be found in oil. Oil firing has, of course, long since passed the experimental stage, and for marine purposes and particularly for naval purposes—where relative cost is not of prime importance—its numerous advantages are recognised and appreciated. Coincident with the rise in the cost of coal, however, the price of fuel oil rose to a relatively greater extent, and its adoption as a fuel so far as electric-power stations are concerned has not hitherto been so marked as might otherwise have been the case.

It is an established fact that, after making full allowance for the great convenience of oil firing, the simplicity of handling the fuel, the ease with which oil-fired boilers can be started up and shut down, the reduction of firing costs, the entire absence of ashes, with their attendant troubles, and many other advantages, *the cost of oil fuel per ton can rarely exceed twice the price of coal*, if it is to compete successfully commercially with our staple fuel.

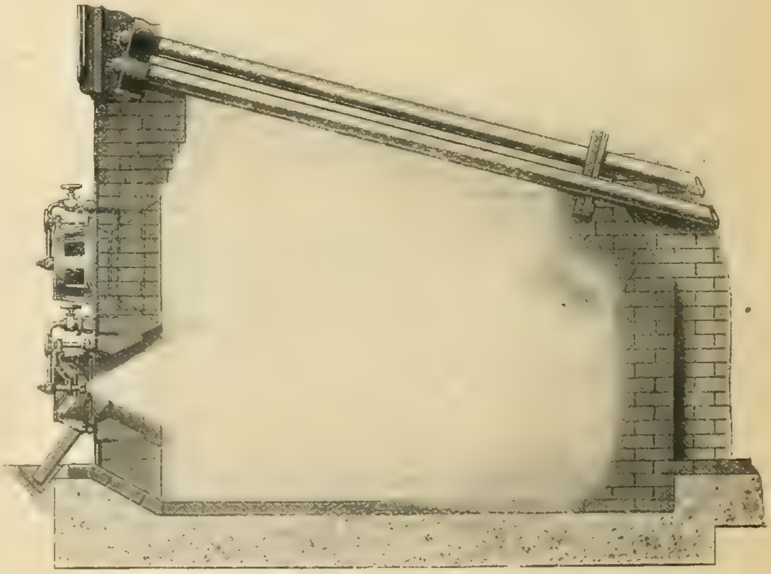

Fig. 2.—Side View, with Brickwork Removed, of Furnace for Burning Oil Fuel alternatively with Coal, arranged with Steam Atomising Burners.

The coal shortage due to labour troubles at the mines has, of course, given a considerable impetus to the demand for oil fuel recently and in addition prices have fallen considerably during the last few months. If, therefore, when industrial conditions have become more stabilised, the price of oil becomes more or less permanently competitive with that of coal, great developments in connection with oil firing for land purposes may be expected

A Successful Oil-fired Installation.

The author has in mind several highly successful oil-fired land installations, notably one in the Lancashire area, where a battery of six water-tube boilers was converted during the war from coal fired mechanical stoking to the burning of crude tar oil, with excellent results. The installation supplied steam to an industrial works operating 24 hours per day, and some indication of the economies effected may be gauged by the fact that the removal of ashes alone formerly cost from £40 to £50 per week, whereas, with oil fuel, expenditure under this head is entirely eliminated.

On the main question, however, it is only fair to state that particular local facilities made it possible to secure the particular fuel in question at something under £5 per ton. Apart from considerations of price the performance of oil-fired boilers compares quite favourably as regards evaporation and efficiency with coal-fired units. The calorific value of oil fuel may be taken at between 18 000 and 19 000 B.T.U.s per lb. Some of the better American, Russian and Texas varieties may rise as high as 19 500, but most are within the limits given. Heavy tar oil and similar compounds may be taken at about 16 000 B.T.U.s. It is not safe to take the average calorific value of bituminous slacks at the present time at more than 10 500 B.T.U.s, while a fair average for the graded coals may be taken as 11 500 B.T.U.s.

Thermal Efficiency of Oil Firing.

From a thermal efficiency point of view, therefore, oil fuel may be expected to give from 65 to 80 per cent. greater evaporation per lb. than bituminous coal of average quality, and this is substantiated under actual working conditions. It may be taken that 250 lb. of oil per burner per hour is a reasonable consumption when steam is used as an atomising agent, or about double this figure where the oil is atomised by mechanical pressure, but in both cases these figures can be increased by 100 per cent. should occasion demand it. Views of furnaces adapted for burning oil are given in Figs. 2, 3 and 4, while details of the burners are given in Figs. 5, 6 and 7.

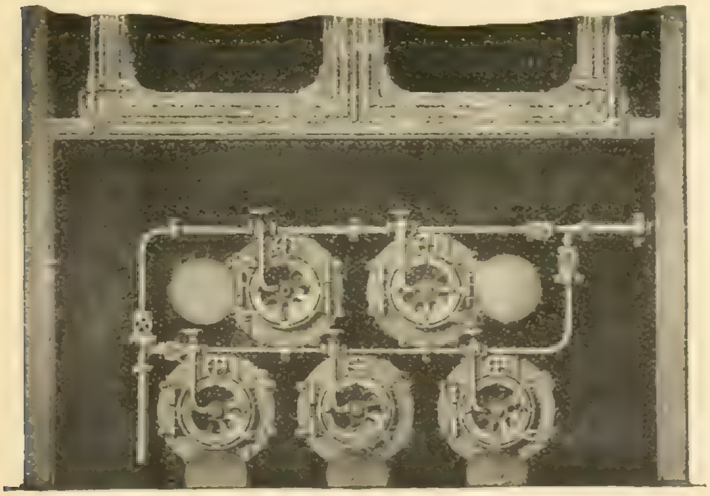

Fig. 3.—Front View of Oil Burning Furnace.

Coke as a Steam Raiser.

The burning of coke under boilers has made considerable headway during the last few years. This was particularly notable during the coal control period, when its use for steam-raising purposes was strongly encouraged by those responsible for the coal-economy campaign. Dealing with power stations in particular, the consumption of coke as a substitute for coal was increased from 26 365 tons per annum in 1918 to 114 991 tons in 1919, and although even the latter total is small relatively to the seven million tons of coal used annually by the Electricity Supply Industry, sufficient evidence has been obtained to prove that, technically, coke is an efficient substitute for coal.

It is a comparatively easy matter to burn coke breeze or small coke with an admixture of bituminous slack coal in varying proportions up to 50 or 60 per cent. on almost any type of furnace or mechanical stoker, but to burn coke efficiently by itself forced draught in some form or other is essential. Without the aid of forced draught, the consumption of coke per square foot of grate area is bound to be considerably less than that of free burning bituminous coal, and therefore under normal conditions, if coke is substituted for coal, the evaporative capacity of the boiler will be reduced. In this connection, too, it will be found that better results will be obtained with coke breeze or small riddled coke than with the larger varieties, as the larger the coke the slower it burns. Fig. 8 illustrates an equipment of this kind.

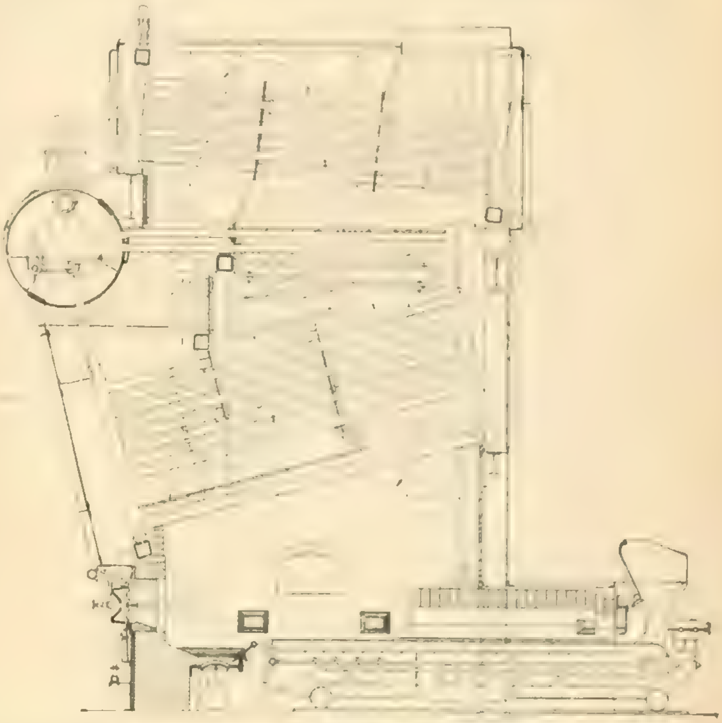

Fig. 4.—B. & W. Marine type Boiler for Land Purposes, fitted with Super-heater, Economiser, Chain-Grate Stoker, and Oil Fuel Apparatus on the Pressure System (Natural Draught).

This arrangement is equally applicable if fitted with oil fuel burners, with steam as the atomising agent.

The "Sandwich" System.

For burning coal and coke together on the chain-grate type of mechanical stoker, what is known as the "sandwich" system has achieved some measure of popularity. By this arrangement the coal and coke are fed from a double hopper—*i.e.*, a hopper divided by means of a longitudinal partition into two compartments—on to the travelling chain in two distinct layers. The lower layer consists of coke breeze or small coke, and the upper layer of bituminous slack, the initial ignition being thus provided by the coal, in the manner usual with this type of setting, and the coke afterwards being ignited by contact with the live coal. The resulting combustion gives very satisfactory results, and the arrangement has been successfully operated in a number of power stations, of which perhaps that of the London County Council is the most notable example.

The Use of the "Crosthwaite" Furnace.

On hand-fired boilers considerable success has been achieved in connection with coke burning by introducing the "Crosthwaite" or similar type of furnace, with steam and air jet blast under the bars. The writer has in mind an installation of Lancashire boilers where coke breeze has been burned under these conditions for over twelve months, showing an average evaporation of 7 lb. of water (from and at 212°F.) per lb. of fuel at an average cost of 17d. per 1 000 lb. of water evaporated while maintaining approximately an average evaporation equal to 80 per cent. of the rated capacity of the boiler. On hand-fired water-tube boilers fitted with steam blowers under the grate, test figures showing 7·84 lb. of water per lb. of fuel, with a boiler efficiency of over 75 per cent., have been obtained while maintaining an evaporation of nearly 4 lb. of water per square foot of heating surface.

One of the most successful methods of burning coke breeze alone on the chain-grate type of mechanical stoker, is to introduce a firebrick arch at the rear of the furnace. This arch is set parallel to the grate, and deflects a considerable amount of heat on to the fuel bed, so that continuous ignition of the advancing fuel is ensured.

A Coke-breeze Test.

With this arrangement, ignition can be fully maintained even with fuels as low in volatile content as 3 per cent. and when run in conjunction with forced or "balanced" draught, high rates of combustion per square foot of grate area—say, 35 lbs. per square foot—can be maintained without difficulty and full evaporations obtained from the boiler. The following result of a coke-breeze test on a water-tube boiler is a good example of what can be done :—

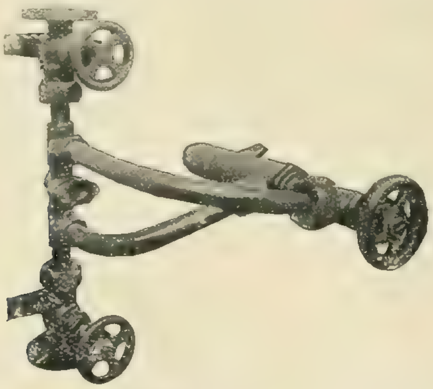

Fig. 5.—Oil Burner with Steam as Atomising Agent.

Heating surface of boiler	4 020 square feet.
Fuel	Coke breeze—
Size	1½ in. to ½ in., 22 per cent.
	½ in. to ⅛ in., 53 per cent.
	Under ⅛ in., 25 per cent.
Analysis :—	
Moisture	15·4 per cent.
Volatile	3·3 per cent.
Carbon	61·5 per cent.
Ash	19·8 per cent.
	100·0 per cent.
Calorific value	9 186 B.T.U.
Duration of test	5 hours.
Steam pressure	184 lb.
Superheat	292° F.
Feed temperature	132° F.
Fuel consumed per hour	3 025 lb.
Fuel consumed per sq. ft. grate	31·5 lb.
Water evaporated per hour	17 292 lb.
Evaporation per lb. of fuel from and at 212° F.	7·408 lb.
Evaporation per sq. ft. of heating surface from and at 212°F.	5·57 lb.
Balanced Draught—	
Suction at rear of boiler	0·2 inch.
Pressure in ashpit	0·86 inch.
Efficiency of boiler, superheater and stoker	78·28 per cent.

The Problems of Anthracite Duff.

There is no essential difference between the burning of anthracite or low volatile coal and the burning of coke or coke breeze, except that in the case of anthracite the question of size is of even more importance than it is with coke. Nuts, peas, pearls or grains can be consumed on the chain-grate type of stoker fitted with rear arches and balanced draught, with comparative ease and a maximum efficiency, but no means has so far been found for successfully burning anthracite slack or duff containing a high percentage of dust.

This fuel is difficult to dispose of, and apart from the manufacture of briquettes—which have hitherto been used chiefly on the French and Italian railways and have found little favour in this country—there is at present no suitable outlet for it. It should therefore be of some interest to steam raisers if means can be found for burning it efficiently under boilers. The difficulty is that the fine dust, if it does not fall through the grate bars, lies on the grate like a blanket of sand, while as the fuel is, of course, absolutely devoid of any caking properties, the application of heavy forced draught only succeeds in blowing holes in the fire bed, and forcing a quantity of the dust over to the back without materially assisting ignition. Much time and thought are undoubtedly being devoted to finding a use for this anthracite duff, which is naturally of high calorific value, and should be of some value as a heat-producing agent.

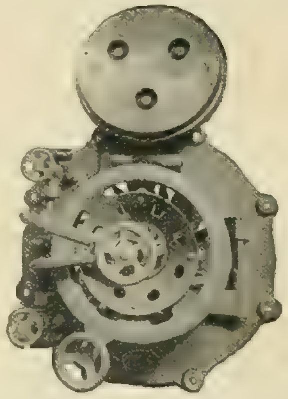

Fig. 6.—Oil Burner Complete, with Steam as Atomising Agent. View shows Air Register and Brick Plug Open.

The Chance for Colloidal Fuel.

The most promising outlook at the moment appears to be in the direction of colloidal fuel, by which it is claimed that pulverised low volatile fuel can be mixed with crude oils up to a proportion of 35 per cent. and the resulting compound used through spray nozzles for oil firing in the usual way, and the result of practical experiments in this direction will be eagerly awaited. Pulverised fuel is also attracting considerable attention at the present time, and although this can hardly be considered a *substitute* for coal, yet it has interesting possibilities.

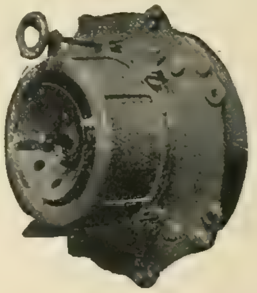

Fig. 7.—Oil Burner Complete (closed), with Pressure as Atomising Agent.

The outstanding feature of such plants as have come under the author's notice is the enormous amount of room taken up by the drying, pulverising and distributing portion of the plant. So far, no greater boiler efficiency appears to be claimed or possible from pulverised fuel than can be obtained by the best type of mechanical stoking, but if ultimately more inferior grades of coal can be used in a pulverised form than by present methods, or a means is found of utilising anthracite duff for the purpose, it will compare very favourably with other systems of coal firing.

The Possibilities of Lignite.

A reference to "alternative" fuels would not be complete without giving some consideration of lignite or brown coal. During recent years a fair amount of attention has been concentrated on the possibility of exploiting the lignite fields of Bovey Tracey and other West Country districts, and various schemes have been mooted to this end. Recent analyses of lignite from Devonshire show somewhat variable results, but the outstanding feature of all lignite is a low calorific value and a high percentage of moisture, which in some districts rises as high as 55 per cent. The following examples may be taken as typical of the Devonshire fields :—

Devonshire lignite.	Moisture.	Volatile.	Carbon.	Ash.	Calorific value.
	Per cent.	Per cent.	Per cent.	Per cent.	B.T.U.
Sample No. 1 ...	27·45	29·60	25·68	17·27	5 376
Sample No. 2 ...	41·09	26·75	21·56	10·06	5 706
Sample No. 3 ...	39·29	26·71	17·58	16·42	4 867

To burn this fuel satisfactorily, it will undoubtedly be necessary to employ forced draught and either back arch settings or some form of drying hearth, similar to that adopted in many refuse destructors, in order to successfully deal with the high moisture content. A number of power station engineers in the West Country are considering possibilities, but no actual experiments on a large scale have so far been made. The lignite beds vary in accessibility, some being quite close to the surface, while others necessitate excavation to as much as 60 ft. deep. As at least two tons of lignite will be required to give the equivalent heating value of one ton of coal, it follows that the cost of mining the former will have to be on a low scale if the use of this fuel is to become a commercial proposition.

Some Curious Fuels.

There are many isolated instances of "alternative" fuels having been more or less successfully used for steam-raising purposes, and these include sawdust, spent tan or bark, flax refuse and loco. ash or char. All these have been successfully burned, either alone or in conjunction with coal, but supplies are usually inadequate, except for very small installations. With regard to sawdust, in particular, this has been quite successfully burned on chain-grate stokers by means of the "sandwich" system, an inch or two of coal covering five or six inches of sawdust, and giving the necessary weight to prevent the lighter fuel from being sucked off the grate by the induced draught. Furnaces that have been designed for this purpose are illustrated in Figs. 9 and 10. Spent tan and flax refuse suffer from the same defect as lignite—viz., an excess of moisture—and must be treated accordingly, while loco. ash differs little in its characteristics or heating value from coke breeze.

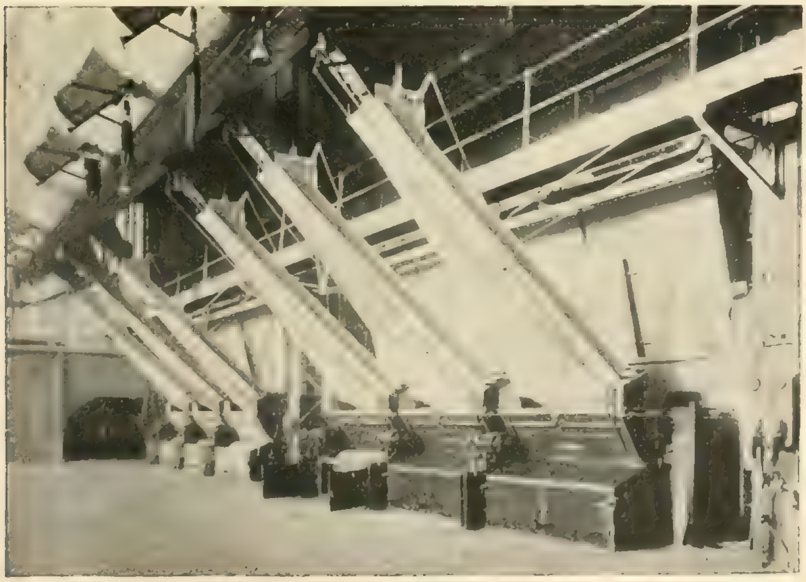

Fig. 8.—Water Tube Boilers fitted with Enclosed Type, Forced Draught, Chain-Grate Stokers (B. & W.), as used for Burning Coke Breeze.

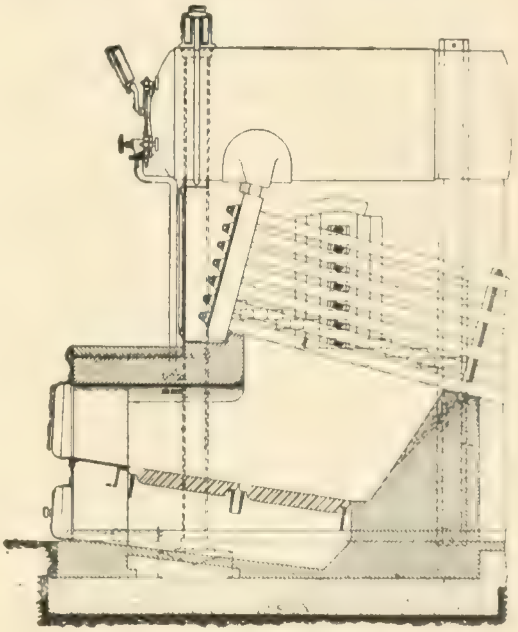

Fig. 9.—Furnace for Wood Burning.

The main fact to be borne in mind in connection with any proposed substitute fuels is that, generally speaking, so long as they contain heat value in any proportion, technical means are either already available or can be quickly developed for making use of it. As to whether it is a sound financial proposition to use it, or to modify existing plant, or instal additional plant to do so, must depend on individual cases, but sufficient evidence has been produced to show that a considerable amount of energy is being directed towards the utilisation of alternative fuels for the production of steam, and a fair measure of success has been achieved.

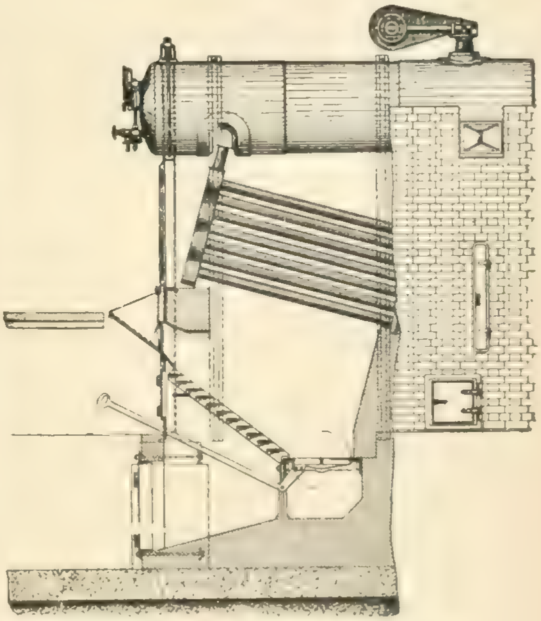

Fig. 10. Step-Grate Furnace for Burning Sawdust, Shavings, Etc.

The Difficulties of the Smaller Electricity Supply Companies.

By A. N. RYE, M.I.E.E.

THE difficulties with which the smaller electricity supply companies are confronted to-day are of such considerable magnitude that unless some solution can be found they may be unable to undertake the further development of their areas. Already many of these smaller companies have had to take steps to restrict new business, and the situation, not only from the companies' point of view, but from the point of view of the public and of the electrical industry as a whole, fully warrants an effort to make these difficulties more widely appreciated. The information on which this article is based has been obtained largely through the writer's official position with Edmundsons' Electricity Corporation, Ltd., but the opinions expressed should be taken as the writer's personal views and not as the official attitude of the Edmundson management.

Small Company Organisation.

The Edmundson group of companies includes about forty undertakings operating some sixty provisional orders; they are situated throughout England and Scotland and the total capital expended is over £3 000 000. These particulars are given in order to show that the business is sufficiently large and sufficiently distributed geographically to enable those connected with the management to speak with some authority on the problems with which the smaller electricity supply companies are faced.

In order to show how any stagnation in such a group of companies may affect the electrical industry as a whole, it may be mentioned that the average rate of connecting new business has exceeded 5 000 kW per annum and it is obvious that if the progress of these companies is prevented, the loss to the electrical manufacturing industry will be considerable. This figure also shows that there is a large demand for electricity in the areas served by these companies and anything which tends to prevent the companies supplying this demand must be against the interests of the general public within their areas. Although the Edmundson companies are perhaps the largest group of small undertakings, it must be remembered that there are many other companies working under similar conditions, and to which the above remarks apply.

The History of the Undertakings.

In order to get a clear idea of the present-day difficulties it is necessary to trace, quite briefly, the history of these small undertakings. The majority were originally established as "lighting" undertakings, between about 1898 and 1904, that is, at the time when the carbon lamp was universal. They were making fair progress when the metal lamp was introduced, and while this lamp led to a marked development of the business, it caused an immediate drop in the output and resulted in a financial setback for several years. Very strenuous efforts were then made to develop power, heating, &c., with the result that before the war in 1914 the companies as a whole were either paying small dividends, or were certain to be in a position to do so in a year or two. The case of the Urban Electric Supply Company, Ltd. (one of the Edmundson Cos.), is typical. Before the war it was paying its full preference dividend and had every prospect of paying an ordinary dividend within a short time. To-day it is unable to make adequate provision for depreciation and cannot pay any preference dividend.

The Urban Company Undertakings.

Fig. 1 shows the combined figures for the Urban Company undertakings, excluding only the Cornwall Power Company because it is not compelled to work under the adverse conditions affecting small undertakings. This curve shows the great increase in working costs, and it also shows that owing to the artificial restriction on selling prices the revenue in 1919 was not sufficient even to maintain the margin between costs and sales which was obtained as far back as 1911, although this margin should have been greatly increased, because during that period more than £200 000 additional capital was expended and more than 18 000 kW of new business was connected.

Fig. 2 shows the financial result realised by the Urban Company after allowing for debenture and loan interest, but before making provision for depreciation and income tax. This curve shows that the net balance rose from 1911 to 1914 and then, owing to rising costs and the effect of control of maximum prices, fell steadily (except in 1917) until 1919, when the net balance was some £12 000 less than in 1914, notwithstanding the fact that during the same period (1914-1919) the output had increased by 5½ million units and an additional £102 000 had been invested in the business.

How near to disaster the company was brought by the action of the Government is clearly proved by Fig. 3, which shows that the costs of 1920 exceeded the gross revenue of 1919, and, but for the relief obtained, it would have been impossible to have earned the debenture interest.

Control of Maximum Prices.

Fig. 4 shows that it is correct to attribute the poor results of 1919 to control of maximum prices, for during the early part of 1920 the Government department concerned granted some measure of relief (largely, we believe, through the influence of the Electricity Commissioners), and the recovery was immediate and substantial, even though the relief granted was in many individual cases inadequate and the return on capital quite inadequate. The case of the Urban Company is a particularly convenient illustration because this company operates a number of undertakings and the danger of selecting an abnormal case is eliminated, the final results of the Urban Company being an average of 14 individual undertakings.

Assuming that the above case fairly represents the experience of small electricity supply companies, it is very clear that their immediate difficulties are due to:—

Increased working expenses.
Altered conditions of supply.
Inadequate selling prices.

Increased Working Expenses.

It is not necessary to go into the details of increased working expenses; everyone is familiar with the general facts, but there are certain items which are particularly hard on the small undertakings.

The standardisation of rates and hours under the Joint Industrial Councils has hit the small undertaking harder than the large undertaking. The units sold per man employed are usually less in the small station and therefore an equal increase in wage has meant a greater increase in labour cost per unit for the small station. Again, the actual wage paid before the war in a small country town was very considerably less than in the larger towns, and while there is still a difference, in most cases the margin between the two has been reduced. Possibly the most serious item in the wages bill of the small station is the reduction in working hours. Most of these stations ran only one or two shifts and the hours of work varied from 54 to 60 hours per week, according to the time of year. In very many cases the reduction in hours has meant 30 to 50 per cent. more men must be employed in the stations. In large stations the increase due to standardisation of wages and hours has not been nearly so great.

A small generating station may use 6 lbs. of coal per unit generated; a large station may use 3 lbs. and for an equal increase in price of coal the increase per unit for the small station will be double the increase for a large station.

Altered Conditions.

Altered conditions of supply have been largely brought about by the " Summer Time " Act, and the earlier closing of shops. In a large undertaking with a power load, the effect of these changes is not very serious, but many of the small companies operate in towns where there is no power worth mentioning; for instance, seaside towns and small provincial towns without any large industrial load. In these cases the effect is very serious.

An investigation at one of the Urban company's undertakings showed that for the June quarter 1912 the units sold for lighting amounted to 78 300, by 1914 this figure had increased to 80 500, but although between 1914 and 1920 250 kW of extra lighting business had been connected the units had decreased to 63 000, a reduction of 22 per cent., notwithstanding the increase of 250 kW connected.

Another serious alteration of conditions is the higher cost of renewals. If formerly it cost, say, £1 000 to replace a given piece of plant, the same renewal would to-day cost over £2 000, and it is necessary to make some provision to meet these new conditions.

Inadequate Selling Price.

If the companies had been free to adjust their prices to meet the rising costs there is every reason to believe that they could, at least have maintained their pre-war position, but this they have been prevented from doing by the unjust and short-sighted policy of the Government in the control of maximum prices.

Before the war the Provisional Orders fixed the maximum price, usually at 8d. per unit, and this figure was inserted without regard to the size of the proposed undertaking or to the electrical prospects of the area concerned.

Thus 8d. per unit was the maximum price allowed to a large London company, and no higher figure was inserted in any of the 24 Orders operated by the Urban company, although it was obvious that a London company did not require the price per unit that it would be necessary to charge in a small country town. As a matter of fact, in pre-war days the price of 8d. was ample in either case; the actual tariff of some of the London companies produced 3d. per unit or a fraction more, the Urban company charged between 5d. and 6d., but in both cases the charges were well below the statutory maximum.

Now, when rising costs forced an increase in price, an altogether different state of affairs arose. A London company's costs probably doubled, the Urban company's costs probably trebled, for the reasons given above; but the former company were free more than to double their price per unit, whereas, a 50 per cent. increase in the Urban company's price per unit brought them up against their statutory maximum. In other words, the almost universal 8d. of the Provisional Orders allowed the large undertaking a margin of about 150 per cent., while it allowed the small undertaking a margin of only 50 per cent. above the prices which each class of undertaking had found it commercially advantageous to charge.

Up Against the Statutory Maximum Price.

It was about the end of 1916 that rising costs brought the small undertakings up against the full stop of the statutory maximum selling price and it then became necessary to take steps to get the maximum prices revised. Then began that long struggle with the Government departments concerned, which is still in progress to-day.

If at that time the Board of Trade (or later the Ministry of Transport) had adopted the policy which the Ministry of Transport adopted with the railway companies and had obtained sanction from Parliament to allow an increase of the maximum prices by a fixed percentage, say 50 per cent. at first, and a higher figure later, the greater part of the difficulties of the small companies would never have arisen, for they would have had sufficient margin to adjust their prices to meet their rising costs, and they would not have had to face the years of starvation which have depleted their resources and brought them to such a pass that it must, under the most favourable circumstances, require years to re-establish them in a sound financial position.

Section 32.

Until 1918 the only way in which the maximum price in any Provisional Order could be increased was by the company making application under Section 32 of the Electric Lighting Clauses Act, 1899, which allowed the Board of Trade to grant an increase (this power is now transferred by the Electricity Supply Act, 1919, to the Ministry of Transport); but to allow Section 32 to be operative it must be included in the Provisional Order of the company concerned.

Now it happens that, for various reasons, the majority of the Provisional Orders held by small companies do not contain this section, and therefore the majority of these small companies had no redress until the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, was passed.

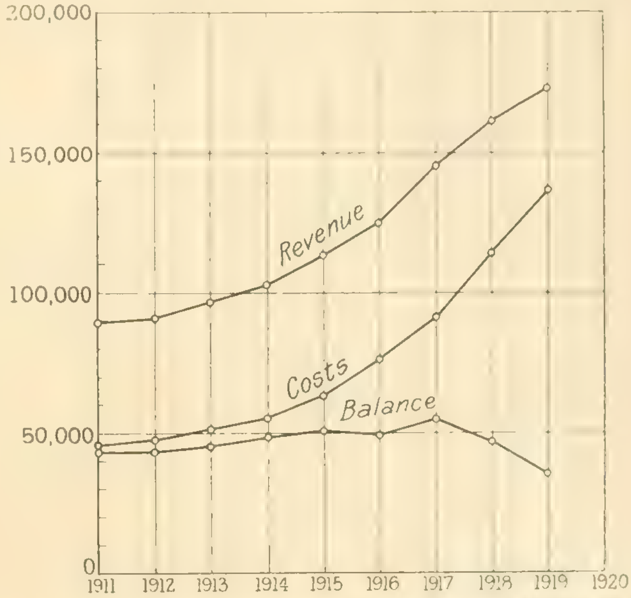

Fig. 1. Combined Figures of Urban Electric Supply Co.'s Undertakings (excluding the Cornwall Co.).

This Act lays down, or is construed by the Ministry of Transport to mean (the result is the same, for there is no appeal from the Ministry's reading of the Act), that they may only allow such an increase in price as will enable the company to earn three-quarters of the average ordinary dividend paid in the three pre-war years.

By way of an example: Suppose that before the war a company which had just reached the dividend-paying stage—had paid in 1911 no dividend, in 1912, 3 per cent., and in 1913, 6 per cent., the average dividend is 3 per cent., and under the Act, $\frac{3}{4}$ of $3 = 2\frac{1}{4}$ per cent. is the dividend on which prices must be fixed; that is, a company which had actually paid 6 per cent. is now limited to $2\frac{1}{4}$ per cent. The case of a company paying no dividend before the war is worse; it will in future be allowed to pay $\frac{3}{4}$ of zero (!), and its maximum prices will be adjusted on that basis.

No Allowance for Improvements.

The Act makes no allowance for the improvement in financial results that seven years of progress should bring. It makes no allowance for the fact that during that seven years plant, which was not fully loaded, and therefore not fully productive financially, is now overloaded and should in the natural course of events be earning a fair return. Even where a company carries on a contracting business outside its supply area and not of an electrical nature, the profits derived from this source are taken into account and applied to reduce the maximum price allowed.

It is evident that no company could raise money under such conditions, and any company compelled to seek relief under this Act must, so soon as their plant becomes fully loaded, cease all attempts to develop electricity supply, because it is obviously impossible to obtain capital. How such a company was to assist in providing a "cheap and abundant" supply of electricity apparently did not interest those who drafted this Act.

A Precarious Existence Inevitable.

It is evident from the above that the conditions under the Temporary Increase of Charges Act are such that no company forced to work under this Act could expect more than a precarious existence even if the Act were interpreted in the most generous manner, but some of the decisions of the Ministry of Transport when applying this Act have been so inadequate that one wonders whether they failed to understand the position of the company concerned or whether they were withholding some of the relief they might reasonably have granted. It must be remembered that the reasons for any decision are not disclosed, and there is no opportunity for the company to point out possible errors in the deductions drawn by the Ministry from the information which the company hands in with its application.

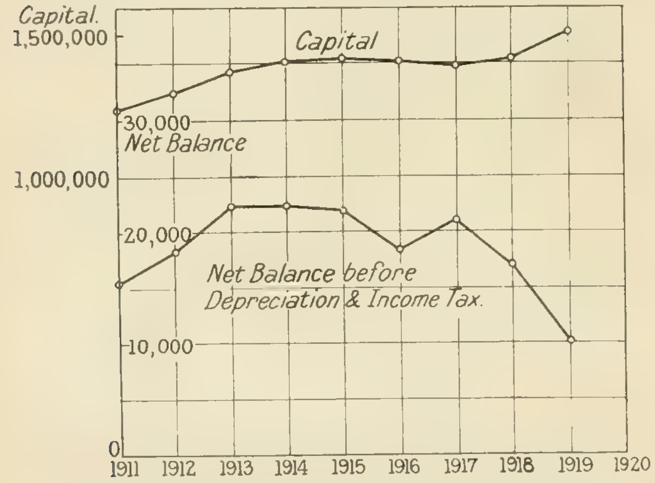

Fig. 2.—Financial Results of Urban Co.'s Operations.

The companies quite recognise that under this Act the Ministry cannot give more relief than the Temporary Act allows, but where an application can be made under Section 32 there is no limit to the maximum price which may be granted. If therefore the Ministry were willing, but unable, to grant the necessary relief under the Temporary Increase of Charges Act it might have been expected that under Section 32 their decisions would have been much more generous, particularly as any decision under this section must remain unaltered for five years.

It would occupy too much space to give a detailed account of the increased prices granted under Section 32, and it must suffice to say that the highest price granted to any of the Edmundsons' Companies at the end of 1918 was only 9d. per unit, an increase of 12½ per cent. over the usual 8d. granted without question in pre-war days.

Such a miserable increase is obviously not sufficient to cover the increased costs from the beginning of the war to the end of 1918, and in addition any further increased costs for the next five years. That the prices granted were hopelessly inadequate is proved by the fact that many Orders granted under Section 32 have since had to be revised under the Temporary Increase of Charges Act, thus showing that the conditions were so little understood by the Government departments that far from the decisions being adequate they actually had to be increased within a short time and under an Act which imposed restrictions never contemplated under Section 32.

The Government and Small Companies.

Another clear indication of the attitude of the Government to the small companies is the fact that after the Temporary Increase of Charges Act was passed in 1918 the Ministry of Transport refused to consider any further increases under Section 32, and forced the companies to apply under the Temporary Act. This procedure was reconsidered at a later date, and permission was given to proceed under Section 32; but between November 1918 and the early part of 1920 no Section 32 Order was granted to any of the Edmundson Companies, and for more than a year the companies were forced to work under the impossible conditions of the Temporary Increase of Charges Act, even though they might have had the advantage of Section 32, but for the refusal of the Ministry of Transport to act under this Section.

Many of the Local Authorities have opposed increased prices, but in most cases more from the point of view of desiring a full enquiry than from a wish to make it impossible for the companies to carry on. There have, however, been certain exceptions where the Local Authorities have acted unreasonably, and when certain of them openly declared that they opposed in order that they might ultimately buy out the company at a low price, it became evident that the ideas of public morality in certain towns were not of a high order, neither were such ideas likely to assist the companies to find capital to develop the supply of electricity.

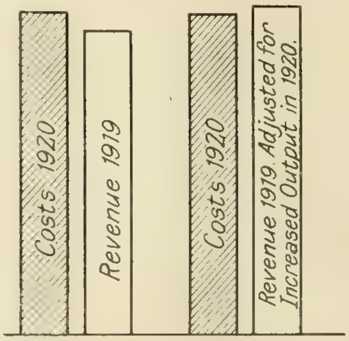

Fig. 3.—Effect of Government Control on Urban Co.'s Undertaking.

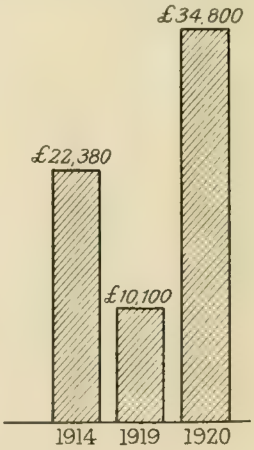

Fig. 4.—Urban Co.'s Net Balance before Provision for Depreciation.

Such then are some of the difficulties of the small Electricity Supply Companies. Is it any wonder that in some areas electrical development has practically ceased?

What Can Be Done?

If a company having no funds, and being prevented from earning profits which will attract capital, finds its plant fully loaded, what can it do? It is compelled under penalty to supply new consumers, even at a loss. To comply with this obligation, in some cases the price for heating, cooking, power, &c. (which are usually supplied below the statutory maximum price), has had to be increased to such a figure that these users of electricity are discouraged in order that there may be plant available to give the compulsory supply to new lighting consumers. In adopting such a policy the companies well know that in many cases they are disconnecting paying business to make room for business that does not pay, but what other course is open to them?

The vital problem to-day is how to overcome these difficulties. It is very evident that, as has frequently been the case with electricity supply, the most urgent problem is of a political nature.

Before any steps can be taken to deal with economic and engineering problems the method of control of maximum prices by the Ministry of Transport must be put on a satisfactory basis. It is impossible for any individual by the present method to fix a maximum price which shall be fair over a period of years. How can anyone foresee the effect of alterations in the cost of fuel, wages, and materials, interest on money, and in all the other conditions that vary from day to day and year to year?

Even if some official were sufficiently competent to adjust the selling price of a company (of which he has no practical knowledge) so nicely that an adequate dividend could be earned, the problem is not solved, for if extensions are to be carried out at to-day's prices for material and labour it is very clear that a selling price which would yield a satisfactory return on the pre-war capital would produce a totally inadequate return on the new expenditure. If, therefore, no margin is allowed in the maximum price the business must remain stagnant.

The Difficulty of Adjusting Selling Prices.

It is sufficiently difficult for those in daily contact with any business to adjust their selling prices to the prevailing costs, the future prospects, and the ability of the consumer to pay; but when the companies are left to bear the whole of the risk, and some outside body fixes the actual selling price, instead of the maximum price with a margin for contingencies, the situation is impossible; it really means that the whole future of the company depends on the accuracy of the guess some Government official makes as to future conditions, and it is clear that no prudent man will invest his money on such terms.

Some of the companies have made great efforts to find a solution of the problem; for instance, Edmundsons' Electricity Corporation promoted a private Bill a year ago, in which powers were sought to establish a sliding scale of maximum prices and dividends. As the dividends increased the price had to be reduced. This suggestion seemed to offer to the companies a degree of stability which would give them some possibility of raising capital; at the same time, it offered to the public all reasonable protection against unfair charges, coupled with every inducement to the companies to manage their business efficiently in order to reduce prices, their dividends only becoming adequate when prices had fallen to a reasonable level. This Bill was thrown out in Committee, mainly, it is thought, because the Ministry of Transport reported adversely on it.

It is true that the Ministry have since introduced the Electricity (Supply) Bill, 1921, containing a clause which would allow all undertakings to proceed under Section 32, and this would be a material improvement, provided the Ministry are prepared to operate this clause reasonably; but so long as they attempt to exercise control by fixing a maximum price so low that it must of necessity be the price charged to practically all the consumers, the companies will be denied the necessary margin to make a tariff which shall be fair to both the long-hour and short-hour consumer; and the existing conditions under which the long-hour consumer is being made to pay the loss on the short-hour consumer will continue.

Destroying Confidence.

The effect of the present method of control goes far beyond any injustice it may inflict on an individual company; it has destroyed all confidence in the future of the business.

The extent to which the small companies have already lost confidence in the Government departments is a serious matter for the future of electricity supply in their areas. When we see the gas companies receiving reasonable treatment and legislation already passed to relieve them of the effects of the Temporary Increase of Charges Act, is it unreasonable to entertain suspicions that somewhere in the departments which control electricity supply there is an element hostile to the companies? This, in turn, engenders the fear that if any company were able to provide funds, and by its enterprise could improve its position, some action might be taken to reduce its prices and bring it back again to an unprofitable position.

Even when confidence is restored, no sudden change from stagnation to rapid development can be expected. From the fact that the companies have been starved for five years it follows that there are accumulated arrears of renewals to be dealt with which will absorb a large part of the earnings during the next few years. Finance for new work will only be possible after the necessary period of time which must elapse before the companies can prove to the investor that the business is one in which he can safely take an interest.

All this means time, but, given fair treatment, the situation for the small companies is by no means hopeless; in fact, there are considerable possibilities before many of them, but to achieve these possibilities the first essential is to free the companies from the impossible conditions of the Temporary Increase of Charges Act, and, after that is done, to convince them that control will be exercised in a reasonable manner, and that it will not be considered a crime for them to pay their shareholders such dividends that the necessary capital for expansion may be available.

Electric Vehicles from the Power Station Engineer's View-Point.

By RAYMOND J. MITCHELL, M.I.A.E., A.M.I.Mech.E., A.M.I.E.E., Etc.

Never in the history of engineering has the watchword of economy been dinned in our ears with more persistence and never has the attainment of really good economy been such an elusive business as at present. But economy can only be attained by correct methods and an adequately trained staff and, above all, by employing plant possessing the highest degree of efficiency, both as regards speed of operation, low cost and reliability.

A False Definition of Economy.

Many engineers and business men are prone to define economy as the negative process of stopping spending money altogether, permitting a business to run on by its acquired momentum due to previous spendings and developments. Such a policy is justified in but very few cases, and would, if universally pursued, result in British industry being hopelessly left behind in two or three years' time at the most. The problem before engineers to-day is frequently the problem, therefore, of revising methods of performing certain operations and of boldly striking out into new fields of endeavour, cutting themselves away in the process from all previous prejudices, habits and traditions, and adventuring into these regions, taking for guide their experience, knowledge and endless optimism, coupled with relentless energy. These remarks in the writer's opinion apply to the whole of the

British engineering industry, and ought to be realised seriously by the whole body of us.

THE INTERDEPENDENCE OF THE INDUSTRY'S BRANCHES.

Another thought which must particularly strike engineers is the tremendous interdependence of the industry and also the vast degree to which one branch of industry often owes its success from that of another and quite different branch.

This is particularly true of the electric-vehicle industry, which, although in its early stages of struggle, gives promise of attaining vast dimensions and of providing a magnificent return in service rendered to those sections of the engineering trade which will at this time do what they can to foster this latest recruit to the transport field.

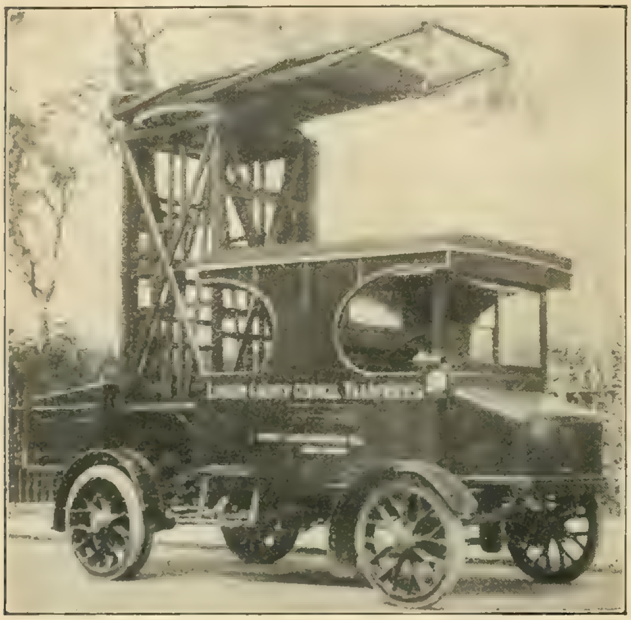

FIG. 1.—EDISON ACCUMULATOR TOWER WAGON ON CHASSIS MODEL "EA," TYPE 6A-8G.

THE TORPOR OF THE STATION ENGINEER.

The station engineer has not in many cases awakened to a full realisation either of his own interests or of the advantages accruing to this industry which a really generous and sympathetic treatment of the electric-vehicle problem at this stage will eventually ensure to him. The majority of power stations to-day are not even equipped for charging the batteries of electric vehicles on demand night or day, and yet it is nearly nine years since the I.M.E.A. began their labours of popularising the electric vehicle, by putting before business men engaged in numerous trades the full case supporting the reasons why the electric vehicle should be used for the majority of town transport service wherever a supply of electricity, that is, a power station, be available.

It is remarkable that most sales departments attached to power stations still spend a lot of trouble over ensuring that a row of houses shall be lighted by electric light, or that the individual consumer shall install small apparatus, such as irons, cookers and radiators, and yet when the owner of an electric vehicle wants a supply of power for charging in the night time, he frequently is met in a manner which can only be described as "lukewarm." No cables available, no charging plug, no convenient means of giving correct voltage, restrictions as to time during which current rate may be given and a general air of incompetence, lassitude and dilatoriness are occasionally to be met with. This should be impossible in any station controlled by the large-minded and highly instructed type of man represented usually by engineers. Perhaps the explanation may lie in the very harassing nature of the duties of many station chiefs, resulting probably in electric vehicles being relegated to the position of "every man's job" and, therefore, "no man's job."

A CONTRAST.

Contrast this with the tremendous enthusiastic energy displayed in advancing the electric vehicle by some of the large Edison stations in the States, where separate departments exist whose business it is to use every available means to augment the use of electric vehicles, and where, moreover, ample facilities are given in the way of general service, charging and garaging, &c., resulting in a very large annual business in favour of the stations so employed, a business which is practically all off-peak and involves an absolute minimum of expenditure on the station accessories required (switch gear, regulating panels and so forth) and not adding one iota to the cost of the generating plant proper. Another point is the very low rate charged for energy for this special job by many American stations, a lead which should be followed in this country if this new industry is to be established on a really firm basis.

WORTH FOLLOWING.

The writer submits that there are very few instances where it would be uncommercial to charge as low as 1½d. per unit for energy during night off-peak hours, and the fact that such a progressive municipality as the city of Birmingham has decided to charge 1·25d. for this service proves that in other cities, such as Manchester, Liverpool, Leeds, Sheffield, Glasgow and London, at least an equally broadminded policy might be followed with advantage.

AN ELECTRIC VEHICLE USERS' ASSOCIATION.

The writer commends the idea to those potentially interested of forming an "Electric Vehicle Users' Association" with headquarters in London to begin with, and an honorary secretary who would deal with the interests of those actually employing electric vehicles for commercial or industrial purposes. Naturally, this Association would be entirely separate in its scope from the Electric Vehicle Committee, who have earned by their very excellent pioneer work under Mr. Ayton's direction a large amount of gratitude from all concerned in this field. The suggested "Electric Vehicle Users' Association" might be represented by sub-committees, under various chambers of commerce spread about the country, and might, in fact, work under the general guidance of the Electric Vehicle Committee.

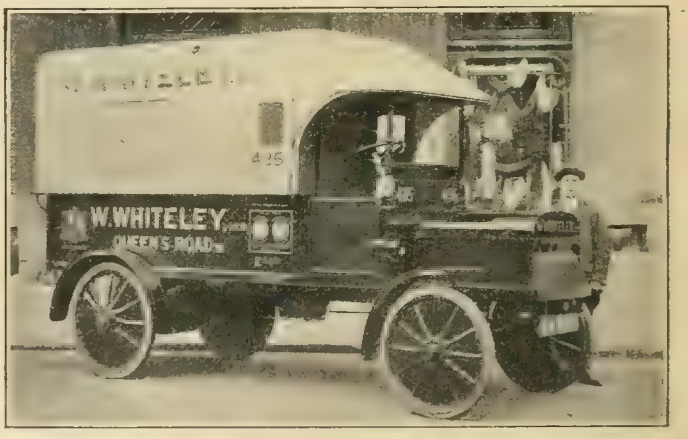

FIG. 2.—EDISON ACCUMULATOR ½ TON VAN MODEL "EAW," TYPE 2 A-5G.

More Information Wanted.

One cannot but feel that this industry will progress very much faster when a great deal more general and specific information shall be circulated among business men who are potential users of electrics. There is too much use of the phrase that electrics are "bound to come." There is no earthly reason why they should not be here now this very moment, thousands and thousands of them distributed in the country in every town and city of 5 000 or more inhabitants where there is a power station. The old idea of the limitations of the electric must go; the fact remains that wherever it has been given a fair trial users have, with the single reservation regarding its high initial price, expressed high appreciation of its general reliability, economy, and remarkable simplicity of operation, which the electric vehicle makes available to those having as one of their problems that of heavy transportation in town areas. We, of course, know electrics are "bound to come," but our definition would be that this means another way of saying "electrics will shortly become universal" in the field of urban transport. At present barely 1 per cent. of our town carrying is done by electricity; what about the other 59 per cent., which competent estimators assess as belonging to the field of electrics?

Questions of Design.

A word or two should be said on the question of design. It does not appear to be the best policy to continue making wagons employing in some cases types of transmission which most extensive experience in other branches of "Automotive" engineering has proved to be inferior to the all-enclosed transmissions in their several forms, which are universally selected by the most advanced lorry designers to-day. This applies to other parts of the vehicle, such as the continued use of wooden wheels, tyres the material of which is not compounded for their special job, and a general construction which errs distinctly on the side of undue weight. Accessibility is also improvable. There are too many greasers on some electrics, and these might well be eliminated in favour of "oil-less" bushes, with a consequent gain in reliability and reduced first cost. The practice of totally enclosing springs with very ruggedly made thick leather gaiters is also worth consideration, and would certainly result in better insulation of the battery from the effects from the more severe shocks sustained in running over our still far from perfect roads.

Meter Types.

Some problems have not been solved at all, such as the design and manufacture of a "perfect" vehicle ampere-hour meter, and much work remains to be done before such becomes available. The writer even begs leave to question whether the mercury motor type of meter will ever give the absolute reliability of operation which is so desirable here. This problem is one of extreme difficulty, but well worth the most serious attention of experts in the field.

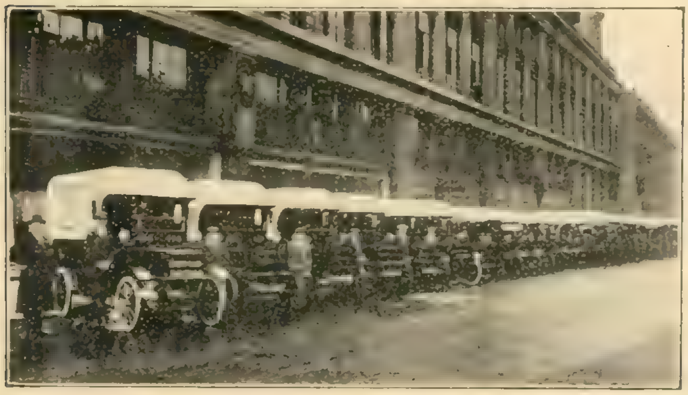

Fig. 4.—Part of Messrs. Whiteley's Fleet of Electricars.

Differences of opinion exist as between multi-motor and single-motor types of transmission and, doubtless, the various types will persist for some time to come, but considered under all headings the single-motor electric vehicle, in spite of some disadvantages, will survive in the long run on account of its somewhat greater reliability factor, its slightly lower first cost and reduced weight, coupled with a considerably simpler transmission lay-out.

Improvements in Truck Design.

It can be confidently asserted that on the whole British-made electric vehicles are ahead of foreign competitors, both in design and workmanship. But this is by no means true as yet in the field of the electric truck. The products of certain American makers in the truck field in the writer's opinion might be studied with great advantage by designers. Americans also have shown a willingness to make available electric vehicles for special purposes, such as quite a variety of elevating electric trucks, crane trucks and other special machines designed for particular industries. Doubtless this phase of the business will receive due attention from British engineers in the near future.

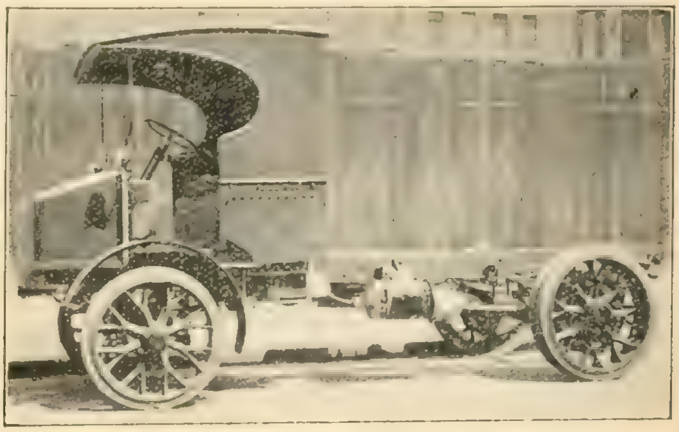

Fig. 3.—A Typical Electric Vehicle Chassis. Electricars' 2½ ton Model.

The Electric Bus.

No reference to the present state of the British electric vehicle industry would be complete without a word as to the great possibilities that exist for the electric bus and the electric taxi if developed along cautious and conservative lines in the first instance, confining endeavour to relatively small flat towns where an intermittent traffic is desired to be handled with the least amount of technical, and therefore expensive, assistance. This may not be a big firm business, but one which would represent a very stable and continuous accessory means of getting revenue on the part of enterprising garages, who by embarking into the electric vehicle field in the manner indicated would also expand their business in other directions through the kudos accruing to public service adequately rendered.

Elsewhere the writer has suggested that the electric vehicle industry might find it well worth while to combine for certain other specific and mutual objects, such as publicity and research into problems the solution of which would be of general advantage. This sort of suggestion is not yet popular, but it is believed that the mechanical civilisation of the twentieth century will, in the not very distant future, be founded on the successful outcome of co-operative endeavours of this kind. At present our industry in common with others is suffering from the slump, and the way out can only be gained through optimism backed by any amount of strenuous work and the co-operation which must ensue, and hence by presenting a solid wall of persuasive argument will lead to the realisation of the immensely successful future which will only be ours if we earn it!

The Writer "Believes" in Electric Vehicles.

An Employer's View of Conditions in the Electricity Supply Industry.

By ALD. W. WALKER.

"THE ability to give a full supply to all consumers for the whole of the time" would be accepted by every chief engineer, board of directors and Electricity Committee as the object for which they were striving. To enable them to do this money has been freely spent to purchase the most efficient plant, to provide expensive instruments with which to record anything abnormal in the running of such plant, and on the duplication of machines and mains as an insurance against failure. Yet events during the last few years have shown that there are still some in control of supply undertakings who ignore the other factor which is equally necessary to obtain the result for which they are striving. If plant, however good, is to run efficiently it must be supervised and operated by a well-selected, well-remunerated and contented staff and workpeople. To spend lavishly on the one and starve the other is bad policy.

A quotation from Berton Braley's verses—"The Human Element"—explains this most clearly :—

Motors, dynamos and boilers are but tools to aid the toilers,
They are genii responsive to command ;
Though their might grows ever vaster, man is still their lord and master,
And it's men who carry out what you have planned.
Is there any greater blunder in the universe, I wonder,
Than to treat this human force with knowledge scant ?
Do you see the thing I mean ? —It is man above machine,
For it's men who give the value to your plant.

Electricity Supply and the Whitley Report.

Before the war each undertaking made its own terms with its own groups of workers, nay, in many cases, with the individual worker, and as a result the variations between district and district, and even between undertakings in the same district were very marked.

As the cost of living went up demands were made for increased pay, and because there was no central body to deal with these the smaller undertakings which paid low rates were the first to be compelled to improve the remuneration of their workpeople. It was evident to all those who were in touch with what was going on that chaos was being produced. At one place higher wages would be conceded, but long hours retained, the result being that the higher wages would be immediately demanded from those undertakings where short hours were the rule. The necessity for a national body to settle the whole question became imperative, and the National Joint Industrial Council for the Electricity Supply Industry was instituted. The method of forming that body was in strict accordance with the recommendations of the Whitley Report, the first members being elected by the existing Employers' Associations for the one side, and by the Trades' Unions for the other. The result has been most beneficial, and to-day there are few people in the industry who would like to revert to the conditions of separate bargaining, with all the waste of time and with all the inequalities and constant state of unrest, which were the inevitable consequences.

The Organisation of Rates of Pay.

The first schedule of "Rates of Pay" and "Conditions of Employment" to be forwarded to the N.J.C. were those of No. 3 North-West District, and they largely served as a model for the other districts The outstanding features were the grouping of undertakings into zones according to their size and/or geographical position, and the clear definition of the duties and the rates of pay of each workman. All the District Councils have now completed their schedules, and are engaged in adjusting anomalies and dealing with the various matters which arise from time to time in connection with the undertakings within their areas.

As one whose lot it has been to read the minutes of all the District Councils, I wish to pay tribute to the very efficient way in which they have done their work, and more still to the feelings of confidence and goodwill which have been created between the two sides represented on the Councils. I do not pretend that there has not been friction, nor that some representatives (of both sides) have not put forward extreme claims, but on the whole the general common sense of the members has prevailed and acceptable results have been obtained.

The Work of the National Council.

It is the work of the National Council to go completely through the minutes of the proceedings of the District Councils, and prevent, as far as possible, the national lines of settlement being jeopardised by the isolated action of one district or undertaking.

As time goes on the machine will become more efficient. During the first year the work was overwhelming, and mistakes were made, but gradually a knowledge of the essential things has been obtained, and also of the effect in practice of the earlier agreements, and these will prove to be of great value in the future.

A Debatable Question.

One of the questions which is still much debated is the position within the industry of the craftsmen, such as fitters and machine-men, &c., who are members of the A.S.E., or other trades union, and whose wages it has been decided shall be based on the district rates as agreed between the Engineers Employers' Federation and the trades unions concerned. This method does, of course, leave the settlement of terms for these men with bodies outside our industry, and on which it has no direct representation, but, on the other hand, the actual percentage of such men employed in the Electricity Supply Industry is small, and it is much better, considering all the circumstances, to adopt agreements which have been come to for and on behalf of the great bulk of that class of men rather than attempt a separate agreement for the few.

The experience of the last few years has shown that the most controversial matters can be amicably discussed. The regular meeting of the two sides round a table enables each of them to know the difficulties of the other, and to learn that a case which appeared to be perfect when only one point of view had been considered requires modification when the objections have been heard.

The Disquieting Feature.

The disquieting feature is the desire of the officials of some district branches of trades unions to try to become parties to every labour dispute within their area, although it may not be even remotely connected with the electricity supply industry. The fact that most of the undertakings are publicly owned and are supplying a public necessity does not appear to count for anything. It has often been said that the unrest of labour, the suspicion of motives, the desire to fight whenever possible, to give no quarter, to keep up a state of constant warfare, were the results of the capitalistic system, but as a member of a City Council I have seen little difference in the attitude adopted towards the services which are publicly owned and publicly controlled and those which are under private ownership ; in fact, in many cases the former appear to have been specially selected for attack. I have closely studied this attitude of mind, and have often spoken of it to my friends who are labour representatives, but have never been able to obtain a satisfactory explanation. On the other hand there have been a few small municipalities which have given an enormous amount of trouble owing to their unwillingness to adopt the conditions agreed to by the District Council for their own area and endorsed by the National Joint Council. They have put every possible obstacle in the way of smooth working and have compelled the National Council and the Ministry of Labour to intervene.

The new conditions arranged for the London area are a very marked step forward. They provide for an automatic reduction of wages for a fall in the cost of living to a certain level, and also means for bringing into consideration a further reduction if and when the cost of living falls below that level. The schedule is worth close study, as it has been well thrashed out, and has been accepted by both sides after, in the case of the trades unions, a ballot of the men being taken.

If agreements such as the above are carried out in the right spirit of mutual confidence, interpreted fairly without showing a desire to strain every point in favour of one side or the other, the hope for maintaining continuity of supply and continuity of goodwill and good conditions are assured.

The Electricity Supply Industry—The Employee's View.

By J. F. HESLOP, A.M.I.E.E.

(President, Electrical Power Engineers' Association).

CONDITIONS of employment and rates of remuneration of technical staffs in the electricity supply industry prior to the outbreak of war in 1914 were admitted to be notoriously bad by all impartial observers.

This state of affairs was not peculiar to our own particular walk in life, but obtained throughout every branch of engineering industry. Mental labour, in common with manual labour, was regarded simply as a commodity to be purchased at a price. The demand was limited, and the supply of engineers—good, bad and indifferent—apparently unlimited and uncontrolled, with the inevitable result that many undertakings were run on the pupil and improver system. The majority were staffed with skilled and semi-skilled engineers in receipt of wages considerably less than were paid to the men over whom they were supposed to have control, and at the same time the engineer's love for his job was exploited to the fullest extent. It is true he had security of tenure, but the same may be claimed for the gentleman who enjoys penal servitude.

Unsuccessful Attempts at Organisation.

Attempts to organise staff men on a protective basis had met with scant success, due in no small measure to the inherent objection to anything that savoured of trade unionism.

The outbreak of war and the consequent increase in economic pressure was undoubtedly instrumental in bringing about a change of thought and outlook amongst staff men throughout the country. They began to realise for the first time that the disabilities under which they laboured could only be improved by co-operation and collective action. Whilst the increase in the cost of living was being met to a certain extent by increases in wages of the manual workers, through the action of their unions, staff men, for patriotic reasons, were expected to "carry on," and in doing so performed yeoman service to the community.

Applications for relief were either curtly refused or resulted in the payment of meagre bonuses, in no way commensurate with the liabilities to be faced, in spite of the fact that legislation was necessary to curtail the activities of the profiteer. It is important to bear in mind in this respect that love of country is a glorious heritage that ought to be shared by master as well as by man.

The Foundations of the E.P.E.A.

During this period the foundations were being well and truly laid of the E.P.E.A. and kindred organisations. The growth and development of these bodies, and particularly of the former Association, was phenomenal, and can only be explained by the absolute necessity for such organisations to protect the interests of their members. Looked upon with suspicion by the manual workers' unions as a possible tool to be used for their ultimate undoing when placed in the hands of the employers, the E.P.E.A. had a strenuous time in the early days. To combat this erroneous impression, and to prove to the manual workers that our policy was not diametrically opposed to their own was no light task. That success attended our efforts was due to the tact and foresight of the Association pioneers in dealing with the problem. There was no doubt in the minds of the leaders in regard to the policy of the Association; our objective was clear—namely, to improve the conditions and status of staff men, and to promote the general advancement of efficiency of the electricity supply industry, and our policy has been framed with this object in view. It was certainly never the intention of the E.P.E.A. to permit the industry to be used for the purpose of political propaganda; but, at the same time, it was fully recognised that the Association, occupying a key position in a key industry, was destined to play an important part in the promotion of industrial peace.

Opponents of the Whitley Councils.

In the supply industry, employers, technical and administrative staffs, and manual workers are fully organised, and the system of Whitley Councils in industry would appear to afford adequate means for dealing with the many problems which face us and press for solution to-day. As far as the manual workers are concerned, the National Industrial Council is in being, the requisite machinery has been set up throughout the country, and it is recognised as the competent body to deal with these matters. A National Joint Board dealing with the technical and administrative staffs has been in existence for some considerable time, but we are still awaiting the formation of District Joint Boards in many areas. The delay in formation is entirely due to dissensions in regard to the constitution of the national body, and to the parochial spirit which is still predominant and made manifest by many local authorities. Cases in point are York, Hammersmith and Wrexham. These authorities have signified their intention to take no further part in the Whitley Council scheme. Surely the day is far spent when this spirit should be allowed to prevail. It is impracticable to conduct separate negotiations on any particular subject with individual authorities with any hope of a satisfactory solution. They can be dealt with only on a national basis, with the requisite machinery necessary for the adjustment of local requirements.

Evading Responsibilities.

One is forced to the conclusion that it is only an attempt to evade responsibilities and ignore demands long overdue. The desire that amicable relations should prevail between employers and employees will be seriously jeopardised if the national aspect of the case is clouded by local prejudice.

The E.P.E.A. is insistent upon the improvement of these relations in the best interests of the industry, and if the Whitley Council system for dealing with industrial problems breaks down, the responsibility will rest with the employers.

The Question of Qualifications.

Reference has been made to the status and qualifications of engineers entering into the industry. The status of the engineer can be raised only by making the profession more exclusive—*i.e.*, by raising the standard of qualification and by the payment of adequate remuneration for services rendered. A step has been made in the latter direction in the agreement arrived at between the E.P.E.A. and the employers on the National Joint Board. The question of qualifications is receiving the careful consideration of the Association, and the active co-operation of the employer and the Association is essential to ensure that the standard determined upon will be maintained. A big advance will be made along the high road to greater efficiency by mutual agreement that only fully qualified engineers will be employed on technical staffs, and that these qualifications will be guaranteed by the Association.

The organisation of the industry to-day affords a unique opportunity to all concerned to place at least one industrial house in order, and assure it against industrial turmoil. If the opportunity is unique, great is the responsibility resting upon the shoulders of every man, and he who would shirk this responsibility will do so at his peril. By approaching the problems of industrial organisation in a spirit of good faith and good will we can travel a long way towards the solution of them, and contribute our quota to the realisation of that which appears to be a mirage at the present time—namely, "A country fit for heroes to live in."

Politics, Commerce and Engineering.

By LLEWELYN B. ATKINSON.

At the present time we hear, see and suffer from a good many of the effects of what is called industrial unrest. This unrest, which had been growing before the war, and has been aggravated by the war, is caused not only by high prices, but by a disinclination to get down to really hard work, and in a good deal of mental irritation for which it is difficult to know the reason and as difficult to suggest a cure. And when we talk of unrest we are inclined to think that this disease has only got its tentacles into what are sometimes called the working classes. But it really is equally evident in other classes, among whom I may instance many electricity supply engineers. I am now not referring to those engaged in subordinate technical positions, but to the chiefs of the undertakings, whether that undertaking be municipality or privately owned. In the case of the engineers of the municipally owned undertakings, in spite of the fact that under normal conditions the engineer has practically a permanent position, and is not primarily concerned with making a profit, two conditions which should make for a quiet and untroubled life, we find, nevertheless, that discontent is undoubtedly rife, and many chief electrical engineers of municipal electricity departments are distinctly unhappy. This, I think, may be largely put down to the fact that in these concerns municipal politics are a factor in deciding engineering and commercial questions. It is, indeed, a case of votes *versus* engineering. Municipal politics are allowed to influence the policy of the undertaking, and, though this is much worse in some places than in others, it is always a great trial to those who have been brought up as engineers.

Electricity Committees and Engineering.

Electricity committees often fail to look upon electrical matters from the engineering point of view; they are not, in fact, sufficiently in sympathy with that point of view, and, with the usual dread of the expert, are inclined to undervalue the opinions that are put forward by their technical advisers. It is only fair to add that in some cases the engineer is too inclined to consider every problem purely from the technical standpoint, and is not sufficiently in sympathy with the more general point of view. But in the result the engineer struggles with the situation for a time, then becomes apathetic, then disappointed and dissatisfied.

Having diagnosed the case, the next thing to do is to try and find a remedy. This is the more difficult, as it may be doubted whether there is a general remedy. One thing, however, may be said, and that is that a preliminary training in diplomacy is as necessary to supply engineers at to those engaged in any other walk of life. For if diplomacy is not allowed to lubricate the industrial machine the result is chaos and friction. Tact is a great factor, but tact is born with a man, and, if not born, will probably always be lacking. Personality is a good thing, but personality carried too far is often responsible for wrecking what otherwise would be an efficient and harmonious co-operation. The engineer must learn to work in with his chairman and committee, and fortunately there are many cases of chairmen, men of wide sympathy, willing to support their officials when the latter have gained their confidence, and able to carry with them the committees over which they preside. An engineer needs particularly to know when to give way and when to be stubborn on some point of principle.

The Cause of Pessimism.

The cause of the dispirited state of mind of many engineers of company-owned undertakings is rather different. The smaller undertakings are having a very bad time from causes well understood, and naturally the poor financial results, and in some cases actual impending disaster, have the effect that there is no expansion, no feeling of good results achieved, and again a feeling that the business is and has been one where government politics rather than commerce or engineering are the factors overruling all.

No doubt the depression and irritation to which I have referred is increasing from the fact that the electrical industry is getting older and the men in it, especially those at the top, are also getting older, and are beginning to feel the weight of their years in the way they did not when they were more youthful. Some of them, indeed, have gone so far as to abandon hope of any improvement, which in itself is a bad thing. Particularly is this the case of the man in charge of a small undertaking, who is becoming more and more depressed, and who seems to lack, or to have lost, the efficiency and ability either to improve his present position or to get anywhere else.

A Remedy Difficult.

As I have said, it is very difficult to suggest a remedy for the troubles, but to some extent it is to be hoped they will automatically decrease as the importance of the electricity supply business increases. This is especially the case in smaller towns, where an increase in the use of electricity will cause the undertaking to develop into more of a business, especially as electricity becomes less of a mystery and more of a thing which everyone can understand. At present the head of an electricity undertaking has to worry about too many things. In future he will mainly have to do with *selling* the commodity. It may, in fact, be said that in the future the commercial element will predominate, as in these cases the supply will probably be purchased in bulk from outside, and distribution and salesmanship will become the more important thing.

Proper early training would also help to improve matters, and the training of engineers, as I have said elsewhere, should be directed to preparing them for a commercial as well as for a technical life.

As an antidote to the condition of mental depression, I can only suggest that engineers must cultivate enthusiasm for their craft. Many men who have all the reasons for discouragement find scope in a certain amount of experimental work, in supporting the work and meetings of the Territorial Centres of the Institution, in becoming pioneers, and specialists in some new line of development. In this direction lies the antidote, if not the cure, of the troubles I have indicated.

Ball Bearings for Electric Motors.

By W. F. HIGGS.

(Director, [illegible])

AS mentioned in a recent issue of THE ELECTRICIAN, there is a strange prejudice against fitting ball bearings to electrical machines. Most of this exists through failures that have taken place with machines so fitted. A few notes on the pros and cons of the application of ball and roller bearings fitted to electric motors up to about 60 mm. internal diameter may therefore be useful. Ninety-nine per cent. of the breakdowns have been found to be due to one of the following three causes: (1) Bad fitting; (2) dirt; and (3) unsuitable lubricant. With regard to bad fitting there is little doubt that the ball bearing costs more in the first place, and is more expensive to fit than oil ring bearings, as the limits required are finer. But when this is properly done the reliability of the ball bearing is worth the extra cost, and the results are very far ahead of oil ring bearings, the necessary attention after the machine is installed being practically nil, while they have an indefinite life. Ball bearings call for accurate workmanship in fitting; the inner race must be a tight fit on the shaft. Various makers have different ways of attaching the inner race, but there is no doubt that with electric motors the cheapest and most satisfactory way is to make the race a sure fit on the shaft. This calls for skilled labour, and the limits required are within 0·0025 mm., the shaft should be left ground about 0·025 mm. larger in diameter than the bore of the bearing, as the bore varies within limits guaranteed by the leading makers. Each bearing must be fitted on to its own shaft, with a *light* driving fit. This will not be sufficient to crack or seriously expand the inner race, while it will hold sufficiently tight. The outer race must be a sliding fit in the bearing housing; this again calls for accurate workmanship, and requires scraping in. The bearing housing should be from 0·025 to 0·075 mm. larger in diameter than the outer race.

THE ELIMINATION OF END THRUST.

Journal ball bearings must not be called upon to take any end thrust whatever. Special thrust bearings must be provided if the motor is expected to have an end thrust. Provided the armature is magnetically central with the field system, and the machine is belt driven, there is no end thrust. Having fitted the bearing satisfactorily on the motor, it is surprising the carelessness that is exercised when erecting ball bearing machines. With belt drives little damage can be done during erection, but trouble occurs when the machines are direct coupled. If two electric motors are fitted with ball bearings and direct coupled, they can be bolted out of line when using solid couplings to an extent that the shafts can be broken off with a few hours run, yet when turning by hand the machines will rotate perfectly freely. This is unlikely to occur with plain bearing machines, as the bearings would seize. The explanation of this freedom of rotation is, the shafts are distorted each revolution, there is practically no bearing friction, and the shafts are acting as springs. It is a very hard job to make people realise the damage that can be done by connecting ball bearing machines out of line, and this causes trouble every day. The bearings are blamed for the trouble they cause, and it is surprising the few people who realise that bad erecting is responsible. When ball bearings machines are direct coupled, flexible couplings should be used.

DIRT AND LUBRICATION.

With regard to dirt, too much care cannot be exercised after the bearing has been unwrapped until it is fitted in its housing to see that it is free from dirt. The last operation of most bearing manufacturers is to wash them mechanically in paraffin, and they even consider it necessary to filter the air, or take other precautions to see that the air is clean before it goes into the washing department. If such precautions are necessary when the bearing is finished, it certainly is important during the erection that dirt and grit are eliminated as far as possible. Dirt accounts for quite a large number of failures. All castings used in a bearing housing must be machined all over to get rid of the sand.

With regard to unsuitable lubricant, graphite, if placed in a ball bearing, in the course of a few months will roll the balls into all sorts of shapes, and the bearing, which under normal conditions will give satisfactory service, will collapse at an early date. The so-called motor greases that are on the market very often contain this material, they also contain a great deal of water, which are two of the enemies of ball bearings. A ball bearing does not consume grease. Once the bearing housing is packed it will last at least 12 months. The most suitable lubricant is commercial vaseline. Packing glands are not necessary; the outside caps should be about 0·05 mm. larger in diameter than the shaft, and the lubricant in the housing will prevent ordinary dust from entering. At the end of 12 months the bearing requires washing out with paraffin, re-packing with vaseline, and is then good for another 12 months. It must be remembered that a ball bearing is not like a plain bearing, it is a machine in itself, and requires treating as such. It is no use expecting to get satisfactory results from ball bearings if bad lubricants are used, and unskilled workers are allowed to fit them.

I have fitted hundreds of thousands of these bearings on to electric motors with remarkably good results, and can thoroughly recommend them, both from the user's and manufacturer's point of view. The advantages gained by using ball bearings over oil ring bearings may be summarised as follows:—(*a*) slightly increased efficiency; (*b*) reduced overall length of motor; (*c*) bearing attention practically nil; (*d*) lubricant consumed practically nil; (*e*) the machine can be fitted in an inverted or horizontal position without any alteration, and (*f*) oil throwing and oil creepage is avoided. This is one constant source of breakdowns of electric motors, and in itself is sufficient reason why ball bearings should be fitted to electric motors.

Heat Economy in the Boiler House.

By EDWARD INGHAM, A.M.I.Mech.E.

AT most works, the cost of the fuel required for firing the boilers is undoubtedly one of the principal items in the total annual expenditure. Even in normal times, when coal can be procured at a reasonable figure, the annual coal bill is a matter of anxiety to the manufacturer, but now-a-days, when fuel is so costly, it behoves the steam user to do everything in his power to reduce the coal consumption. For instance, a firm possessing four or five Lancashire boilers, each 30 ft. by 8 ft., consumes per week about 100 tons of coal. Assuming the price of the fuel to be £2 per ton, the money spent in coal alone is therefore £200 per week, or £10 000 per annum. But although the coal bill is so serious an item, the great majority of firms are burning far more coal than they should. For the average efficiency of steam boilers is from 15 to 20 per cent. less than it should be, and though the best modern boilers, when maintained in first-class condition, are capable of attaining an efficiency of 80 per cent., numerous tests carried out by the various Boiler Insurance Companies and other authorities show conclusively that the average efficiency is between 60 and 65 per cent., whilst many boilers have an efficiency of little more than 50 per cent.

REASONS FOR REDUCED EFFICIENCY.

The question naturally arises, "What are the factors responsible for the low efficiencies which prevail?" These are many and of a widely varying nature, but the principal losses are usually due to one or the other of the following causes: (*a*) The admission of either too much or too little air to the boiler furnaces; (*b*) the resistance offered to the free flow of heat from the furnaces' gases to the water in the boiler; (*c*) the loss of heat by radiation from the hot boiler.

With regard to item (*a*) the losses from this cause were far more serious at one time than they now are. The practice of having the flue gases analysed from time to time, with a view to determining the percentage of CO_2 present in the gases, and hence judging whether too much or too little air is being supplied for the combustion of the fuel, has done a great deal towards improving boiler efficiencies, and no steam user who installs a CO_2 Recorder need suffer loss of fuel through improper methods of firing or regulating the draught. Similarly, with regard to item (*c*), the heat losses from radiation are not nearly so great now as formerly, steam users having realised that, by efficiently covering their boilers with some good non-conducting material, the losses occuring from this cause may be reduced to the minimum.

RESISTANCE TO HEAT FLOW.

Item (*b*) is the one which concerns us most in the present article. In all cases, very considerable resistance is offered to the flow of heat through the plates.

At one time it was generally believed that the nature of the material of which the plates were constructed, and their thickness, were the two factors which determined the efficiency of the heat transmission, but experience has shown that these are factors of practically no importance in comparison with other factors such as a very thin layer of scale on the water side or of soot on the fire side of the plates, which will have a far more serious effect in impeding the heat flow than any clean metal plate of great thickness. Even with clean plates the quantity of heat actually transmitted under working conditions, has been shown to be extremely small, and the reason for this is that a stationary film of water on the water side and of gas on the fire side of the plates has an enormous effect in preventing the flow of heat through the plates.

Experiment has proved that if the gas film could be removed, the heat transmission, and consequently the boiler efficiency, would be greatly increased, but in order to remove the film, it is necessary to force the gases over the plates at high velocity, and to do this, a powerful fan is required, which consumes a large quantity of steam. The late Prof. Nicolson, of Manchester, designed a modified form of Cornish boiler, in which a powerful fan was employed for propelling the gases at high speed over the heating surfaces. The boiler efficiency was unusually high, but owing to the large quantity of steam consumed by the fan, the actual gain was practically nil. There can, however, be no question that if a boiler could be designed in which the gases could be made to flow rapidly over the plates, without necessitating some device which itself absorbed considerable power, boiler efficiencies would be much higher and coal bills much lower then they actually are. At present, this problem remains unsolved, and steam users must submit to the losses incurred by the presence of stationary films of gas on the heating surfaces of their boilers.

Loss of Efficiency due to Scale.

There is, however, one very common and considerable source of loss which can be overcome, and that is the loss due to the presence of accumulations of scale on the plates. Large numbers of boilers are constantly worked with their plates coated over with layers of scale of varying thickness, and although steam users are alive to the fact that they are incurring heavier coal bills on this account, they refuse to have their boilers scaled until the last possible moment. Many steam users do not appear to realise that scale not only gives rise to needlessly heavy coal bills, but also to increased wear and tear of the boilers.

Most forms of scale are bad conductors of heat, and when present in any considerable thickness, interfere with the heat flow to such an extent that the plates become overheated. This means increased expansive movements and greater straining throughout the boiler, and, in severe cases, the overheating may lead to leakage of the riveted joints, distortion and fractures. It is, therefore, of the utmost importance that all boiler plates should be kept clean of scale as far as possible.

Some Striking Statistics.

Various figures may be quoted to show the losses which occur from the presence of scale on boiler plates. Hutton, for example, states that the losses due to layers of scale $\frac{1}{16}$ in., $\frac{1}{8}$ in. and $\frac{1}{4}$ in. thick are respectively 9, 18 and 38 per cent., but such figures are not to be relied upon. It is a fact that considerable thicknesses of some forms of scale have little effect in impeding the heat flow, whilst thin layers of other forms of scale produce a very serious effect, but in the generality of cases, scale is responsible for serious losses, whilst it increases the wear and tear of the boilers, and further, may conceal important defects.

In the case of water-tube boilers, the effects of scale are probably even more serious than with large cylindrical boilers. The bulk of the work of the evaporation in a water-tube boiler is performed in a large number of tubes of small diameter, and the formation of only a very thin layer of scale inside the tubes will generally lead to a serious falling off in the efficiency. Any appreciable quantity of scale in the tubes is liable to lead to overheating, bulging, distortion and rupture, and hence, it is of vital importance that the tubes should be kept well cleaned of scale. It must be remembered that the rate of evaporation in a water-tube boiler is extremely high, so that any scale-forming matter in solution is liable to be deposited very rapidly. Owing to the serious consequences which may arise from accumulations of scale in these boilers the insurance companies generally advise that thorough cleaning should be resorted to after about 1 000 or 1 200 hours working, even with the best waters, and much more frequently with waters of indifferent quality.

The ordinary methods of removing scale from boilers are laborious and costly. With water-tube boilers the removal presents much greater difficulty, owing to the inaccessibility of the tubes, and in such cases the adoption of some special power-driven tool becomes an absolute necessity. Several such tools, some driven by water and others by compressed air, are now on the market. One of the latter kind, of a most interesting design, has quite recently come under my notice. This is known as the "Skatoskalo," and is made in two patterns, one especially adapted for the scaling of Lancashire, Cornish, marine, loco-type and vertical boilers and the drums of water-tube boilers, and the other for all water-tube boilers.

The "Skatoskalo" Tool.

The principle of action of this tool is simple. A piston is made to deliver blows at a very high rate, from 8 000 to 12 000 per minute, and these blows being transmitted to the encrusted plate, set the plate in a state of intense vibration, which causes the scale to fall away. The tool requires about 18 cubic ft. of air per minute at a pressure of from 60 lb. to 80 lb. per square inch. Since there are no valves to get out of order, and no cutters to break and give trouble, the tool is one which will no doubt appeal strongly to steam users, particularly those who are not fortunate in having a good water available for boiler-feed purposes.

There are, of course, other causes responsible for heavy coal bills, in addition to those above-mentioned, such as leakage of steam from the junction valve, frequent and unnecessary blowing off of the safety valve, irregular feeding, priming, &c., but the losses arising from these are, generally speaking, slight in comparison with those from the causes we have considered, and can be avoided if ordinary care is taken, so that we need not do more than mention them.

Multispeed Induction Motors for Power-station Auxiliaries.

It has been suggested that a short article pointing out the advantages of the use of the pole-changing type of induction motor for alternating-current power stations as built under Creedy's patents by Messrs. F. & A. Parkinson, Ltd., Guiseley, would be of interest to readers of The Electrician, especially as a considerable number of these machines are now in use for various purposes in connection with power-station work, including the operation of stoker motors, ash-handling plant, various fan application and all apparatus in fact which is required to vary its speed according to the load on the station.

The most modern type of multispeed induction motor is equipped with a simple drum controller having twenty-one fingers and can be made interchangeable with nearly any single-speed motor of the same horse-power. It is usually built to be capable of giving three to four speeds, such speeds as 1 000, 750 and 500 or 1 000, 750, 500 and 375 revs. per min. being usually chosen. The easy change of speed in accordance with the demand on the boilers is a feature much appreciated by users of this apparatus. In accordance with the usual practice one motor operates each bank of boilers, and as the load increases, by a mere movement of the controller handle, the chain grate can be increased in speed, or when the load decreases may be correspondingly reduced. This type of apparatus is fitted with slip rings, but in certain cases where motors are required to operate in very dirty situations a machine having a short-circuited type of rotor is called for. This involves a slight change of design, involving the use of a small auto-transformer and somewhat more elaborate switchgear, such as is used with the larger motors.

Multispeed Motors and Forced Draught.

Other applications in the central station where these motors are of service are in connection with forced and induced draught fans. For such purposes motors of much greater horse-power and variable speed are required to deal with variations of load on the steam-raising plant. The usual plan is to make use of ordinary resistance control on the induction motors driving the fans, a process which apart from its initial costliness and waste of power, owing to the immense bulk and elaboration of the continuously rated resistances, gives constant trouble owing to these resistances becoming overheated and requiring replacement. Here again two types of motor are available, one a machine with slip-rings and a very simple drum-type controller which enables three or four speeds to be obtained as before described. For a great many purposes this type of machine is, it is claimed, the most suitable, as it contains practically the same parts as the old resistance control motor, namely, a slip-ring type induction motor and a small drum or other type of controller, but minus the objectionable continuously rated resistances.

A New Application of Squirrel-cage Motors.

On the other hand, of course, only a limited number of fixed speeds not above four can be used. Where the above type of machine is not satisfactory another type is available, in which a machine which permits of the use of a squirrel-cage rotor for fan driving (a type of winding never previously employed satisfactorily) is combined with a type of control devoid of resistances and therefore generating no heat in the process of operation. This control consists merely of a small auto-transformer, which changes the number of phases of the supply, and of a controller consisting of three to five switches mounted on a slate panel which can be opened and closed in proper sequence by a suitable mechanism to give the necessary speed changes.

The number of switches required depends of course upon the number of speeds. With five switches as many as six speeds can be obtained, and the method of control adopted is such that the motor is not confined to fixed ratios of speed, but practically any six speeds corresponding to definite pole numbers lying within a speed range of three to one can be obtained. If fewer than six speeds are required a smaller number of switches can be used. As pointed out above, when a small motor is required for any reason to have a squirrel-cage rotor or to have a greater number of speeds than four this type of control is often adopted, in spite of the slight added expense as compared with the drum-type controller.

High Efficiencies.

All the above motors are, we understand, characterised by a very high efficiency at all speeds, the drop in efficiency from the highest speed to the lowest speed being not more than 5 per cent. in machines of considerable size or 10 per cent. in the small sizes. None of these motors, it may be pointed out, employ any apparatus such as resistances involving continuous dissipation of power when they are running on reduced speeds. Another advantage which users appreciate very highly is the constancy of speed which these motors show as compared with motors whose speed is reduced by resistance control. In the latter case, of course, slight variations of load corresponding to any given speed produce exaggerated variations of speed, and consequently a controller notch which corresponded to a given speed yesterday may correspond to an entirely different speed to-day, owing to a slight change of conditions in the interval. In certain cases this characteristic of the resistance-control motor has been known to give rise to very serious trouble. In the multi-speed motor, of course, speed depends only on the frequency and is practically constant, independent of the load, for each setting of the controller, the slip being only that of a normal induction motor. By the use of this type of machine the difficulty in obtaining adequate starting torque with moderate current in the squirrel-cage induction motor has been completely overcome.

It would be out of place here to discuss how and why this result is obtained, but reference may be made to a Paper recently read by Mr. F. Creedy before the Institution of Mining Electrical Engineers, where this matter is fully discussed.* It will be sufficient to say here that squirrel-cage motors of this type having a three to one speed range can be made to start with full-load torque with not more than twice full-load current, or when even better starting characteristics are required can be made of the ordinary slip-ring type with resistance starting at one or more speeds.

The "Invincible" Wet Air Filter.

With the present necessity of using to the best possible advantage the materials at our disposal, ventilation becomes essential to the operation of turbo-generators, and a supply of air of the right kind is obviously equally vital. To obtain a supply of air for this purpose is not, however, simply a question of installing fans, as those who live in the neighbourhood of large towns or manufacturing districts are painfully aware that the dirt in the atmosphere amounts to several tons per acre in the course of a year. To drive or draw ordinary air from the windings of an alternator hour by hour would soon result in the small interstices becoming choked up and local heating with all its attendant troubles arising. These difficulties can be got over by the use of some kind of filter, and recent experience has shown that the so-called wet filter possesses many advantages. A number of these filters are now on the market, and among the most interesting is that known as the "Invincible," which is made by Messrs. William Grice & Sons, Ltd., of Birmingham, and which we describe below.

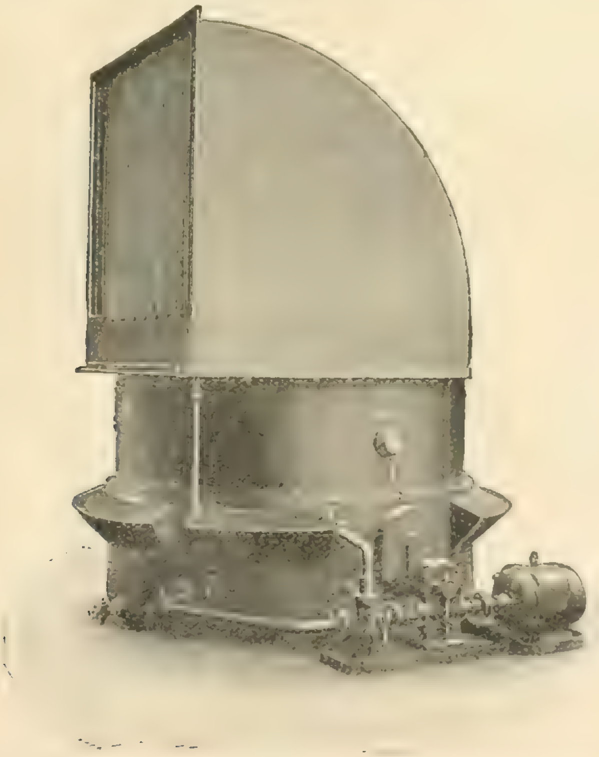

Fig. 1.—General View of the "Invincible" Filter.

This filter, it is claimed, thoroughly washes the air, removes all particles of dust and solid matter, and delivers it to the generator clean, humid and at a considerably lower temperature than the atmosphere. Fig. 1 shows one of the latest type "Invincible" filters ready for installing, and attention may be called to the general symmetry of design and pleasing harmony of the whole machine. This may be a small point, but in engineering design even small points are worth notice.

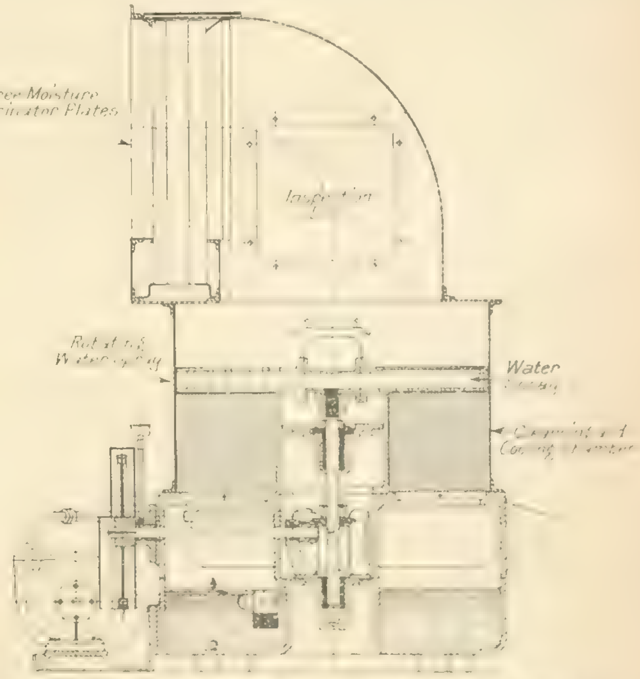

Fig. 2.—Sectional Elevation of Patent "Invincible" Wet Air Filter, showing Bend with Special Eliminator Plates.

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* See The Electrician, Vol. cxxxvi., p. 378.

The illustration represents a machine suitable for dealing with 23 000 cub. ft. of air per min. Seven sizes of filters are built, covering a wide range. For very large requirements it has been found advisable to install twin sets which, while saving the transport difficulties attendant on a very large machine, has the obvious advantage that one machine can be cleaned while the other is still running.

The Internal Arrangements.

Fig. 2 is a section showing the internal arrangement of the machine. The method of cleansing the air is extremely simple, and there are no complicated parts to get out of order or become choked with dirt if reasonable attention and care is exercised. Unfiltered air passes into the base of the machine through openings which, to prevent splashing and the passing of paper and other large foreign matter, are fitted with steel covers, the upper faces of which are constructed of expanded metal. The air then passes upwards through a large number of thin galvanised steel plates arranged to stand vertically and to form a complete circle. These plates are bent to the form of a true involute, thus enabling them to be equidistant at all points. They are kept the correct distance apart by a series of small projections punched out of the plates themselves. The plates are kept continually wet by spray arms, which revolve slowly over the upper edges and discharge water through a series of holes. The water running down the plates serves the double purpose of maintaining a film of water on the plates and washes down the dirt, which is deposited on them from the air. The total area of the plates is very great, and the air being split up into thin sheets leaves every particle of dirt on the wet surfaces in passing through. The action is similar to that of a fish's "gills," which are a perfect natural filter. Every cubic foot of air, we are informed, comes into contact with about 200 sq. ft. of filtering surface. This accounts for the exceptional cleansing qualities of the machines, and also for the big reduction in temperature which takes place. After passing through the filtering element the air is drawn over a system of vertical eliminator plates, which prevent any drops of free moisture which may be lifted with the air from the filtering plates passing over into the ducting, and at the same time removes any stray particles of wetted dirt which may still be mixed with the air.

Efficiency Experiments.

With a view to testing the efficiency of the eliminator plates as a prevention to the passage of free moisture, some interesting experiments have recently been conducted. In one case a filter designed to deal with about 16 000 cub. ft. of air per minute was loaded up to 21 000 ft., with the result that a considerable amount of water was lifted off the filtering plates and precipitated against the eliminator plates. The amount of water drained out of the trough in which the eliminator plates stand was carefully measured and found to be as much as one pint per minute. The side of the plates remote from the filter were quite dry, and after running for some hours no trace of free moisture had found its way into the ducting.

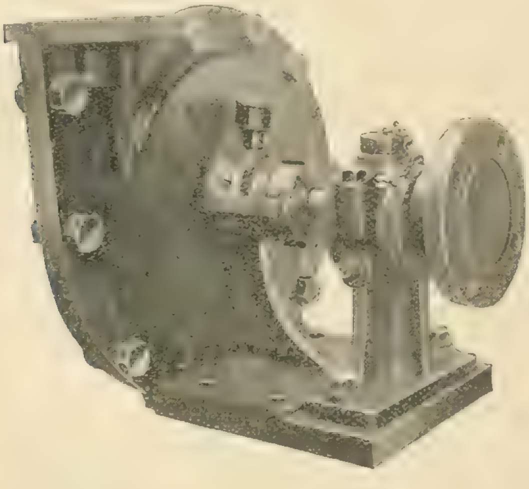


Fig. 3.—An Impeller Pump for Use with the "Invincible" Wet Air Filter.

General Construction.

The general construction and details of these filters is of interest. The machine consists of a strongly constructed cast iron circular tank, on which all the working parts are mounted. The filtering plates are carried on a galvanised drum which is mounted on the circular tank or base. In the centre of the tank is a vertical hollow bronze spindle, to the upper end of which are fitted hollow arms for spraying the water on the filter plates. The hollow spindle is made to revolve slowly to maintain an even distribution all over the filtering element. The power required for driving the filter can be supplied by means of a belt, if required, but usually a small motor is fitted having a brake horse power of from 1 to 1½ according to the size of the filter, running at a speed of about 1 000 revs. per min.

The arrangement is clearly shown in Fig. 1. It will be noted that the motor is coupled direct through a worm reduction gear on to the centrifugal pump, which is arranged to circulate the water through the filter. The pump draws from the base of the machine, and the end of the suction pipe is fitted with a suction box provided with a gauze strainer, which can readily be removed for cleaning without stopping the filter. The delivery is conveyed to the bottom of the bracket which carries the vertical spindle, the water passing through this to the spray arms.

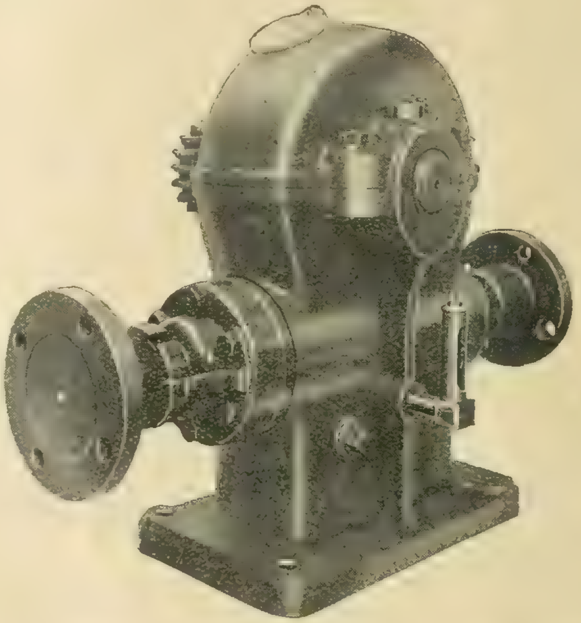


Fig. 4.—Gearing Used in Driving the "Invincible" Filter.

The pumps are the result of careful study of the special requirements. A pump of the latest type is shown in Fig. 3. The impeller and spindle are of phosphor bronze cast in one piece. Very little power is required to drive these pumps and an ample supply of water is obtained. No priming is required, as the level of the pump is below the water level in the base of the machine.

Every filter is run at the works at the correct motor speed, and the pump is adjusted to supply water at a pressure of about 2 lbs. per sq. inch. A plate is fixed above the gauge stating the correct working pressure. If the pressure tends to increase it is an indication that the spray arms are becoming choked up and must be cleaned, which is easily done by removing the covers.

The reduction gear used with this apparatus is worthy of notice, for it has received very special attention by the makers. Great care has been taken to prevent any oil leaking out of the case without unduly increasing the friction. The gear is shown in detail in Fig. 4. The reduction through the worm gear is 40 to 1. The slow motion is transmitted by means of a pinion keyed on the worm-wheel shaft which meshes with a spur wheel; a horizontal spindle passes to the centre of the machine and drives the central spindle by bronze bevel wheels.

The Importance of Proper Lubrication.

The question of lubrication in a machine which is required to run continually is of very vital importance, and in the case of the "Invincible" Filter has been dealt with very thoroughly. To prevent the possibility of oil finding its way into the filtering water and coming into contact with the air, no form of lubricant is used inside the machines except water. The three internal bearings and thrust block which carry the weight of the spindle are of lignum vitæ and are lubricated by water splash only. The pumps and reduction gears are ring oiling and the reduction gear runs in an oil bath. A ball valve is fitted to the base of the filter to maintain the correct water level. This must be connected to any available clean water supply. There is no loss of water except that due to evaporation, which varies with atmospheric conditions.

A commendable feature is that no special foundation is required for these filters and there are no foundation bolts used, a solid level surface only being required. The amount of attention required is thus reduced to a minimum. The action is entirely automatic in every respect. As the machines are installed to remove dirt from the air, obviously it is necessary from time to time to flush out the base of the machine and to see that other parts are reasonably clean, the frequency of this depending in a great measure upon the district in which the machine is working. Apart from this, no attention is required.

Some Practical Tests.

Testing filtering plants with a view to ascertaining the amount of dirt removed from the atmosphere is a very absorbing study, but unfortunately in practice is attended with many difficulties. Arrangements can be made whereby a known quantity of filtered and unfiltered air can be drawn through small filters of cotton wool, which are afterwards weighed, the difference in weight of the two samples representing the weight of the dirt removed by the filter. The scales necessary to ascertain correctly these small differences in weight must be extremely sensitive and are very seldom obtainable.

A practical way of ascertaining if efficient filtering is taking place is to draw a known quantity of air through a small filter composed of a single sheet of white blotting paper clamped so as to leave a small circle about 3/16 in. diameter through which the air passes. If the filter is efficient the filtered air will not discolour the paper, while unfiltered air will usually produce a black disc. Many "Invincible" filters have been tested in this way with excellent results.

The Pneumatic Handling of Coal.

It is now nearly thirty years since a pneumatic plant for the discharge of grain cargoes was first introduced into the London Docks, and although for many years the system was looked upon in this country by those who were not users as an expensive luxury on account of the comparatively high consumption of power, those who had once tried it showed no disposition to return to the use of mechanical appliances. Step by step the great advantages of the pneumatic method won their way to general recognition, first at the important grain ports of the Continent, Rotterdam, Antwerp, Hamburg, Genoa, &c., and then in this country, where pneumatic plants are now rapidly superseding all older methods. During the last eight or ten years very marked improvements have been introduced by English makers who once more lead the way.

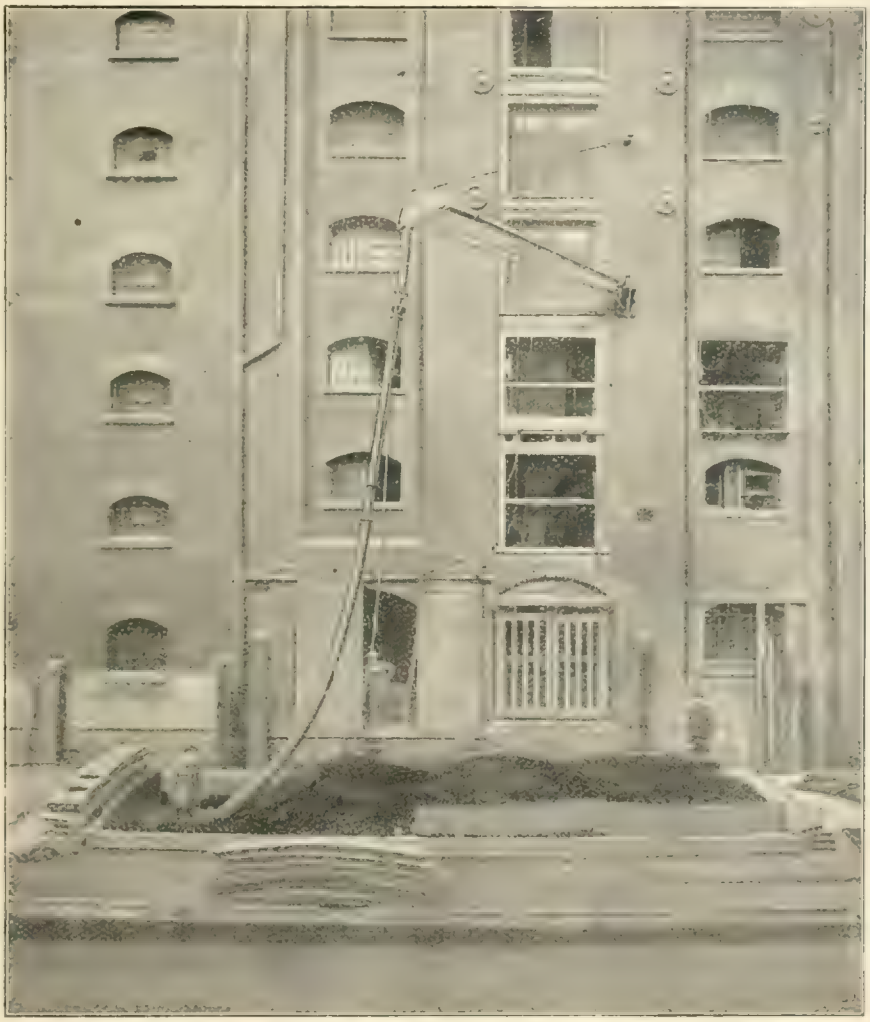


Fig. 1.—Pneumatic Plant (installed by Messrs. Henry Simon, Ltd.), Discharging Coal from Barges at the Mills of Messrs. Chas. Brown & Co., Bermondsey, London.

Some account of this development will be found in an article by Mr. C. Bentham in The Electrician of Jan. 19, 1919. It will suffice here to say that though no one intimately acquainted with what has been and is being done in this branch of engineering would for a moment suggest that finality has been reached, modern installations now exhibit a very high degree of technical perfection and detailed adaptation to the ends in view.

A Direct Result of Grain Handling.

This brief historical reference to the pneumatic handling of grain is a necessary introduction to the subject of pneumatic coal handling since the latter is a direct development from the former. Experience gained in handling grain has led to the perfecting of the apparatus to a form which is found to be entirely suitable for dealing with industrial coal (nuts or slack).

The advantages of the pneumatic system are largely summed up in the word flexibility. The material is simply drawn through a pipe, the action of the air current on each particle being of the kind now familiar to many engineers through the wind-tunnel studies of the last few years on aeroplane parts; that is, there is a combination of direct impact pressure, air friction and suction induced on the forward-facing surfaces of the particle. Since the conveying pipe may be fitted with swivelling or universal joints, with telescopic and flexible sections, and need not be very large (an 8 in. pipe will carry up to 60 tons per hour of coal), it will be apparent that there is hardly any conveying problem too difficult for solution by employing the pneumatic method.

The pipe may be run overhead across buildings, roads, or railways, or underground, if necessary, and may be provided with a system of branches commanding a wide area.

Pneumatic plant, whether for grain or coal, finds its widest field in the discharge of barges and ships. Fig. 1 shows a typical installation of the kind made by the well-known firm of Messrs. Henry Simon, Ltd., for discharging coal from barges into an adjacent building. The pipe is attached to the wall by means of a swivelling connection and is provided with a flexible section immediately under the bend, followed by a telescopic section giving 10 ft. of movement and a long flexible extremity. Just inside the building the pipe enters the receiving chamber where the coal is deposited owing to the great reduction of the air-speed. The coal is continuously extracted from the chamber by means of a tipper seal (Figs. 2 and 3).

The Principle of the Method.

The principle of the operation of this mechanism is as follows:—The rocking member (*G*) contains two pockets (*H J*), which are alternately brought into communication with the outlet (*K*) of the receiver. While each pocket is thus engaged and therefore under vacuum, its hinged discharge door (*L*) is held closed by the pressure of the atmosphere. Simultaneously the other pocket has been swung far enough over to admit air through the feed opening, and has permitted the hinged door to open and discharge its contents. The frame of the tipping box, including the circular rubbing face, is of cast iron, and is pivoted in adjustable bearings, the bearings being supported by brackets carried from the upper or seat casting (*M*), in which ports (*N*) are arranged for exhausting the air from the pockets before coal is admitted to them. The object of the latter arrangement is to prevent the in-rush of air carrying the coal over and into the dust collector. The air-tight joint between the tipping box and the upper casting is made by two means. There is a steel packing strip (*O*) held in the cross bar between the two pockets against the face of the upper casting by bow springs, and at the sides and ends of the rubbing face of the tumbling box leather strips are provided. The hinged discharge doors are also rubber faced, to make an air-tight joint.

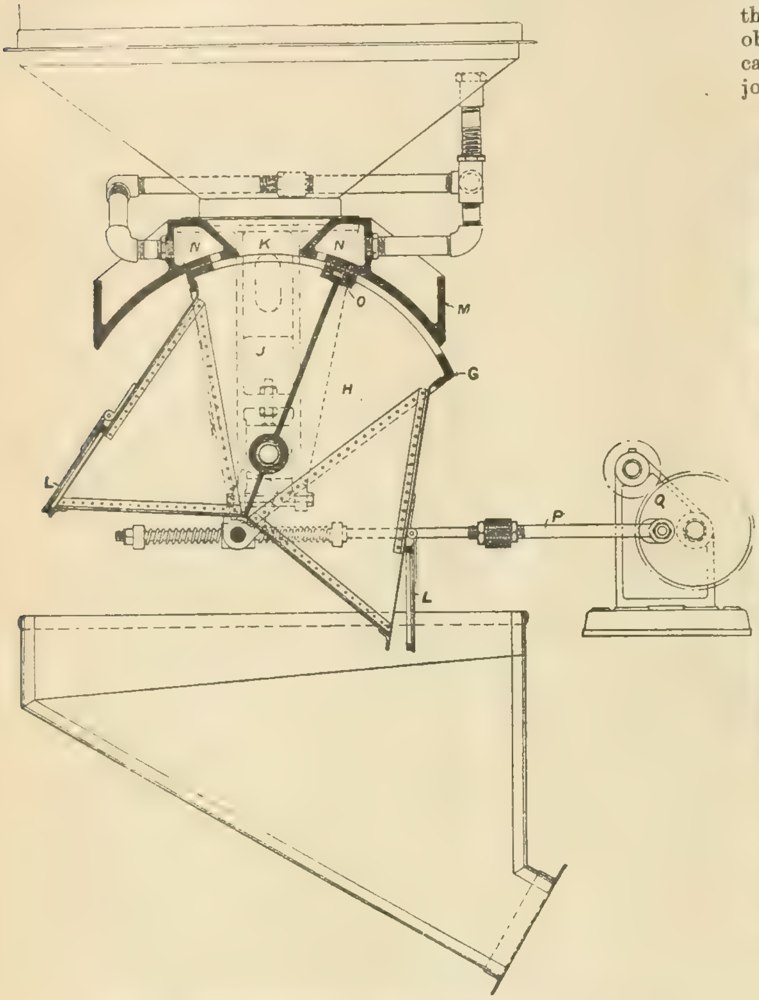


Fig. 2.—Diagrammatic Sketch of Patent Tipper Seal.

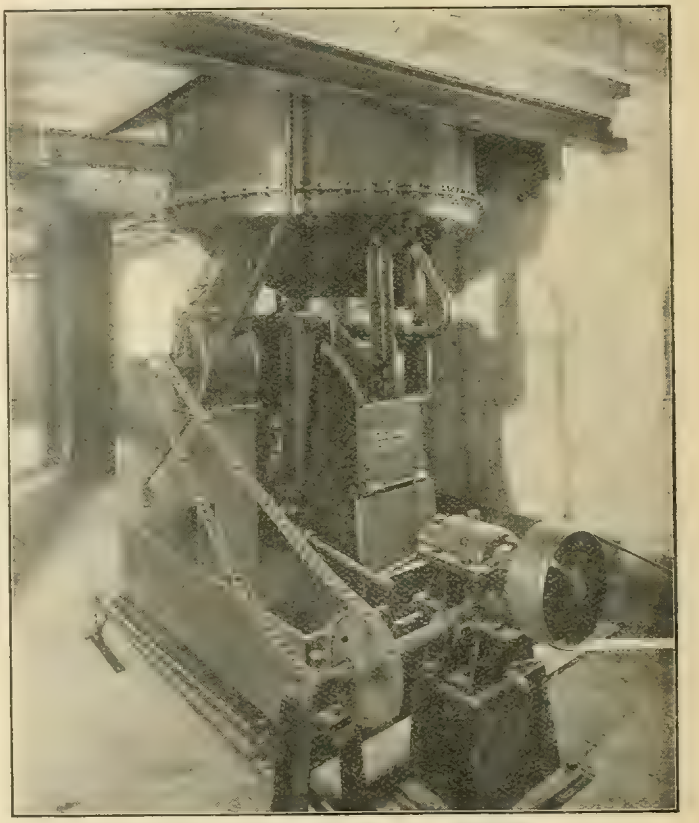


Fig. 3.—View of Receiver and Patent Tipper Seal.

The pumping set is electrically driven, and in order to prevent dust from entering the cylinders, the air is first drawn through a series of textile filters for purification.

The electrically driven vacuum pumps are usually of the vertical pattern with valves situated in the top and bottom covers. The valves are composed of single steel discs of special material, mounted on spindles with light springs. The pump is designed to give a high efficiency with a low vacuum, or small pressure difference of some 7 in. to 12 in. of mercury, and is constructed so as to be unaffected by any dust which may be carried over in the air. The piston is not lubricated in the ordinary way, but to prevent any unnecessary friction the cast-iron piston rings carry a special dry graphite composition, which requires little or no attention. The pumps, which may be single or twin cylinder, are driven through enclosed double-helical gearing.

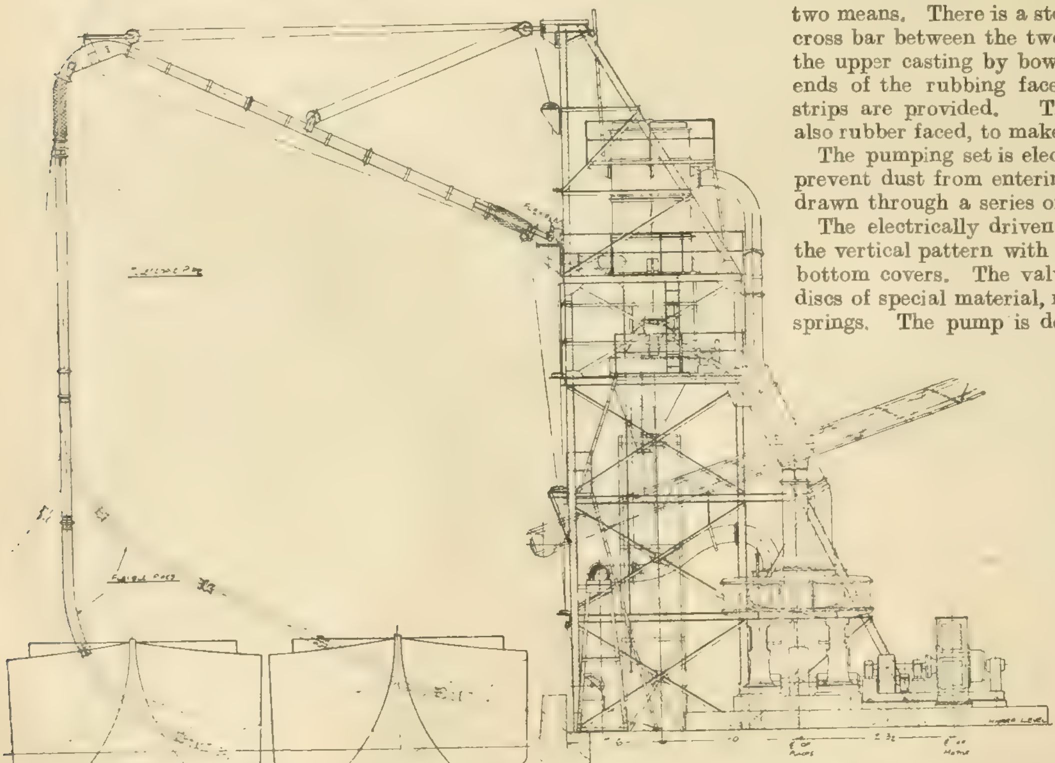


Fig. 4.—Diagrammatic Sketch of the Pneumatic Handling Plant Installed by Messrs. Henry Simon, Ltd., for the City of London Electric Power and Lighting Company.
Capacity of Plant, 120 tons per hour.

A City of London Plant.

The whole lay-out of such an installation is perhaps more clearly seen on Fig. 4, which shows a part of the plant at present being installed by Henry Simon, Ltd., of Manchester, for the City of London Electric Power and Lighting Company, Ltd., at their Bankside station. In this case the receiver, tipper seal and suction pipe are supported by a steel tower. There are two towers each with a capacity of 60 tons per hour and each pipe will cover four Thames lighters lying abreast. A belt conveyor takes the coal from the tipper hopper and distributes it in the bunkers by means of a travelling throw-off carriage.

In a somewhat similar installation which the same firm is constructing for the North Metropolitan Electric Power Supply Company, Ltd., an additional branching pipe range is to be provided covering the whole of the storage dumps and a third system will draw coal from a railway siding nearly 200 ft. away. In the same way, a plant once installed for one purpose can readily be extended to meet other needs, or for the handling of ashes and flue dust.

The economies introduced by the use of such a plant in these days of high labour costs are so obvious as to require no emphasis.

The London Electricity Inquiry.

Some Engineering Details of the L.C.C. Scheme.

During the week the Electricity Commissioners continued their investigation of the schemes submitted for the improvement of the electric-supply organisation in the London and Home Counties District.

Mr. G. H. Hume concluded his evidence for the L.C.C. scheme, and he was followed by Mr. J. H. Rider and Mr Johnson.

Technical Details of the Scheme.

Mr. J. H. Rider said he had been engaged with three other engineers in drawing up the technical scheme which was before the Commissioners. It was an agreed report by the whole of the members of the technical committee. They did not attempt to alter the area delimited by the Commissioners. One of the advantages they had on the committee was that of having representatives of company and local authority interests. They were able to get information which he might not have got if he had been acting alone for the L.C.C. They had to devise a scheme with the ultimate object of generating the bulk of the supply at stations in better positions than many stations which now existed. They had to aim at ultimately getting the bulk of their stations on the river where there were water facilities, and at points not too far from the points at which the energy had to be delivered. There would be no benefit in putting three stations together on one site. There must be a physical limit to the number of mains that could be taken away from any power station. That was limited by the size of the road and considerations of that kind. The capacity of the plants in the area was 480 000 kW, chiefly reciprocating plant and mostly in small units. To that there were being added or about to be added 255 000 kW of new modern turbine plant. A curve accompanying the technical committee's supplementary particulars showed that, excluding the railway load, the maximum demand was estimated to reach 650 000 kW in 1931, or with the railway load added about 800 000 kW, and the number of units sold was estimated in 1931 to have reached 1 380 million without or 2 030 million with the railways.

Existing Organisation.

The best of the existing stations were to be kept at work and connecting mains laid between those stations and the remainder. In an inquiry put to them by the Commissioners they were met with a difficulty as to the meaning of the term "existing organisation." They had understood it to mean the operation of the existing authorised undertakings in their own areas, and they were of opinion that it was not necessary to consider that position, as it would be of no advantage to London as a whole. Upon inquiry, however, they were informed that it meant the existing facilities operated under the guidance of an overruling body which would decide which stations were to be worked, which should be extended, which should be shut down and so on. The alternative scheme was got out on that understanding. The reason for putting forward their additional particulars was entirely financial. If money and plant could have been got on pre-war terms they would not have suggested an extension of the existing organisation such as he was going to put before the Commissioners, but, considering that about 250 000 kW of modern plant was now going in or on order, the position was entirely different. By developing the existing organisation under a central control there would be practically the same result for some years to come, with considerably less cost, than would have been possible if the scheme they first prepared had been carried out. Certain stations were already linked together, and the amount of plant being erected or on order would bring the total effective plant in the area to 653 000 kW, allowing for putting out of use 85 000 kW of existing plant. They had divided the existing stations under two heads, (1) grouped stations and (2) other stations which it was proposed to shut down. In the grouped stations there was 395 600 kW of plant, and extensions were in hand or authorised amounting to 246 800 kW, making a total of 642 400 kW. In those stations it was proposed to scrap 85 400 kW, leaving 557 000 kW. In the other stations there was 76 000 kW of plant available, including the present extensions, making a total of 633 000 kW. That would give as much plant as they would have had under the original scheme, excluding the railway supply. They would get a result equivalent to that obtained by putting 100 000 kW of plant in capital stations in the first stage. The stations shown in the accompanying table were to be group stations.

	Existing plant, in kW.	New plant being added, in kW.	Plant to be scrapped, in kW.	Net result, kW.
West Ham	17 900	10 000	3 900	24 000
Poplar	9 750	6 750		16 500
Stepney...	16 000	10 000	—	26 000
Shoreditch	8 800	5 000	3 800	10 000
Hackney	18 200	9 000	1 200	26 000
Walthamstow	5 800	3 300	1 800	7 300
Bow (Charing & Co.) ...	20 400	12 000	6 400	26 000
Bankside (City Co.) ...	30 000	26 000	10 800	45 200
Islington	9 250	5 000	3 250	11 000
St. Pancras (King's-road)	5 500	11 600		17 100
Grove-road (Central Co.	20 220	35 000	5 220	50 000
Horseferry-road (Westminster Co.)	5 100	3 000	—	8 100
Hammersmith	11 400	12 000	2 400	21 000
Wood-lane (Kensington & Notting Hill Co.) ...	11 900	—	1 600	10 300
Battersea	9 524	5 000	3 024	11 500
Barnes	1 500	3 000	—	4 500
Kingston	3 240	–	700	2 540
Wimbledon	4 825	3 000	1 325	6 500
Willesden (Metropolitan Co.)	23 000	16 000	9 000	30 000
Uxbridge	6 100	2 000	1 700	6 400
Wandsworth (County of London Co.)... ...	20 500	6 000	—	26 500
South Metropolitan Co.	17 500	—	1 000	16 500
South London Co. ...	7 000	—	3 500	3 500
London Electric Co. ...	44 350	3 500	15 350	22 500
Croydon	5 500	10 000	1 000	14 500
Woolwich (Globe-lane)	12 510	10 000	–	22 510
Gravesend	1 800	7 000	800	8 000
North Metropolitan Co. (Brimsdown) ...	12 750	15 000	4 750	23 000
North Metropolitan Co. (Willesden)	18 500	—	—	18 500

These added up to 557 000 kW already in the group stations, and the plant proposed to be shut down amounted to 84 500 kW. The other stations, in which the plant was 76 000 kW, were almost in process of being shut down or would be shut down fairly early by their present owners. The term group stations was a relic from the first proposed scheme. They were not at present grouped any more than the others.

Stations to be Shut Down.

In the following cases the plant mentioned was not necessarily the plant in existence at the moment. It included existing plant plus plant authorised which would be available for use:—Barking, 1 850 kW; Beckenham, 2 050 kW; Bermondsey, 3 400 kW; Bexley, 950 kW; Dartford, 2 300 kW; Ealing, 2 520 kW; East Ham, 2 925 kW; Erith, 3 000 kW; Finchley, 1 900 kW; Fulham, 6 850 kW; Hampstead, 5 950 kW; Heston and Isleworth, 1 240 kW; Hornsey, 3 550 kW; Ilford, 3 600 kW; Leyton, 3 165 kW; Southwark, 3 040 kW; Bromley, 1 260 kW; Brompton and Kensington (Earl's Court), 3 000 kW; Chelsea, 3 400 kW; Chiswick, 1 195 kW; County of London Company (City-road), 12 700 kW; Egham, 325 kW; Surbiton, 580 kW; Tottenham, 300 kW; Twickenham, 4 440 kW. Total, approximately 76 400 kW. He did not include Egham, but he had had to take the whole load in the area. The stations not taken into account, as going to be shut down, were the Amberley-road station of the Metropolitan Company, St. Pancras, Regent's Park station, Westminster Electric (Davies-street and Eccleston-place); St. James' Company, Carnaby-street, and Kensington & Knightsbridge Company, Cheval-place station. Caterham also, it was understood, was to be shut down. The existing facilities should be sufficient to carry the load until 1925 or 1926, when the maximum demand was estimated to be 480 000 kW. If at that time it was not expedient to build a capital station it would be possible to put additional plant in nine or 10 of the existing stations.

Capital Stations and Finance.

It had been assumed in the second part of the scheme that about one and a half millions would be spent in obtaining sites and preparing for the capital stations. He thought it most likely that by 1925 or 1926 capital stations would not have been proposed, on account of financial conditions. It had been assumed that the second stage of the modified scheme could be met by the additional plant in the existing stations and the one and a half millions was to prepare for the period beyond that. The estimate of £5 000 000 was for additional plant in the group stations. No credit had been taken for new plant in capital stations.

Sir John Snell said he understood that they would carry on with the present stations and the extensions authorised until 1925 or 1926, during a period beyond they would be preparing for further extensions of stations which would bring the total to 76 000 kW and thereafter they would begin to prepare for the new capital stations.

Mr. Rider said the date at which it would become proper to start capital stations must be determined in the future according to the financial conditions. He and his colleagues realised that the capital stations had to come, but the development must take place naturally under the guidance of a Joint Electricity Authority who must be controlled as to the expenditure of their money by the financial conditions. They had endeavoured to show that they could get practically the same result as to cost per unit, but with considerably less capital expenditure, by means of the existing stations. When it could be seen that the saving in coal in capital stations would more than pay the capital charges, then would be the time for capital stations. In regard to transmission pressure between one station and another, they had to be guided partly by the pressure at which the existing interconnecting mains were operated. They thought it should be 6 600 V or 11 000 V. If new mains were put down they would be for 11 000 V.

The Railway Supply.

There were two ways of dealing with the railway load. If they attempted to utilise the existing facilities by interlinking stations they could not supply to the railways to any extent. If the railways were prepared to pay to the Joint Authority the cost of a railway supply from capital stations at present-day prices it would be the duty of the Joint Authority at once to put up stations for that purpose and also utilise them for the general supply. On the other hand, it was probable that the railway companies might elect to put up their own stations. In that case, it was hoped they would be prepared to put in additional plant and give a supply in bulk to the Joint Authority. They could probably do it at a less cost per unit, as they would not have the same capital charges as the Joint Authority would have. They would be subject to no fixed sinking fund and would not have to depreciate at a rate equivalent to a sinking fund.

In reply to Mr. Page, witness said if a private enterprise offered to supply the railway companies it would be a matter for the railway companies to find out whether they could get it as cheaply as from their own stations. In regard to a suggestion that an undertaker who was a constituent member of the Joint Authority might be in a better position to do the railway supply because he could get advantage of the diversity factor of the electricity authorities Mr. Rider said such an undertaker would have no right to put up stations on his own account. It should be done by the Joint Authority. He would not advise that a private body or company should be permitted to build a capital station to supply railways and supply also in bulk to the Joint Authority. If a railway company built it for itself it would probably not be acquired by the Joint Authority. He thought the Joint Authority was likely to get a supply more cheaply from the railway companies than by building stations and incurring the capital charges. In the original scheme it was estimated that the railway demand would increase the total demand to about 800 000 kW.

Four new capital stations were proposed to be built ultimately, and it was proposed to extend the Marylebone Borough Council's station and the London Electric Supply Corporation's Deptford station so that they would form capital stations in the future. These and the Central Electric station at Grove-road, the Hackney and Bow stations and the Bankside station were the stations that would be continued in use when the capital stations were going. He could not give the date when that stage would be arrived at. Reigate, Gray's Thurrock, Ascot, Dorking, Guildford, Sevenoaks, Slough and Datchet and Woking were not taken into account.

Supplies to Outlying Districts.

In reply to Sir John Snell, witness said the question whether advantage could be taken of the railway sub-stations to give supplies in places like Guildford and Reigate would depend partly upon the kind of supply the railway companies took. At a place like Guildford, on the South-Western, they would take it on the general supply at 25 cycles. There would be a difficulty as regards lighting unless rotary converters were put in, as 25 cycles was not suitable for a general lighting supply. He did not see how such places could be supplied from the central system. It would cost too much for mains for the load they would get there. Purely from a financial point of view it would be a better scheme if some of the outside fringe were cut off.

The Proposed Barking Station.

With regard to the proposed Barking station of the County of London Company, it would be a difficult matter to arrange for distribution to the London area from a 600 000-kW station in that position, or from any individual site. In practice one would not put more than 10 000 kW through a single cable, and that would mean that 60 cables, or probably more, would be required, because the capacity of the cables must always be in excess of the capacity of the generating sets, and the cables must be spaced out for heating reasons.

In reply to a question by Sir John Snell as to whether, if such a station were established and could supply current on reasonable terms and the Joint Authority had the right to purchase the station on reasonable terms, such a supply would be less advantageous than the development he had been proposing, witness said he thought it would. It would cost more to give the supply from Barking than it would cost to get it under the scheme he proposed. But he would want to examine the Company's scheme before he could give a proper reply to that. It would interfere with the County Council scheme if it comprised the London area, which would include the City-road and Wandsworth supplies. If they charged up the cost of the mains from Barking to City-road and Wandsworth, the scheme would be more expensive.

In reply to Mr. Sydney Turner (for the Conference of Local Authorities), witness said, so far as his knowledge went, he believed that the statement that the railways could supply their own demand cheaper than it could be supplied by the Joint Authority was correct. Under the County Council's scheme an authority using inefficient machinery could be compelled to close down at once, but under the Conference scheme an appeal to the Commissioners would be necessary, and the inefficient plant would be used while inquiries were being made.

Present Prices and Capital Stations.

Replying to Mr. Donald (for Poplar Council) witness said he could not agree with a suggestion that each of the capital stations would be more or less serving its own sub-area. They would be linked together and used for the general area. It was not estimated that there would be any benefit from the capital stations at present prices. He hoped they would be able to erect the capital stations at less cost. The cost per kilowatt of plant in the new capital stations was estimated at £25 per kilowatt. There was about £5 per kilowatt more for buildings and other things compared with the cost of installing plant in the existing stations. In the scheme for the first two capital stations the estimate was £40 per kilowatt, because that included the whole of the preliminary cost—land, railway connections, river works, &c. At pre-war prices the cost would be down to about half of the £25. Taking the railways into account, the cost per unit was reduced by 0·01d. per unit in the first stage and by 0·11d. in the second stage. The capital charges under the original scheme were two and a half or three times as much as under the modified scheme. The latter brought the cost down to 0·1055d. against 0·1063d. The reduction in working cost brought down the cost per unit in spite of the additional capital charges, taking into account the estimated increased load. He was not able to consider the London scheme by taking districts out of London and considering them by themselves. He would be surprised if the Commissioners decided that London should be divided up as Poplar proposed to divide it—to take the cream of the load of the Poplar district and leave the remainder to get on as best it could. Local Government areas had nothing to do with the proper arrangement of districts of supply, from an engineering point of view. There was no point in dividing the area up into sections each of which could be served by one station. He took several areas and the load factor came to 26·56. The average cost of local generation was 1·58d. per unit for 1919-20, and the average estimated price under the County Council's scheme was 1·29d. That was the average of prices varying from 0·9d. to 3d., and he thought it was obvious that they could sell to the individual consumer at a cheaper price than he now paid. Even if a district were supplied at an average of 1·55d. and another at 1·186d. there might be an advantage to the 1·186d. district, as it might get a diversity of load. If it only made a difference of a decimal of a penny in cost he would oppose the dividing up of London on that account. Amongst other purposes for which the Joint Authority would require £40 000 or £50 000 a year during the early stages would be the cost of an engineering staff. He did not think it could be done by an advisory body representing the undertakers. The Authority would control an annual expenditure of over 5 millions, and if the individual stations were under the control of the Joint Authority it would keep their accounts.

Hertfordshire and Surrey.

In reply to Sir Herbert Nield (representing Hertfordshire and Surrey County Councils), Witness said £50 000 a year was not excessive for a 5 million turnover. No provision was made for the pay of a chairman and vice-chairman. The expense of experiments might be charged to the revenue for the particular year, or be spread over several years. He saw no objection to authority for experiments being under the control of the Commissioners. He had visited parts of the area, but had not been into Hertfordshire for a long time. The proposals as to scrapping plant were based on information obtained from the various undertakers as to type and size of plant and the number of units. It was not proposed to interfere with the working of the Brimsdown station, nor to carry mains into Hertfordshire to supply Hertfordshire. It had been one of the curses of electrical distribution in the past that they had been limited to Local Government areas. In regard to a suggestion that Hertfordshire should be left out of the scheme, he would not like to commit himself by saying particular parts should go out. He had to agree with his colleagues in regard to the area. If Hertfordshire were in the scheme, and there was a loss on other parts of the area, Hertfordshire consumers would share in the loss, but if the engineering were good there would probably be a profit, in which Hertfordshire would share. Hertfordshire would get the advantage of the grouping together of several big stations. Brimsdown would be left alone for the present so far as joining up was concerned, and its inclusion in the scheme would not put the cost up.

He was not surprised to hear that certain rural areas in Surrey were severed by the proposed boundary. It would do no harm to the area if outlying districts were taken away on the north, west and south.

In reply to questions on behalf of the North Metropolitan Electric Power Supply Company, Witness agreed that the company had been given wide powers by Parliament, and he had no reason to doubt that it had exercised almost all its powers. He was not aware that since the company began to give supply in 1903 only one generating station had been erected in the area by any other company or body. It was not essential that the whole of the area dealt with under the L.C.C. scheme should be included. With regard to including the Stoke Newington portion and excluding the remainder of the company's area, he did not admit that the northern boundary of the County of London was the proper boundary of the scheme. If Stoke Newington were eliminated there would be demands for the elimination of a multiplicity of little bits. If the whole of the company's area were taken out, the scheme would lose the advantage of a district which, having tramways amongst its consumers, would have given diversity of the load.

AREAS EXCLUDED FROM MAIN SUPPLY.

In reply to questions by Mr. S. MORSE (for the County of London, City of London, Charing Cross, Edmundson's, Twickenham and Teddington Urban Electric Supply and Bromley Companies), WITNESS said at the moment it was not proposed to carry the mains as far as Twickenham, nor to supply Reigate, Dorking, Guildford, Sevenoaks, Slough, Datchet or Woking. With regard to Twickenham, Bromley, Surbiton, Caterham and Weybridge, about which Mr. Morse particularly inquired, those would go on working with the advice which the Joint Authority could give them for the betterment of the general area. The stations were so small that the amount they would have to pay to the Joint Authority in case of any loss would be very little. The smallness of the saving of 0·008d. per unit anticipated in the first stage of the scheme, with the existing stations linked up, was due to the heavy capital expenditure in the early stages. If the West Kent Company had an increased demand of 50 000 or 60 000 kW in the near future, he thought the Joint Authority's engineers could supply it. In the estimates, the cost of the sites of the four capital stations was put at £100 000 each. The size of the sites varied from 10 to 25 acres. They had no options on them. It was intended to extend the plant at Deptford station up to 120 000 kW, at any rate. It was now about 44 000 kW. It was proposed to extend Marylebone up to 34 600 kW.

In reply to a question by Mr. Wrottesley, Mr. RIDER said he could not specify any particular parts of Middlesex which could be excluded. Certainly part, at any rate, of Middlesex should be included. Middlesex and East London were probably the portions of the area in which industrial development would progress most rapidly.

THE CAPITAL STATIONS AND THE DEMAND.

Furthe[illegible]errogated by Mr. Morse, WITNESS said no arrangement had been made as to who would build the capital station on the Thames Ironworks site. If the Great Eastern Railway Company had not built it by the time it was required, the Joint Authority would build it. The proposed locations of the four new stations were at Chiswick, the Thames Ironworks site (Blackwall), at Greenwich, and at Beckton. There was only a difference of about a mile between the distances of Barking and Beckton from London, but Beckton was only intended to have 20 000 kW of plant, whereas the County of London Company's proposal for Barking was 600 000 kW. At the inquiry in October last he had said there was no doubt additional generating plant would have to put in hand at an early date, and that he did not think there had ever been enough plant in London. The necessity for more plant had increased during the war, and, in some places, since the war.

ESTIMATE OF SALES.

The estimate of sales of units in 1925-26 was 960 million to individual consumers, or 1 057 million in bulk. That meant an increase of nearly 8 per cent. annually. In 1919-20 the sales were 496 million, compared with 437 million in the previous year. On that basis, there would be an increase of 130 per cent. in 6 years——a greater increase than the Engineering Committee had assumed. They had taken it as 26 000 kW per annum. He would not expect the County of London Company's load factor to increase by 30 per cent. in six years. He would put it lower. The new plant at Bankside would be reserved for the supply to the County of London Company if the Company required it. He did not know whether the County of London Company would be given the preference if there were two demands for the whole of the output of the Bankside station, but he took it the Joint Authority would have sense enough to meet all the loads that they might have.

Sir JOHN SNELL said there was to be 20 700 kW of plant at the City-road station, 26 500 kW at Wandsworth, and 10 000 kW at Bankside for a limited purpose (supply to the County of London Company). Would that be sufficient plant to meet the load of 40 000 kW which the County of London Company expected to have in 1924-5?

FIGURES OF PROSPECTIVE DEMAND.

Mr. RIDER thought it would, by being linked up with other stations in the area. They had earmarked nothing for the Company. If the growth were greater than was anticipated, all it did was to bring on the second stage earlier. Additional plant would be put in 9 or 10 of the best stations, which would take them up to a much later period. As he had stated, they could get up to 756 000 kW in the best stations, and 76 000 kW in the others, a total of 832 000 kW. He did not think the growth of demand would apply more to the County of London Company's area than any other part of the whole district. The estimate of the Engineering Committee of the demand in the Company's area in 1925-6 was 38 650 kW. That did not include the Romford area. The estimate was based on the Company's load over a series of years. The Company could have 10 000 kW from the Joint Authority in Romford, probably in a couple of years. The mains for such a supply would run from Stepney to Romford, through Poplar, West and East Ham. They would probably cost £100 000, but would be made suitable for giving other supplies as well as that to the County of London Company. The portion from Barking to Romford might add £10 000 to the cost. The railway supply was not essential to the scheme, but it would be better with it. A good deal of the capital expenditure on the existing stations had already been wiped off by means of the sinking funds in the case of local authorities. In some cases the Companies had depreciated, and in some they might not have done so, but the value of the majority of the plant would be gone in five or six years' time. The average of 33s. 9d. for cost of coal was taken from information received towards the end of last year. He and his colleagues thought 11 000 V was high enough for secondary mains.

THE METROPOLITAN ELECTRIC SUPPLY CO.

In reply to an inquiry, Mr. RIDER said, under the scheme, the Croydon station would be operated in the first two stages under the direction of the Joint Authority. It might be left in the hands of the local authority by agreement. If the scheme were carried out in its entirety, the understanding was that the financial responsibility for Croydon would be taken over by the Joint Authority. It would be able to supply Croydon at prices not greater than Croydon was now paying. The supply would still be generated at Croydon until the mains extended there from the central supply. Barnes and Kingston also were outlying districts, and would not, at any rate in the early stages, be connected up with the main scheme.

In regard to the Metropolitan Electric Supply Company, Mr. Rider said the Company had the rights of a power company for parts of its area, but not in the County of London. It had carried out, to a large extent, the powers conferred upon it by Parliament. Their Willesden station was a comparatively large one. He accepted the statement that the putting in of 20 000 kW of additional plant was in progress and that the cost of the extension would be £400 000. He thought the Company would be in a position to meet all demands in its power supply area for several years to come. It was essential that a large portion of this area should be included in the proposed Joint Authority's district for the proper development of the area as a whole. The Willesden station would be continued in conjunction with the supply from Chiswick until the Willesden station could no longer be economically used. It would be used until long beyond the date of starting the capital stations.

CHARGES FOR CURRENT.

With regard to Guildford, it was not proposed to connect the district up under the scheme until money was cheaper, but Guildford would be retained under the scheme. If the Guildford generating station was inefficient it would be for the Joint Authority to consider whether it would pay to put in new plant. It would not cost much money in such a small station. In fixing charges for current the Joint Authority would have to take into consideration load factor, distance of transmission, and the quantity taken, but they would not ask anybody to take energy from the Joint Authority and pay more for it than the price at which he could generate it himself.

In regard to Gravesend, he thought if the Corporation could show they would do better by being placed in, say, the Chatham-Maidstone area it would be reasonable for them to ask to be excluded from the scheme.

He knew Watford Urban Council had given a certain supply. The Joint Authority's action in regard to Watford would depend upon finance and all sorts of things.

POWER COMPANIES' AREAS.

Re-examined by Mr. Henderson, he said in the power companies' areas the Joint Authority could not supply anybody other than a bulk receiver, an authorised distributor, or a power company. The only case in which they could compete with a power company was in the event of the company failing in its statutory duties to give a supply.

The County of London Company were giving supplies to the South Metropolitan Tramways and the South London Company, and had been in negotiation for a supply to Croydon. That was a strain on their plant for their own area. There was nothing to prevent further additions to the plant at the Bankside station. There was already a link between Deptford and Bermondsey, and Bermondsey could be linked with Bankside. Besides the main that had been mentioned as practicable to Barking and Romford, a supply in parallel to Romford could be given by linking up Hackney and Poplar. If a station had to be erected at Barking the Joint Authority could get the necessary money at a cheaper rate than the Company, but the Authority would not, on his advice nor that of his colleagues, put a station at Barking of the size which had been indicated by the company for the supply of that area. An advantage of the Beckton site was that of being able to put into operation an existing coal distillation plant and utilising the by-products. Where an undertaking was left to operate with its own staff the undertaker might keep his own accounts and submit them to the Authority.

ALL UNDERTAKINGS UNDER ONE DIRE[illegible]

Replying to questions by the Commissioners, Mr. [illegible]DER said the general idea was that all the undertakings should [illegible]e under the direction of the central authority. It was essential t[illegible] a very large majority should come in. The figure estimated for the new plant was £4 421 219, and the new capital required was £1 050 000. Out of the £4 421 219, the total for local authorities was £2 183 019, and the balance would relate to the companies. The expression "less amount for which capital has already been provided" meant "less amount for which capital would be provided by the existing undertakers for the plant which was now going into the stations." The L.C.C. scheme anticipated that all the liabilities not yet incurred would be the liabilities of the Joint Authority, which would take over the operation of the stations and sell the current to the distributors. The Authority would probably take over the capital debt also. In connection with the cost of coal, they had taken the stations and grouped them as stations that required x lb. of coal, others that required x+1, others x+2 and so on, and then obtained the average consumption for the whole of the plant which it was proposed to put in. It came to 2·87 lb. per unit sent out by the whole of the stations that would be left in operation. The figure of 2·75 lb. was obtained by assuming a certain number of stations to be working on railway load. Having regard to the altered nature of the scheme he would turn his attention to a revised estimate of the administration expenses.

THE FINANCES OF THE AUTHORITY.

Sir **Harry Haward** said the capital expenditure during five years was £1 050 000 and the administrative expenses were put at not less than £40 000 per annum. He wanted to see what deficit, if any, would have to be met, and what revenue the Joint Authority would have.

Mr. **Rider** said on the income side it would sell 1 057 million units to the authorised undertakers at an average price which would bring in the revenue required to pay those expenses, If the Joint Authority did not take over the whole cost of the generation it could not sell the whole output to the undertakers. For the sake of simplicity, it had been assumed that all the expenses would devolve on the Joint Authority, and the Joint Authority would take all the money for the energy supplied. The cost per unit would go up, owing to the enhanced cost of the new plant, so far as capital expenditure was concerned, but the plant which was going in would be of a more efficient coal-consuming type than that in the old stations. There was an obvious advantage in having the whole supply under one organisation, particularly in regard to safety of supply, but for the London area there must be a number of stations interlinked.

Mr. **Booth** said some question had been raised as to whether Clause 14 of the scheme, in which it was laid down that the whole of the generating stations and main transmission lines of the undertakers mentioned in the schedule should be used by the owning undertakers as the Joint Authority might direct, was *ultra vires*.

Mr. **Rider** said if the scheme was to succeed the co-operation of all the electrical undertakers within the area was essential. If the clause were *ultra vires*, then they must get agreement if possible, and if not they must do without it. In the capital stations it was not proposed to go beyond 200 000 kW, because it would mean putting in larger units than those which had been found most efficient.

THE RAILWAY LOAD.

The railway companies were not prepared to buy energy at a price the Authority would have to charge after making proper provision for interest and sinking fund. They could generate it more cheaply in their own stations. If supplies were taken from the railway companies they would be sure of the railway power stations working at a high load factor. The Great Eastern site was owned by the Company, and it was practically at the point at which they would want the energy at Stratford, and they could, therefore, provide the energy cheaper than the Joint Authority could. Probably most of the railway companies would establish their own stations, but two or more might combine. The Engineering Committee had estimated the load for the L.B. & S.C., the G.E., the S.E. & Midland railways at 200 000 kW. The G.N., S.W. and N.W. had their own stations. He did not see why the Joint Authority should have anything to do with distribution. The h.t linking-up mains would not be used for distribution. The inter-connecting system would cost £2 050 000. That expenditure would be necessary because it assumed that many more stations would be shut down than under the existing organisation. In the first stage £700 000 for mains would be adequate to give the desired effect, plus the existing mains. They would have preferred to establish capital stations right away if it had not been for the high cost of buildings and plant, but they would have to wait for a considerable growth of the load before it would be advisable to establish the capital stations. A million and a half had been allowed in readiness for capital stations. That was included in the charges for which there was no corresponding advantage in output. The 33 000 V cables would carry 10 000 kW at 220 A per phase, and 8 per cent. load factor. That would allow for rise of temperature to 60°F., which was as high as was safe underground. The County of London Company's increase in load showed a uniform rise up to 1918 and a big jump in 1919 in consequence of supplies to other companies. The estimate of £40 per kilowatt for the first stage of the capital stations was so much higher than the capital expenditure in subsequent stages, because of cost of land, foundations and river work and various expenditure in preparation for supply beyond the immediate needs, He thought the railway companies could supply themselves at a cheaper rate than the Joint Authority, to the extent of the capital charges. Small stations, such as Dorking, might benefit by inclusion, as it would enable them to get a greater area of supply, and it would ultimately enable them to get their supply at a cheaper rate than that at which they could generate it.

Questioned by Sir **John Snell**, witness said the £100 000 for the site for each capital station was to cover the purchase of the land and getting rid of trade liabilities, but not such work as levelling, &c. He thought the principle of pooling sources of supply was sound. The railway and other loads would improve the diversity factor. They would have to work out to what extent the railway loads coincided with the peak of the ordinary loads. He agreed that the combination of the supply to railways in the industrial area supplies had been found to lead to a large development of the supply.

RAILWAY ELECTRIFICATION.

This scheme would help in paving the way to electrification of railways—suburban railways in particular. In regard to the question whether it was right, in that case, that the railways should be allowed to put up separate stations, they were bound by the 1919 Act. In some cases probably it was not impossible for the Joint Authority to give as cheap and as abundant a supply as the railways could generate in their own stations. In the case of the Great Eastern, no doubt the company could supply current from a station at the Thames Ironworks site to Stratford cheaper than the Joint Authority could. It might, he thought, be possible that the Railway Company might let the Authority have that site to erect a station for the suppply of current to the railway and also for general purposes if they could show the Company an advantage.

Sir **John Snell** suggested that if the Authority had that particular site and other things were equal the price ought to be satisfactory. The local authorities could raise their money at 6½ per cent., and it was expected in the next five or six years it would be reduced to 6 per cent., and assuming the railways could not raise capital at less than 7½ per cent. it would wipe out the advantage of their having only to provide for depreciation as against the sinking fund. Anyhow, that would represent £70 000 a year at the least to £105 000 at the most.

Mr. **Rider** said the railway companies would have to depreciate at some time or another, but they might carry it on over a longer period than that allowed to electricity supply authorities for repaying capital. The companies would not have to make depreciation for land—it was more likely to appreciate. A Joint Authority or local authority would have to raise its charges to meet a deficit in any particular year, but the Company could carry the loss forward.

Sir **John Snell** said if the station were at the Thames Ironworks site, and undertook the general supply, in addition to the railway supply, he did not see why it was impossible for some other authority to erect the station on a load factor basis and supply as cheaply as the railway company could do it.

RESERVE PLANT.

Another point to which he wished to refer was that no allowance seemed to have been made for the fact that if plant were concentrated in one location the reserve plant was reduced as compared with the creation of a number of generating stations.

Mr. **Rider** did not think so. They had assumed that 110 000 kW would be sufficient for a load of 800 000 kW. One had to be careful how far the concentration of plant was carried. In London the stations must be spread well over the area, because of the extra cost of transmission that would otherwise be incurred. The saving on the trunk mains would more than pay for the benefit that would be got by reducing reserve plant.

Sir **John Snell** remarked that in the present 77 stations there must be more plant and therefore more capital invested in plant than would be necessary if those stations were wiped out and a few larger stations erected. If there were 10 or 12 stations instead of 77 and three morle railways prepared to erect separate stations, would not that policy resut in more plant being installed than would be the case if the railways were supplied from the 10 or 12 stations ?

Mr. **Rider** replied that that would depend upon the extent to which linking up was done between the railway stations and the others. On the other hand you might pay more for linking up cables than for the spare plant. Each case must be considered on its merits. When the demand approached 660 000 kW the erection of the capital stations would have to be begun, and then the old stations would be shut down to the extent to which the capacity of the capital stations exceeded the demand. The position might be consolidated in 10 or 15 years. It would depend upon how the load grew.

Sir **John Snell** said there was much information missing. Would Mr. Rider provide figures showing the output of capital, grouped and other stations, with maximum loads, load factors and so on and an analysis of capital expenditure subdivided amongst them ?

Mr. **Kennedy** handed to the Chairman figures got out on behalf of of the London Electricity Joint Committee giving the outputs of the stations which the Commissioners required, and Mr. **Rider** undertook to get out similar figures on behalf of the L.C.C. with the additional information that had been asked for.

COAL CONSUMPTION.

With regard to coal consumption, Mr. **Rider** continued, they had assumed, in the first stages, for grouped stations, 2·87 lb. per unit sent out, other stations 4·02 lb. and capital stations 1·9 lb. In the second stage they expected to get down to 1·8 lb. He did not accept Mr. Morse's figures of 60 000-kW as the anticipated growth of load in the West Kent Company's area. Allowance had been made for a load of 18 400 kW. Their load in 1919-20 was 8 500-kW. In the event of an increased load in any locality the Joint Authority would accommodate itself to circumstances. If necessary, even in the first stage, a capital station would have to be proceeded with.

Mr. **C. D. Johnson**, Comptroller to the London County Council, gave particulars of the financial features of the scheme and the evidence of Mr. **F. Hunt**, valuer, with regard to rating questions, concluded the case for the London County Council's scheme.

Mr. **Sydney Turner** then opened the case for the scheme of the Conference of Local Authorities owning Electricity Undertakings, and Mr. **Duncan Watson**, chairman of the conference, and Mr. **C. H. Wordingham** gave evidence in support of it.

The inquiry was adjourned.

Correspondence.

THE CANDID FRIEND.

TO THE EDITOR OF THE ELECTRICIAN

SIR: In your issue of June 3 you print an abstract of my Paper on "The English Electrical Industry" read before the Vienna Electrotechnical Institution. I gratefully acknowledge that in your Editorial "The Candid Friend" you give me credit for my endeavour to put the matter before Continental readers in a fair and impartial way, but I would like to point out that some of the conclusions drawn in your Leading Article are not my own.

Although I mentioned that the war has reversed the respective positions of buyer and seller, it was far from my mind to suggest that war was necessary to improve the position of the British electrical industry. I know that the cut-throat competition had been mitigated a great deal before the war started, and that several electrical firms just then began to prosper. I also mentioned in my Paper that the foundation of the B.E.A.M.A., which took place a few years before the war, has had such beneficial results that "even the payment of a dividend in 1914 was no longer an unheard-of event."

As to the consulting engineer, although I have pointed out at great length the harmful effect of too severe and too detailed specifications I did not entirely close my eyes to the fact that some consulting engineers have really put forward just requirements in their specifications, and, in fact, have advanced the art. Allow me to quote the following sentence from my Paper:—

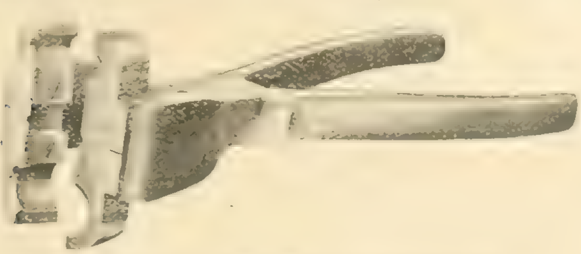
> "Everybody will understand that a consultant with a great experience is entitled to ask for improvements; and there is many a British consulting engineer who has a great deal advanced electrical engineering not only of his own country, but also of other countries, by his requirements, which may have seemed ruthless and unpleasant to the manufacturer, which, however, were justified in fact."

I am, &c.,

Steiermark, Austria, June 14. E. ROSENBERG.

The "Glo-clad" Electric Wiring System.

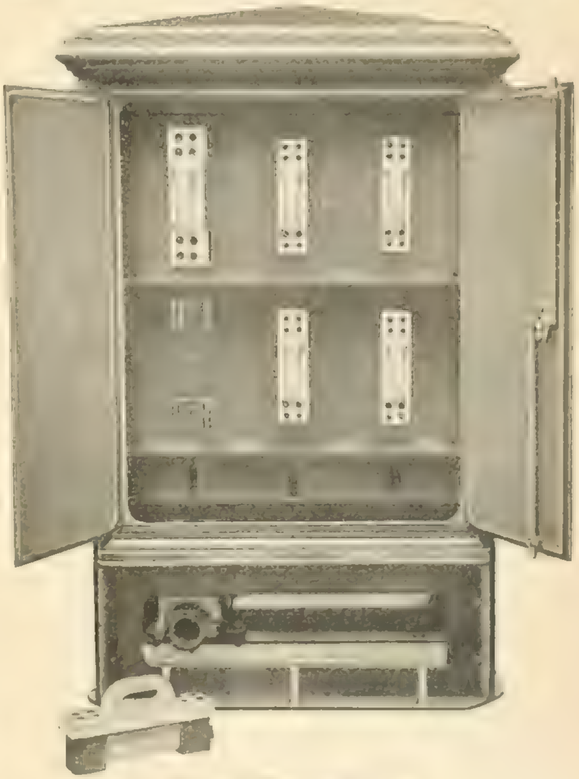
A further addition has been made to the already numerous systems of electric wiring. It is known as the "Glo-clad" and its design and manufacture are both in the hands of Messrs. W. T. GLOVER & COMPANY, while it contains a number of features which should render it of interest to electrical engineers. It is claimed for it, and it is a large claim, that while it is water-tight, gas-tight, acid-proof and electrically continuous it contains all the advantages and none of the disadvantages of an installation made up of screwed metal pipes with more or less water-tight fittings. That well-known system, although generally conceded to be an engineering job, is expensive to install and has certain weak points, especially at joints and terminals. In the "Glo-clad" system, on the other hand, no metal pipes are required, the whole of the mechanical protection of the rubber-insulated cable being provided by a continuous water-tight lead-alloy sheath in a way not dissimilar to other well-known systems on the market. Its special feature, however, is that the cable instead of being soldered to the fittings is bonded and sealed by means of an internally screwed brass gland fixed in a water-tight iron box. This intimate bonding is obtained first by screwing the gland into the box, next by screwing the gland back along the cable sheath, and finally by means of a gasketted lock-nut which completes the water seal. An interesting fact is that the covering of the cable is itself screwed by means of a special die holder. "Glo-clad" cable is stocked in two sizes, 3/0·036 in. single and 3/0·6 in. twin, the latter being, of course, intended for use of alternating-current circuits. The catalogue recently issued by Messrs. Glover descriptive of this system contains a number of interesting details regarding the installation and should certainly be studied by those who are considering the question of undertaking this class of work. The easy installation of the system is made easier by the use of a special tool for cutting the metal sheath and stripping the wire. This we illustrate herewith.



THE "GLO-CLAD" STRIPPING AND CUTTING TOOL

An Ediswan Feeder Pillar.

The accompanying illustration shows a view of a 1 000-A feeder pillar, which has recently been manufactured by the Edison Swan Electric Company, Ltd., at their Ponders End Works for a large power consumer. The supply is on the three-wire system, the power being taken from the outers, and a circuit for a small amount of lighting between the outers and the neutral busbars, and links are seen below the fuses. The fuses on the left are rated at 1 000-A, and the other two pairs at 500 A each. The illustration shows the front of the pillar, but there are doors at the back opening in a similar manner. The company are also supplying the 0·5, 0·5, 0·1 sq. in. lead-covered and armoured cable and the junction boxes which will connect the pillar to the consumer's switchboard.



EDISWAN FEEDER PILLAR.

American Engineers' Visit.

The deputation of American engineers at present visiting this country for the purpose of expressing their appreciation of the work done by British engineers in the war will be present at the Institution Conversazione to be held next Thursday at the Natural History Museum, South Kensington.

The deputation consists of: Mr. Ambrose Swasey, Chairman of Deputation; Mr. Charles T. Main, chairman, American Society of Civil Engineers; Mr. Robert A. Cummings, vice-president of the American Society of Civil Engineers; Mr. John R. Freeman, past vice-president of the American Society of Civil Engineers; Mr. D. C. Henny, director of the American Society of Civil Engineers; Mr. Ira N. Hollis, past-president, American Society of Mchanical Engineers; Mr. Jesse M. Smith, past president, American Society of Mechanical Engineers; Col. A. S Dwight, vice-president, American Institute of Mining and Metallurgical Engineers; Mr. C. F. Rand, past president, American Institute of Mining and Metallurgical Engineers; Dr. G. Otis Smith, American Institute of Mining and Metallurgical Engineers; Mr. W. Kelly, American Institute of Mining and Metallurgical Engineers; Dr. F. B. Jewett, vice-president, American Institute of Electrical Engineers; Dr. A. E. Kennelly, past president, American Institute of Electrical Engineers; Major-General G. O. Squier, American Institute of Electrical Engineers; and six ladies.

About 10 p.m. Mr. Ambrose Swasey will speak in the Central Hall of the Museum, and he will be followed by Dr. F. B. Jewett, who will convey a message from the American Institute of Electrical Engineers to the Institution of Electrical Engineers.

Electricity Supply.

Aylesbury Corporation has applied for authority to borrow £4 500 for house services.

The restrictions upon the use of electric power in Liverpool have been withdrawn, and a full service of tramcars is now being run.

In order to be able to meet the additional demands for electricity supplies, Neath Rural Council has decided to borrow £6,000 for extensions of mains, &c.

The Southwold electricity works have recently passed into the hands of Edmundson's Electricity Corpn. The station was owned by the Coast Development Company, which has gone into liquidation.

Increased charges for electric current at Accrington are expected to bring in an additional £15 000 a year. Last year's deficit on the electricity undertaking was £13 000.

The accounts of the Plymouth electricity supply undertaking for the past year show revenue £124 629, gross profit £28 042, and net profit £4 666, compared with £274 for the previous year.

Stafford Corporation has authorised an expenditure of £45 000 on extension of the electric supply mains. Arrangements have been made to supply the English Electric Company's works with electricity.

Sums of £3 000 for house services and £2 500 for mains are to be borrowed by Great Yarmouth Corporation. On the past year's working there was a net profit of over £2 000 on the electric supply department.

Owing to the poor quality of the coal the cost of fuel per unit generated at Oldham electricity works is now 1·77d., against 0·70d. a year ago. There were a couple of breakdowns at the Burnley electricity station last week owing to the inferior character of the fuel.

The Blackpool electricity works accounts show a net profit of £8 180 for the past year, against £4 000 estimated. The income amounted to £112 206, or £20 500 more than estimated, and the expenditure to £83 321. Of the gross profit of £28 885 interest and sinking fund absorbed £20 705.

The Pelton Fell ward of the Chester-le-Street urban district is to be lighted electrically, and the Electricity Commissioners have authoised the use of overhead wires and poles. The tender of Messrs. Gray Bros., at £6 286, for carrying out the work has been accepted.

During the year ended March 31 there was a net profit of £34 897 on the St. Pancras (London) Borough Council's electricity department and £20 000 has been allocated to the relief of rates. A sum of £6 918 has been applied in reduction of the loan for new boilers at King's-road station, leaving a balance of £7 979, which will probably be placed to reserve.

Dover Electricity Committee has decided to offer the following reduced salaries to members of the electricity works staff: Chief assistant (1914 salary, £200; 1920 salary, £538 and cost of living award), £400; mains engineer (£200 and £427), £300; senior shift engineer (£100 and £293), £236; second and third shift engineer (£94 and £287, and £78 and £287 respectively), £231, with the cost of living award. These officials are to be given notice to terminate their engagements, with the option of re-appointment at the reduced salaries.

The Electricity Committee, after considering a report by the engineer, has decided not to burn oil fuel, as the conversion of the boilers would mean an extra cost of £5 000 a year.

The Halifax Electricity Committee have not taken steps to adapt their boilers for oil fuel, as the cost would be £2 000 to £2 500, and the makers would not submit a proposal whereby the existing mechanical stokers could be retained and oil used in connection therewith. When ordering four new boilers some time ago, the Committee, anticipating a situation when coal might be difficult to secure, arranged with the makers to construct the water-tube boilers so that they would have, in addition to stokers for coal, an oil feeding installation. There is also a probability that two of the existing boilers will be converted permanently with oil burning apparatus.

In reply to a question as to the use of oil fuel at the last meeting of Derby Corporation, Ald. Wilkins, chairman of the Electricity Committee, said there were few large towns which had managed to keep up the supply of electricity as Derby had done. Large inland towns had not at present adopted oil fuel. The cost of oil in Derby would be £6 per ton, and 2 tons of coal or slack were equal to 1 ton of oil. At present they had been able to maintain the supply, and they hoped to be able to continue to do so. Were they to adopt oil firing they would need 100 barrels of oil per day, and there would have to be a considerable sum spent on alterations to furnaces. The Committee was making inquiries, and long before the supply by means of coal was exhausted it would be in a position to supply by means of oil fuel.

Formal sanction to the borrowing of £18 000 has been received by Kingston-on-Thames Corporation on account of its application for a loan of £19 750 for the expenditure on the extensions of plant installed by arrangement with the Ministry of Munitions in excess of the engineer's estimate of £45 000. The Electricity Commissioners stated that the deduction of £1 750 represented repayments which would have been made if loans had been raised in the years in which the expenditure was actually incurred, and that such sum should, therefore, be charged direct to revenue. The Town Clerk was authorised to communicate with the Commissioners, pointing out the provisions of the agreement between the Corporation and Ministry of Munitions, by which the Corporation were entitled to receive sanction for the total amount, and to request that sanction be given for the balance of £1 750 accordingly.

Hackney (London) Electricity Committee has reported to the Borough Council that, being in agreement with the opposition of the Conference of Local Authorities owning electricity undertakings in Greater London to the County of London Electric Supply Company's Bill, the Council has requested the three members of Parliament representing the borough to oppose the Second Reading of the Bill until the schemes of the London County Council, the Conference of Local Authorities owning electricity undertakings in Greater London, and the London Electricity Joint Committee has been inquired into by the Electricity Commissioners.

The Electricity Committee has given directions for boilers at the generating station to be converted for the burning of oil fuel at an estimated cost of £2 500, and has authorised the acceptance of a quotation or the supply of the equipment.

The accounts of the Marylebone (London) Electricity Department for the year ended March 31 show revenue £330 909, compared with £280 016 in previous year, gross profit £139 401 (against £133 066) and net profit £28 061 (£23 112). Working costs were 2·156d. (1·798d.) per unit sold, and capital and special charges 1·251d. (1·334d.). Units generated were 28 111 570 (26 631 963) and sold 21 322 480 (19 770 781). Maximum load was 14 947 kW (12 709 kW), and load factor 16·3 (17·8) per cent. The report of the Electricity Committee states that sanctions have been obtained during the year for borrowings amounting to £200 450 for the 1920 plant extension scheme and £6 400 for the e.h.t. services for Messrs. Selfridge, and an expenditure of £60 370, reduced to £47 908 by the scrapping of accumulators, &c., has been incurred on capital account. Capital outstanding is £1 581 253. A debit balance of £1 148 is shown on the working of the sales department, but the turnover has increased. The value of apparatus on hire is £12 388.

The Torquay Electricity Committee has received a report by E. T. Ruthven Murray on the present electricity undertaking in which it is pointed out that the existing station is unsuitable owing to the restricted area and the arrangement of the buildings. There is no possibility of providing even an additional boiler in the boiler house or in the small space outside the building. The only feasible scheme is to increase the output of the existing boilers. Two boilers might be converted to the use of oil fuel, but the original boilers are of considerable age and ought not to be forced.

Mr. Murray strongly recommends the provision of supply from another source with a view to this becoming available in three or four years. Large economies in production costs would result from the installation of modern plant upon a suitable site, and the increase in output and the improved load factor of the supply which would result from the development of the domestic and power loads would ensure the plant operating under greatly improved conditions. He thinks "it would be very false economy and very detrimental to the success of the undertaking to postpone longer taking the steps which are absolutely necessary to safeguard the future."

The Council has authorised the engineer to adapt one of the boilers for oil firing at an estimated cost of £100.

An unopposed inquiry was held last week at Belfast into the application of the Corporation for sanction to borrow £120 000 to be used as working capital for the electric supply undertaking. Evidence was given by the city electrical engineer (Mr. T. W. Bloxam) and the city accountant (Mr. R. G. Geale). It was pointed out that hitherto it had been possible to adjust the different trading accounts so that the borrowing of money for working capital had not been necessary, but a tremendous change had come over municipal undertakings owing to the enhanced price of material, the increase in wages, &c., and the credits depended upon in the past had largely if not entirely disappeared. The loan was to meet the requirements which a business man would need to carry on the transactions of his trading. In connection with the undertaking it had been found necessary to carry heavy stocks of coal, cables, &c. The revenue account showed that, up to March 31, the amount in respect of these stores was £82 000, and it was fortunate that such large supplies were in stock, having regard to the strikes which had occurred and the difficulty of getting coal. In addition there was a considerable amount required for salaries and wages, and it was approximated that all those sums would amount to over £120 000.

Electric Traction.

The Bournemouth Corporation tramways undertaking shows a net deficit of £15 016 on the past year's working.

The Southend tramway accounts for the past year show revenue £119 122 and total expenditure £127 987—a deficit of £8 865.

Cardiff tramways committee has decided to put into operation the decision of the National Joint Industrial Council for the Tramways Industry. According to the chairman of the tramways committee, the corporation is "losing money hand over fist" on the tramways, and a special meeting is to be held to consider the revision of the fares.

Sunderland Corporation is spending £6 768 on doubling portion of the track in Ryhope-road, and £3 950 on making an additional entrance to the Wheat Sheaf car depot. Of the twelve saloon-deck and vestibule tramcars recently purchased by Sunderland Corporation from the English Electrical Company, two of the vehicles have been put into service, and the remainder will be delivered in a short time.

As there was a deficit of £5 549 on the past year's working of the Ayr Corporation tramways it has been decided to place only 4 per cent. instead of 6 per cent. to depreciation account, and the remainder of the deficit is to be made good from the reserve fund. This will exhaust the reserve fund, and unless the finances improve the tramways may become a heavy charge on the rates. The Tramways Committee has, therefore, been asked to submit proposals for making the tramways self-supporting.

Miscellaneous.

The Senate of Glasgow University have approved of the proposal to institute a Faculty of Engineering and the University Court has been requested to take steps to give effect to it in the engineering ordnance or otherwise.

We learn that the radio telegraph conference, which was to have been held in Paris this month, has been postponed indefinitely. Major-General Squier, Chief of the Signals Department of the American Army, who came over to attend the conference, has gone to Paris.

We understand that Prof. J. A. Fleming, F.R.S., has recently completed a book entitled "Fifty Years of Electricity, The Memories of an Electrical Engineer." This will contain descriptions of the chief notable achievements in electrotechnics during the last half century with many of which Prof. Fleming has been intimately connected.

The new trunk telephone cable between Liverpool and Chester has been completed, and will give improved trunk line facilities between the Manchester, Liverpool and North Wales districts. The cable contains 108 wires each weighing 70 lbs. per mile, thus providing 54 new circuits having a speaking efficiency six times as great as a standard cable with wires weighing 20 lbs. per mile.

The Bristol, Cardiff and Swansea staff of the Edison Swan Electric Company held their annual outing on the 8th inst., when the Wye Valley was visited by motor coach. Leaving Bristol at 9.30 a.m., Tintern was reached about three o'clock, and the company, numbering about 70, indulged in various sports until tea time. After tea an impromptu concert agreeably occupied the time until 6.30, when the return journey was commenced, Bristol being reached by about 11.30 p.m.

We have received the first issue of the "Cost Accountant," the official journal of the Institute of Cost and Works Accountants. The issue is prefaced by a foreword by Lord Leverhulme, the President of the Institute, and contains a number of interesting articles, among which we specially notice a report of a lecture by Mr. Robert Stelling on "The Work-in-Progress Account." Accurate accountancy is such a feature of present-day works organisation that the need for an institute of this kind is obvious.

The half-yearly report issued by the Air Ministry on the progress of Civil Aviation for the period from Oct. 1, 1920, to March 31, 1921, states that the value of direction finding in wireless communication has been proved on many occasions, examples of which are given. The distribution of meteorological information throughout the country has been developed and an extension of the wireless telegraph facilities has been found necessary in order to make this possible.

A new organisation, entitled the Federation of British Propaganda Societies, has been formed, in order to co-ordinate the work of propaganda societies, and, as far as possible, to prevent overlapping. Already about fifteen propaganda societies have expressed their willingness to join. The Duke of Northumberland has consented to act as president, and Sir Henry Birchenough, K.C.M.G., is the treasurer. The general secretary is Mr. David Gilmour, O.B.E., Sicilian House, Southampton-row, London, W.C. 1.

Catalogues, Price Lists, &c.

The Hart Accumulator Company, Ltd., of Stratford, E. 15, are circulating their price list of 4 volt 3 plate "A B S" type of Hart ignition batteries. The capacity is 5 ampere-hours, and they are suitable for small electric motors on model and toy work, &c.

In a leaflet (E.2030) issued by the Photector Company, Ltd., of Southall, technical particulars of the revised prices are given of wrought copper cable sockets supplied by them. These sockets, which are made of solid drawn seamless copper tubing of high conductivity, are made in 14 sizes and four types. The back of the leaflet gives the international standards of resistance for copper.

A new price list of "Henley" sticky tape has been issued by Messrs. W. T. Henley's Telegraph Works Company, Ltd., Blomfield-street, E.C. 2, who are now producing this article on mass production principles. Two obvious advantages of mass production of British goods are price reduction to the user and help towards levelling up the exchange rate, because many articles produced abroad on the mass production basis compete in the home market. "Sticky" tape is one of these, and for years supplies for home consumption have been largely imported. Although Henley "Sticky" tape has been made and sold by Messrs. Henley's ever since the need for such a tape arose, its sale has never been pushed to any extent. The company made it for their own use, and a limited number of regular customers have purchased it. Now the firm has put down a plant for producing "Henley" sticky tape in large quantities, and the cost has been considerably reduced. It is claimed that it is now sold at a lower price than imported tapes and the quality remains of the same high standard. A further advantage is that "Henley" tape is packed and sold in approximate nett weight coils.

Bankruptcies, Liquidations, &c.

Wm. Aaron Davis, electrical engineer, 14, Basinghall-street, Leeds, has been adjudicated bankrupt.

The public examination of Thos. Hardman, electrician, Holmfield, Burnley-road, Rawtenstall, will take place on July 15, at the Public Hall, Rochdale.

Mr. A. E. Carr, 26, Collingwood-street, Newcastle-on-Tyne, has been appointed trustee in the bankruptcy of Joseph Francis Lyons, electrical engineer, 25, Palmerston-street, and Front-street, Consett, Co. Durham.

Personal and Appointments.

Dr. W. Wilson has been appointed to the London University chair of Physics tenable at Bedford College.

Mr. E. K. Rideal has been appointed Humphry Owen Jones lecturer in physical chemistry at Cambridge University.

Mr. Herbert Tetlow, manager of the electricity department of Bacup Corporation, was married last week to Miss Edith Holland, of Heywood.

Mr. Robert Robinson, D.Sc., has been appointed to the chair of chemistry and the directorship of the chemical research laboratory in the University of St. Andrews.

Mr. G. H. Purkiss, assistant superintendent of the Southend tramways traffic department, who has resigned after 16 years' service, has been presented by his colleagues with a canteen of cutlery and silver.

Mr. Frank Ayton, chief engineer and manager of the Ipswich Corporation Electric Supply and Tramways Department, has been appointed joint managing director of Messrs. Ransomes, Sims & Jefferies, in place of Mr. Victor Bone, who is taking up a position as works director on the Board of Messrs. Ruston and Hornsby, Ltd.

Mr. G. H. Rowbottom has been appointed sales manager to the Clyde Valley Electrical Power Company in succession to the late Mr. R. Robertson. Mr. Rowbottom was educated at Dundee High School and completed his studies at St. Andrew's University, where he obtained his B.Sc. and was medallist in electrical engineering. He served his apprenticeship with Messrs. Alley & McLellan and for many years has been associated with Messrs. Crompton & Company, Chelmsford, both on their engineering and commercial staffs, latterly being assistant branch manager in their Glasgow office.

Last Friday evening a gold loving cup was presented to Sir James and Lady Dewar by the members of the Royal Society to mark the celebration of their golden wedding. The Duke of Northumberland called attention to the work done by Sir James Dewar during his 44 years as resident professor and director of the laboratories, and mentioned in particular the invention of cordite and his researches on low temperatures. Sir James Dewar, in reply, said that the total cost of the professors, laboratories, apparatus and assistants of the Institution during the nineteenth century was £100 620. Apart from the pension received by Faraday for some years there had been no State aid, and comparatively little assistance from donations and legacies.

Business Items, &c.

Evan Philip Evans and Emily Sherman, trading as S. Sherman & Son, electric light fittings makers, &c., 57, New Compton-street, London, W., have dissolved partnership. Debts by Mr. Evans.

Messrs. Henry J. Fowler and Alfred Edward Jones, electrical engineers, trading as Fowler & Jones, 1a, Menzies-street, Liverpool, have dissolved partnership as from Jan. 7 last. Debts by Mr. Fowler, who continues.

Messrs. Ernest E. Clarke and Henry Schofield, electrical engineers and contractors, trading as Ernest E. Clarke & Co., at 4, Alhambra-buildings, Morecambe, have dissolved partnership. Debts by Mr. Clarke.

Mr. Arthur T. Smith, A.M.I.E.E., Albion House, Hanley, Stoke-on-Trent, has recently been appointed agent for the Midland Counties for Messrs. Bruce Peebles & Co., Ltd. The counties covered by the agency are: Stafford, Derby, Nottingham, Lincoln, Rutland, Leicester, Warwick, Worcester and Salop.

Mr. L. W. Wild, M.I.E.E., physicist to the Automatic and Electric Furnaces, Ltd., sailed on the "Olympic" on the 15th inst., for New York, where by arrangement with leading manufacturers he will give practical demonstrations of Wild-Barfield automatic steel-hardening furnaces. In addition to supplying Germany the Company is now in course of concluding negotiations for the sale of articles under the Wild-Barfield patents on a still larger scale in the United States.

Mr. F. H. Howell has been appointed London representative of the electrical cooking and heating department of the Falkirk Iron Company, Ltd., Craven House, Kingsway, W.C.1. For over 15 years Mr. Howell has been district and showroom manager for the County of London Electric Supply Company, but this included nearly five years with the R.F.A. He has specialised in electric cooking apparatus from a practical as well as selling point of view and he has recently spent several weeks at the Falkirk Iron Works, where the "Falco" appliances are manufactured.

Institution Notes.

A general discussion on "Catalysis with Special Reference to Newer Theories of Chemical Action" will take place on Sept. 28 next, before the Faraday Society. During the afternoon session a discussion will be opened by Prof. J. Perrin on "Radiation Theory," and in the evening Dr. Irving Langmuir will open a discussion on "Heterogeneous Reactions."

The report of the Committee of the North-West Centre of the Institution of Electrical Engineers for the session 1920-21 shows a large increase in membership from 984 to 1 214. The Committee are, we are glad to hear, considering whether informal meetings should be held during next session. The Committee for 1921-22 has been constituted as follows: *Chairman*, Ald. W. Walker; *Vice-Chairmen*, Messrs. A. S. Barnard and G. A. Juhlin; *Hon. Secretary and Treasurer*, Mr. A. G. Ellis; *Committee* (in addition to those now serving) Messrs. A. G. Livesay, C. D. Taite, and Townend.

Tenders Invited and Accepted.

MANCHESTER ELECTRICITY DEPARTMENT require tenders by June 28, for about 27 000 yards of weldless steel upright and socket tubes; also six months' cable requirements. Specifications from Mr. F. E. Hughes, Town Hall.

ISLINGTON (London) BOROUGH COUNCIL require tenders by July 4 for h.t. switchgear for 2 500 V and metal-cored flame carbons for Excello lamps. Specifications from the Engineer, 50, Eden-grove, N.7.

The LONDON COUNTY COUNCIL invite tenders (by July 11) for the supply and laying of h.t. electric cables, &c. Specifications from and tenders to the Clerk of the Council (Mr. James Bird), County Hall, Spring Gardens, S.W.1.

The GOVERNMENT OF MALTA invite tenders for a 1 000 kW single-phase steam alternator (2 200-2 500 V, 100 cycles). Particulars and forms of tender from the Crown Agents for the Colonies, 4, Millbank, S.W.1, and tenders to Malta by July 7.

The Commercial Secretary to H.M. Legation at MONTEVIDEO (Capt. E. C. Buxton) reports that the local authorities advertise for tenders (by Sept. 3) for the supply of 59 250 metallic filament lamps (from 10 to 300 c.p. for 225 V circuits) which are required by the State Power House. Local representation is essential.

It is notified that the date for tenders for the supply of plant and material for the electrification of the CAPE TOWN-SIMONSTOWN & DURBAN-PIETERMARITZBURG RAILWAY lines has been extended to noon, July 5, Tenders to the High Commissioner for the Union of South Africa, Trafalgar-square, London, W.C.

LONDON County Council invite tenders for the supply, delivery and erection of one 8 000 kW steam turbo-alternator and exciter, condensing plant, &c., and seven 1 000 kW rotary converters, static transformers and accessories. Specifications from the Clerk of the Council, County Hall, Spring Gardens, S.W., to whom tenders by 4 p.m., July 11.

The WAIROA (N.Z.) Electric Power Board invite tenders for the supply of material for an 11 000/3 300 V 600 kW outdoor sub-station, including four 200 kVA transformers (11 000/1 900V), insulators, air-break switches, fuses, lightning arresters and choke coils, accessories, &c. Tenders (by July 31) to Messrs. Hay & Vickerman, Wellington, N.Z.

THE VICTORIAN GOVERNMENT RAILWAY COMMISSIONERS invite tenders (by July 27) for the supply and delivery of 24 000 metal filament lamps for electric car lighting (46-W, 116-V) and 4 000 carbon filament lamps (32-W, 140-V), and (by Aug. 3) for a 5-H.P. electric motor, controller, &c. Tenders to the Commissioners, Spencer-street, Melbourne.

The VICTORIAN GOVERNMENT RAILWAYS COMMISSIONERS, MELBOURNE, requires tenders by Aug. 10 for 250 impedance bonds for power signalling (Contract 34 130) and 56 miles of insulated copper wire (Contract 34 131), and by Aug. 17 for renewals for 3 000 sets of caustic soda primary cells (Contract 34 145). Specifications can be seen at the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1.

The ELECTRICITY COMMISSION OF VICTORIA, 673, Bourke-street, Melbourne, require tenders by Aug. 15 for the following plant and material for the Morwell power scheme: steel work for power station, &c. (specification 95) and boilers, stokers, fans, steel chimneys, sooting and dust extraction equipment, ash-handling plant, &c. (specification 99). Specifications, &c., from the Agent-General, Victoria House, Melbourne-place, Strand, London, W.C.

BARBERTON (Transvaal) Municipal Council invite tenders for two boilers (3 000 lb. of steam per hour at 180 lb. pressure), two 75 kW three-phase 2 200 V (50 periods) steam alternators (engines to be high-speed and coupled direct), switchboard and instruments, steel chimney, piping, feed pumps and connecting cables; steel poles, conductors, insulators, lightning arresters, &c.; three 30 kW three-phase and 10 5 kW single-phase transformers, house services and meters for 150 consumers. Specifications from Prof. W. Buchanan, 75, Louis Botha-avenue, Johannesburg, and tenders to the Town Clerk, Municipal Offices, Barberton, by July 20.

TAUNTON Corporation has placed an order with the Anglo-American Oil Company for 600 tons of standard fuel oil for the electricity works, at £5. 5s. per ton.

ALDERSHOT Urban Council has accepted the tender of Callender's Cable & Construction Company, at £5 476, for the supply and laying of armoured cable for the bulk supply of electricity.

The Park Royal Engineering Works, Ltd., have again been selected for the supply of l.t. cubicles (sub-station) for the MANCHESTER Corporation and have been accorded the contract for the ensuing twelve months.

CHRISTCHURCH Council has accepted the tender of the Bournemouth and Poole Electricity Supply Company for lighting the street lamps during the six winter months—viz., 100-W lamps at £4 6s. and 60-W lamps at £3 5s. each.

E.D.A. Circulars and Postage.

The Director of the BRITISH ELECTRICAL DEVELOPMENT ASSOCIATION asks us to state that information and enquiries may, in future, be sent under same cover as circulars. Engineers and managers and others are therefore requested to open and *examine* carefully all sample parcels of publicity matter and other communications from E.D.A.

Patent Record.

SPECIFICATIONS PUBLISHED.

The following abstract from some of the specifications recently published have been specially compiled by MESSRS. MEWBURN, ELLIS & CO., *Chartered Patent Agents, 70 and 72, Chancery-lane, London, W.C.*

COMPLETE SPECIFICATIONS.

161 765 KONIECZNY. Electric lamps. (10/2/20.)
161 798 CRABB. Electric switch devices for preventing unauthorised starting and running of internal combustion engines. (4/3/20.)
161 804 MINCHIN & PRITCHETT & GOLD AND ELECTRICAL POWER STORAGE CO., LTD. Electric storage batteries or accumulators. (9/3/20.)
161 806 BLUNT & MITCHELL. Switches for electric signalling systems and like uses. (13/3/20.)
161 815 MORSE. Apparatus for electric welding and cutting. (22/3/20.)
161 827 MARGERISON & SHENTON & CO., LTD. Electrical resistance apparatus. (6/4/20.
147 817 B. T.-H. CO. Enclosed electric arc devices. (30/10/15.)

The anode is constituted in part or entirely of a highly chemically reactive metal, such, for example, as calcium, magnesium, or titanium, and the gaseous atmosphere surrounding the arc consists of a monatomic gas such as argon, neon, zenon, krypton, or helium. Under these conditions it has been found that a voltage drop in the arc of a hitherto unattainable low value is obtained.

150 701 GES. FUR DRAHTLOSE TELEGRAPHIE. Receiving apparatus for electrical oscillation. (6/9/19.)
151 285 GROB & CO. Cut-outs for electrical circuits. (20/9/19.)
152 024 METROPOLITAN-VICKERS ELECTRICAL CO. Thermal relays for use in electrical circuits. (6/10/19.)
154 872 NAAMLOOZE VENOOTSCHAP PHILIPS GLOEILAMPEN-FABRIEKEN. Incandescent cathode rectifiers for alternating currents. (2/12/19.)
162 118 BRITISH THOMSON-HOUSTON CO., LTD. (General Electric Co.) Systems of regulation for electric circuits. (6/2/20.)
162 119 HENLEY'S TELEGRAPH CO., LTD. & NICHOLS. Electric switch boxes and the like. (7/2/20.)
162 120 QUINT & KEARNEY. Electrically-operated diaphragm horns. (9/2/20.)
162 128 ZWEIGBERGK. Magnetic blow out devices for electric switches and the like. (13/2/20.)
162 145 IGRANIC ELECTRIC CO., LTD. (Culter Hammer Manufacturing Co.) Electric magnetic brake. (1/3/20.)
162 183 FULLERS UNITED ELECTRIC WORKS, LTD., & FULLER. Portable electric lamps. (27/4/20.)
162 199 CAMPBELL. Electrically heated perforator. (19/5/20.)
162 202 CURNOW & HOWES & BURLEY, LTD. Electric projector lamp for motor vehicles. (25/5/20.)
162 220 SODRING & WINTHER. Covers for electric switches and the manufacture thereof. (17/7/20.)

APPLICATIONS FOR PATENTS.

January 10, 1921.

1 136 SUCHOSTAWER. Dynamo or motor.
1 139 FRANCE. Incandescent lamps, &c.
1 141 FRANCE. Shades and reflectors for incandescent lamps, &c.
1 145 PRITCHARD. Electric heaters.
1 152 LOWENSTEIN. Spark-gaps for electro-magnetic wave signalling systems. (25/8/14, U.S.)
1 156 PLAUSON. Electric machines operating with high-frequency electro-magnetic wave energy. (5/7/19, Germany.)
1 157 PLAUSON. Converting static atmospheric electrical energy into dynamic electrical energy. (13/11/19, Germany.)
1 158 PLAUSON. Converting static atmospheric electrical energy into dynamic electrical energy. (—/3/15, Germany.)
1 214 DEUTSCHE TELEPHONWERKE GES. Cathode tube transmitters for telephoning with high-frequency oscillations. (29/8/18, Germany.)
1 215 DEUTSCHE TELEPHONWERKE GES. Circuit arrangements for high-frequency telephony. (17/9/18, Germany.)
1 216 DEUTSCHE TELEPHONWERKE GES. Circuit arrangements for stations provided with transmitters and superposed receivers for high-frequency telegraphy. (25/9/18, Germany.)
1 217 DEUTSCHE TELEPHONWERKE GES. High-frequency telegraphy and telephony. (15/11/19, Germany.)
1 228 FELTEN & GUILLEAUME CARLSWERK A.G. Self-induction coil couple for charging duplicate four-fold cores of telephone cables. (3/1/20, Germany.)
1 233 DE MEDICO. Apparatus for recording and reproducing telephone messages. (31/10/19, France.)
1 235 SIEMENS & HALSKE AKT.-GES. Arrangement for telephone installations with intercommunication working. (8/12/16, Germany.)
1 237 SIEMENS SCHUCKERTWERKE. Arrangement for suppression of earth-leakage currents. (31/5/18, Germany.)
1 238 SIEMENS SCHUCKERTWERKE. Arrangement for compensation of charging currents of high voltage net works. (2/6/19, Germany.)
1 243 KRING & STALHANE. Connecting plugs. (27/11/18, Sweden.)
1 291 CATTLEY. Accumulator plates.
1 293 BURSTYN. Determining distances by wireless telegraphy.
1 297 DREYER. Protective device for electric circuits. (12/1/18, Germany.)
1 303 LEDERER. Gas-filled glow discharge lamps. (15/9/13, Austria.)
1 304 LEDERER. Gas-filled glow discharge lamps. (16/9/13, Austria.)
1 305 DEWERGER. Transmission of electrical energy. (16/2/18, France.)
1 306 DEWERGER. Transmission of electrical energy. (15/1/19, France.)
1 307 DEWERGER. Transmission of electrical energy. (21/1/19, France.)
1 308 DEWERGER. Transmission of electrical energy. (8/5/19, France.)
1 317 BOLLINGER. Automatic switches. (19/8/13, Germany.)
1 324 GES. FUR DRAHTLOSE TELEGRAPHIE. Wireless telegraph receivers. (29/8/19, Germany.)
1 325 GES. FUR DRAHTLOSE TELEGRAPHIE. Wireless receiving systems. (2/12/19, Germany.)
1 326 GES FUR DRAHTLOSE TELEGRAPHIE. Wireless telephone transmitters. (11/12/19, Germany.)
1 327 GES FUR DRAHTLOSE TELEGRAPHIE. Automatic adjustment of constants of oscillation circuits. (13/12/19, Germany.)
1 328 GES FUR DRAHTLOSE TELEGRAPHIE. Wireless telephone transmitters. (23/12/19, Germany.)
1 329 GES FUR DRAHTLOSE TELEGRAPHIE. Changing periodicity and tension of a.c. supply. (27/12/19, Germany.)
1 340 JUCHLIZ. Insulating material. (8/8/19, Switzerland.)
1 364 VOGT ENGL & MASSOLLE. Correction of amplitude of high-frequency oscillations (7/4/19, Germany.)
1 371 VOGT ENGL & MASSOLLE. Control of electric currents by sound. (2/8/17, Germany.)
1 397 HEROLD & CO. Switch. (23/1/20, Germany.)
1 406 VOGT, ENGL & MASSOLLE. Electron tubes. (2/12/19, Germany.)
1 419 MOLL-WERKE AKT.-GES. Electric welding machine. (28/4/19, Germany.)
1 420 MOLL-WERKE AKT.-GES. Electrodes for resistance welding machines. (5/6/19, Germany.)
1 421 B.T.-H. CO. A.C. motors. (11/9/14, U.S.)
1 422 B.T.-H. CO. Electric braking. (25/3/18, U.S.)
1 423 B.T.-H. CO. A.C. motors. (28/12/15, U.S.)
1 424 B.T.-H. CO. A.C. motors. (22/12/17, U.S.)
1 425 B.T.-H. CO Motors. (4/1/18, U.S.)
1 427 BIJAR. Electrical apparatus. (8/11/19, U.S.)

Companies' Reports, &c.

CALLENDER'S CABLE & CONSTRUCTION COMPANY, LTD.

Sir J. Fortescue Flannery, Bart., M.P., who presided over the 25th ordinary general meeting of Callender's Cable & Construction Company, Ltd., on the 16th inst., said that the past year had been one of exceptional pressure and difficulty. The volume of business had been very large and had taxed their resources to the utmost. The new workshops for the manufacture of super-tension cable had been completed and were already turning out that type of cable which would be very largely employed in future for electric power distribution. They had also taken over the workshops erected on the company's land for manufacturing war material. The Picardy works had now been completely converted for manufacturing ordinary telephone cable and had been actively employed all the year, and the other shops would also be utilised for more peaceful operations. The year's profit was sufficient to maintain the dividend at the previous year's rate of 15 per cent., to deal effectively with the requirements as to depreciation and to add several thousand pounds to the amount carried forward. Towards the end of the year they began to feel the competition of other nations whose currency had become depreciated and whose workpeople had recognised the necessity to work hard so as to restore the commercial and industrial prosperity of their country. As the trade of those countries improved and their exports increased the advantage they at present enjoyed in a depreciated currency would tend to disappear. The relations between the company and its employees were excellent.

Colonial and Foreign Business.

The managing director (Sir Tom Callender) paid a visit to India during the year and his visit had materially strengthened their position in that country. Their agents in Australia and South Africa had sent them large orders during the period and their recently opened branch in South America had been eminently successful, and large contracts were in hand for that Continent. Further developments were in progress. Their business in the Near East was growing, but had been held up by the present unsettled conditions and exchange disparities. The output of the factories during the earlier months of the current year had exceeded the output for the corresponding period of last year, but there had been grave and serious dislocation within the last few weeks. As a result of the dispute in the coal industry they had found themselves at Erith faced with the alternative of exhausting their stocks of fuel without any possibility of replenishing them, or closing the works. After full consideration, they decided that the better course was to close the factory. The effect of that could not fail to make itself felt in the results of the year, although the directors were hoping that the good trade in the earlier part of the year, and the business which was awaiting the company when they again resumed operations—which they hoped to do immediately—would compensate for any loss incurred owing to that unfortunate stoppage. He said that during 1920 the company paid in rates and taxes a sum equivalent to a dividend of 15 per cent. on the ordinary share capital. That was a very heavy burden and handicapped them, especially in their foreign trade.

Sir Tom Callender said that the expenditure incurred on super-tension work was completely justified and they were looking forward to a great increase in business in that type of cable. They had large orders in hand which would keep them busy for some time to come. Taking the outlook on the whole, they approached the remainder of the year with great confidence, and believed that, subject to any other unfortunate disputes and stoppages occurring, they would have quite a good year.

UNITED RIVER PLATE TELEPHONE COMPANY.

Sir Frederick Green, who presided over the annual meeting of the United River Plate Telephone Company, Ltd., on the 14th inst., was able to give a satisfactory account of the past year's working. The earnings in Argentina and London (including profit on exchange) amounted during 1920 to £1 096 373, against £976 168 in 1919; the expenses, including maintenance, management in Argentina and London, and income and corporation tax, with the usual provision for the depreciation of plant, amounted to £855 606, compared with £764 076 in 1919, resulting in a profit of £240 767, an increase of £28 675 compared with 1919. The working expenses showed a considerable increase, due partly to the growth of the business, but still more to higher wages and costs. The increased telephone earnings were between £90 000 and £100 000, and the total increase in earnings from all sources was over £120 000. The addition to plant account was £374 587, and was much greater than for 1919, and was the largest addition to plant account in the Company's history. Roughly, it was made up of underground wire plant, £118 270; overhead wire plant, £99 056; exchange and subscribers equipment, £157 260. Unfortunately, higher costs account for a considerable part of this increased total. After explaining the other items in the balance sheet, he said they were paying a final dividend of 5 per cent. on the ordinary shares, making, with the interim dividend paid in November last, a total distribution of 8 per cent. for the year, after placing £50 000 to reserve fund and £35 000 to exchange suspense account, leaving £38 367 to be carried forward. They had thought it desirable to create an exchange suspense account in view of the large sum resulting from profit on remittances to this country.

Extensions and Developments.

Sir Frederick stated that a very considerable amount of new plant had been shipped during the year and before long would be brought into service. That would enable them to reduce somewhat the list of waiting subscribers, which amounted to more than the 11 000 in the city of Buenos Aires alone. It would not be possible to satisfy all until their new automatic exchanges were working, and that could not take place until early next year. During the year under review 5 431 new subscribers had been added, making the total number of stations 83 602, against 78 171 at the end of 1919. Those additions had been rendered possible by opening a new exchange, the first part of which was completed during last year, and also by certain extensions ordered in 1917, but which they were only able to bring into service in 1920. The new Rivadavia exchange was a fine building, well adapted for its purpose and when extended over the whole site would accommodate also the Libertad exchange, in addition to a considerable portion of the engineering staff. Further new buildings were in course of erection in the Federal capital for their automatic exchanges; as the Government had suspended certain regulations which had held up their trunk line construction some hundreds of miles of new trunk routes had been constructed, enabling a number of towns to communicate with the capital. The Company had also recently absorbed several small independent enterprises, and they would form the nucleus of new systems they intended to establish. In addition to those small concerns they had entered into an arrangement to take over as from the 1st July the telephone system known as La Bahiense, operating with 3 185 subscribers in the south-west of the Province of Buenos Aires, with headquarters at Bahia Blanca. That enterprise was the second largest of the local telephone companies in the Republic. The system would strengthen the company's position in that portion of the Province of Buenos Aires, and as soon as possible it was intended to connect Bahia Blanca to the Federal capital. They had still a great deal of work in front of them and for the current year their capital expenditure would probably be heavy. They had therefore decided to issue 108 000 new ordinary £5 shares.

GLOBE TELEGRAPH & TRUST COMPANY.

Sir John Denison-Pender, G.B.E., K.C.M.G., who presided over the forty-eighth ordinary general meeting of the Globe Telegraph and Trust Company, Ltd., on Tuesday, prefaced his remarks by a reference to the loss sustained by the company through the death of Sir James Pender. He said the company's financial year, which ended on May 31 last, had again been a very prosperous period. The total receipts, after deducting working expenses, amounted to £287 802, an increase of £23 821 compared with the preceding year. With the balance brought forward the total was £289 181, which was by far the largest figure it had ever been the board's privilege to report. Out of those receipts they had paid to their preference shareholders the three usual quarterly dividends of 3s. per share (less tax), and to their ordinary shareholders three interim dividends of 5s. per share net. They now recommended payment of a final dividend of 3s. per share on the preference shares, making 6 per cent. (less tax) for the year; and of 5s. per share on the ordinary shares, making a total of 10 per cent. net. The year under review must be treated as an exceptional or transitional one for dividend purposes, owing to the difference in the dates on which the cable companies commenced to pay their dividends on the new shares, as compared with the dates on which the Globe Company paid their dividends. As the Trust derived its income solely from its investments in the shares of other companies, the directors would not make any forecast as to the future. Without in any way binding themselves as to what might be done in years to come, they had decided to pay the dividend on the ordinary shares for the current year in equal quarterly payments of 5s. per share, and not, as formerly, pay small interim dividends and retain a larger sum to be paid at the end of the year. The directors regarded the present position and the prospects of the Trust as highly satisfactory, and the present market value of its securities showed an appreciation over the original capital invested of more than £1 500 000.

WEST INDIA & PANAMA TELEGRAPH REPORT.

The report of the Directors of the West India & Panama Telegraph Company, Ltd., for the year 1920 states that the amount to credit of revenue is £80 177, but the expenses have been £138 325, resulting in a loss on the year's working of £58 148. From this are deducted £10 033 brought forward, and interest on investments (£2 104), leaving a net deficiency of £46 011 for the year. In addition the balance of the cost of the third survey of the Company's cable ship (£38 579) fell to be dealt with. Inasmuch as the total cost was £74 253, of which a part (£35 674) was dealt with in the accounts of 1919, the directors have added the £38 579 to the original cost of the ship, being satisfied that the increased amount at which she thus stands in the books is within her present commercial value.

The unfortunate position of the Company is due mainly to the cumulative results of entrusting the Cable ship, "Henry Holmes," to the Government Dock at Trinidad for her third survey repairs in 1919, and, in a lesser degree, to the increases in working expenses. In a cable system like that of the Company breaks must occur from time to time, and, as it was only occasionally possible to secure the services of other repairing ships, the conditions gradually became worse and worse, so much so that in the spring of 1920, when it was found possible to charter a ship for five months, there were as many as sixteen of the cables interrupted. Although the chartered ship worked well, some sections were still interrupted when the "Henry Holmes" was released from Trinidad, early in October last. It is a matter of experience that telegraph traffic, when lost, is recovered but slowly, and, although by the end of 1920 it was steadily moving towards recovery, the traffic receipts during the year were over £30 000 below those of 1919. Another consequence of the interruptions was the loss of over £10 000 of the Imperial, Canadian and Colonial subsidies. The hiring of cable ships in the nine months cost at least £28 000 more than the expenses of the "Henry Holmes" would have been, and there was also an expenditure of £2 109 in the hire of sloops for Inter-Colony communications. Of the increases in expenses an important one was in respect of cable. With such an accumulation of interruptions a large quantity of cable had to be used in repairs, of which the cost was £19 683, compared with an average of £9 253 for each of the three preceding years. Another large increase was in respect of the "Henry Holmes," and there was also some increase in the expense at the stations.

To meet the general heavy expenses in 1920, coupled with loss of revenue, it was necessary to sell the bulk of the Company's investments. Owing to the state of the money market the sales realised only £66 027 for securities which had cost £96 582. The position at the end of 1920 was so difficult that the directors decided to approach the Treasury for financial help. Their Lordships were unable to accede to the request for a special grant, but they were good enough to obtain the sanction of the House of Commons to the waiving of clause 14 of the agreement of 1914, under which the Company could have been called on to repay as much as £13 000 of the Imperial and Canadian subsidies for the year 1919. In consideration of this relief the directors agreed that whenever the cable between British Guiana and Trinidad is interrupted (as it is at present) the subsidy payable by British Guiana shall be reduced by three-fourths. For the first four months of this year the traffic receipts, although not as large as in 1919, show a considerable increase over 1920; and, now that the cable ship is available for repairs, it is hoped there will be no check on the growth of traffic. But in any event it will be recognised that, in view of the debit balance of £76 566, there can be no question of dividends for the year 1920.

The MACKAY COMPANIES have declared a dividend of 1½ per cent. less tax) on the common stock for the quarter, payable July 1.

During the week the PERNAMBUCO TRAMWAYS & POWER COMPANY, LTD., invited applications for an issue of £500 000 8 per cent. prior lien bearer debentures at 96.

The directors of the CHLORIDE ELECTRICAL STORAGE COMPANY, LTD., announce a dividend of 5 per cent. (tax free) on the ordinary shares, making 10 per cent. for the year, placing £25 000 to reserve, £5 000 to employees' benefit fund, and carrying £23, 340 forward.

The directors' report of EDMUNDSON'S ELECTRICITY CORPORATION, LTD., for the year ended March 31 states that, after providing for income tax, mortgage and note interest and debenture stock charges, the net profit amounts to £16 053, compared with £8 099 for the previous year. With the balance of £10 090 brought forward, the total profit available is £26 143, which the directors recommend should be applied in paying the dividend for one year on the cumulative preference shares (£12 000), leaving to be carried forward £14 143. At the end of the year the 22 undertakings in which the company is interested had a connected load of 134 259 kW (against 122 233 kW in 1919) and the gross profit was £299 774, compared with £208 622.

Prices of Metals, Chemicals, &c.

		TUESDAY, June 21.		
		Price.	Inc.	Dec.
Copper—				
Best selected............	per ton	£73 0 0	—	£1 0 0
Electro Wirebars ...	,,	£78 0 0	—	£1 0 0
H.C. wire, basis	per lb.	0s. 11⅞d.	—	⅛d.
Sheet	,,	1s. 0½d.	—	—
Phosphor Bronze Wire (Telephone)—				
Phosphor-bronze wire, basis	,,	1s. 3⅞d.	—	⅛d.
Brass 60/40—				
Rod, basis	,,	0s. 8½d.	—	—
Sheet, basis	,,	1s. 1¼d.	—	—
Wire, basis	,,	1s. 1¼d.	—	—
Pig Iron—				
Cleveland Warrants .	per ton	£6 10 0	—	—
Galvanised steel wire, basis 8 SWG	,,	£27 0 0	—	—
Lead Pig—				
English	,,	£23 5 0	—	£0 10 0
Foreign or Colonial ...	,,	£22 2 6	—	£0 7 6
Tin—				
Ingot	,,	£167 0 0	—	£0 5 0
Wire, basis	per lb.	2s. 3¾d.	—	—

Salammoniac.—Per cwt. 75s.-70s.

Sulphur (Flowers).—Ton £15.

,, (Roll-Brimstone).—Per ton £14 10s.

Sulphuric Acid (Pyrites, 168°).—Per ton, £9 17s. 6d.

Copper Sulphate.—Per ton £30.

Boric Acid (Crystals).—Per ton £69.

Sodium Bichromate.—Per lb. 7½d.

Sodium Chlorate.—Per lb. 4¼d.

Rubber.—Para fine, 11d.; plantation 1st latex, 8d. lb.

The metal prices are supplied by British Insulated & Helsby Cables.

The Editorial, Advertisement and Publishing Offices of "THE ELECTRICIAN" *are at* 8, *Bouverie Street, London, E.C.* 4. *Telegrams: Benbrotic, Fleet, London. Telephone: City* 9852 (5 *lines*).

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Forty Years Ago.

(THE ELECTRICIAN, JUNE 25, 1881.)

ELECTRIC LIGHT AT KING'S CROSS.—The Great Northern Railway Company have adopted the Crompton electric light at their station at King's Cross.

OVERHEAD V. UNDERGROUND WIRES.—The vestry of Plumstead the other day refused their sanction to the erection of six iron telegraph poles along Burnt Ash-lane, at Lee, by the General Post Office.

THE ELECTRIC LIGHT AT SOUTH KENSINGTON.—At the opening of the Domestic Economy Congress on Monday last at the Albert Hall, the Royal Horticultural Society's Gardens were illuminated by electric lights. The effect is described as having been most beautiful.

ELECTRICITY AMONG THE NIHILISTS.—Amongst the officers arrested as implicated in the proposed plot on the guard ship off Peterhoff against the Czar's life was a certain Lieut. Khotinski, who is also implicated in the Mala Sadowa-street mine. He has been connected with electric light production, and is said to be a man of scientific mark.

OVERTIME.—The Postmaster-General has explained that the clerk attached to the Western London District who is suffering from mental derangement owing to excessive work undertook the overtime voluntarily, but that steps would be taken under the new scheme to guard against such prolonged duties. The sick man in this instance will receive full pay.

Benn Brothers Journals.

SOME FEATURES OF THE CURRENT ISSUES.

"Aeronautics": "The Subsidy Scheme"; and "On Board R.36."

"The Cabinet Maker" (Merchant Shippers' Issue): "Coloured Plate: New Cushions in Suede Leather and Silk"; "Sale of Furniture at Stowe"; and "Restoration of the Red Lodge, Bristol."

"Chemical Age" (Special Number): "Works Organisation and Management"; "Works Management in America," by Ernest J. P. Benn; and "Economical Upkeep of Chemical Plant and Machinery," by C. W. Brett.

"Farm and Home": "The Wages Problem"; "Lesser Live Stock in the Winning Lists" (illustrated); and "Hay-making on Easy Lines."

"The Fruit-Grower": "Covent Garden from the Air" (illustrated); "Current Work in the Nursery"; and "State of the Fruit Crops."

"Gardening Illustrated": "Starting an Orchard"; "Pruning Flowering Shrubs"; and "A.B.C. of Gardening."

"The Gas World": Annual Meeting of French Gas Engineers at Tours; "A Study in Natural Gas"; and "Gas-workers and Coal Miners."

"Hardware Trade Journal" (Special Shipping Number): "Review of Foreign Hardware Markets"; and "Competitive Hardware" (illustrated).

Arrangements for the Week.

FRIDAY, June 24th (to-day).

PHYSICAL SOCIETY.

5 p.m. At the Imperial College of Science, South Kensington, London, S.W. Papers to be read: "Capacity and Eddy-current Effects in Inductometers," by Mr. S. Butterworth, M.Sc.; "New Specific Heat Apparatus," by Dr. E. Griffiths; "On Encounters between Non-spherical Gas Molecules," by Prof. A. O. Rankine, D.Sc.; and "An Electro-Culture Problem," by Dr. C. Chree, F.R.S.

MONDAY, June 27th.

ELECTRICAL TRADES' BENEVOLENT INSTITUTION.

2.30 p.m. At the Cable Makers' Association, Sardinia House, Sardinia Street, London, W.C. Meeting to confirm alterations made to the Rules.

INSTITUTION OF MECHANICAL ENGINEERS.

Thursday, June 30th.

10.15 a.m. At Storey's Gate, London, S.W. Conference on The Means of Increasing the Thermal Efficiency of Heat Power Units.

Friday, July 1st.

10.30 a.m. Conference concluded.

INSTITUTION OF CIVIL ENGINEERS.

Tuesday, June 28th.

9 p.m. At Great George Street, London, S.W. James Forrest Lecture on "Fuel Problems of the Future," by Sir George T. Beilby, F.R.S.

Wednesday, June 29th.

10 a.m. Engineering Conference opened by the President.

9 p.m. Series of Photographs to be shown by Sir Alexander B. W. Kennedy, F.R.S.

Thursday, June 30th.

10 a.m. Various Papers to be discussed.

Friday, July 1st.

10 a.m. Further discussion on various subjects and close of Conference.

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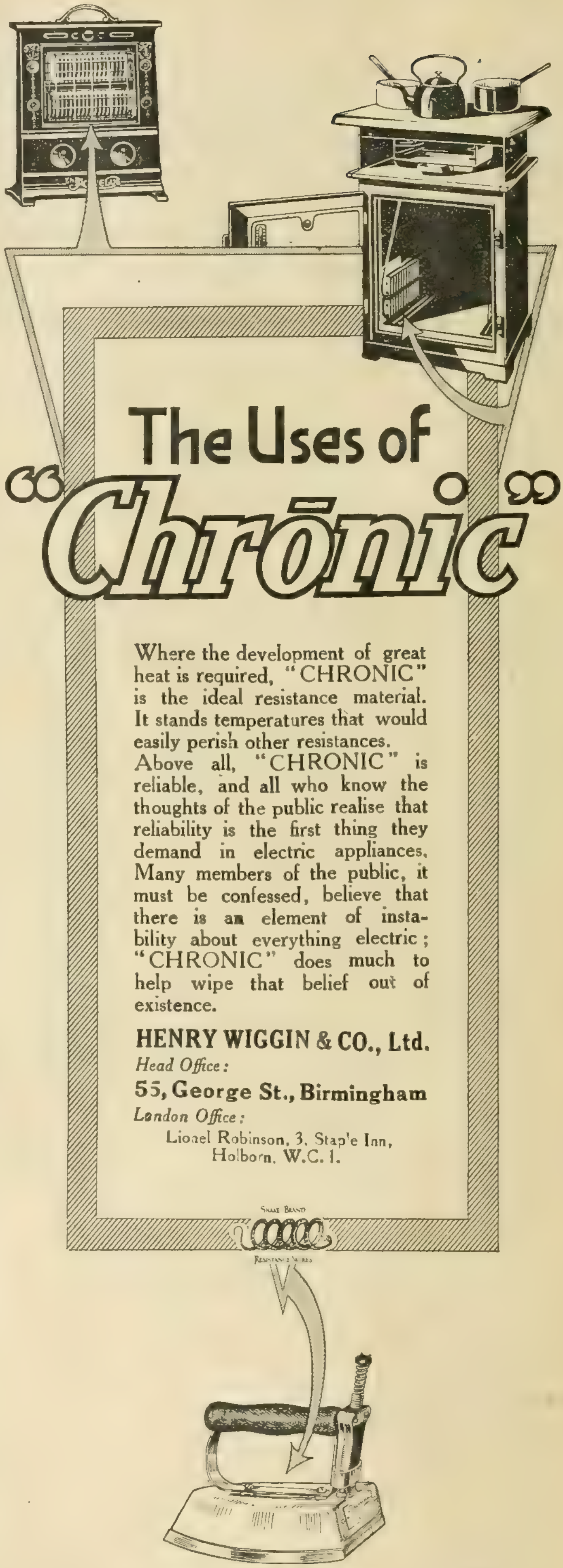

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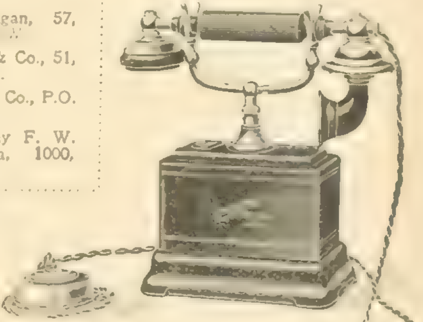

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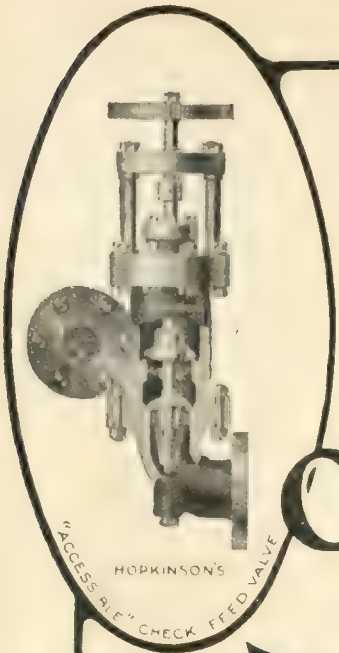

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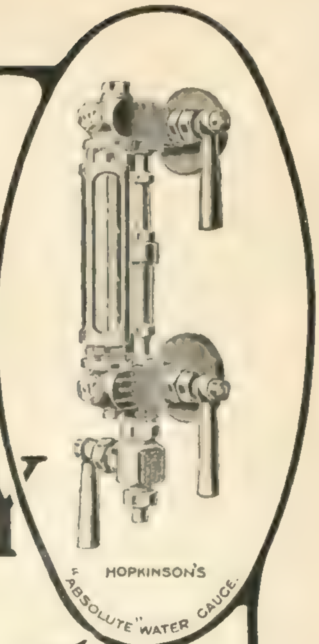

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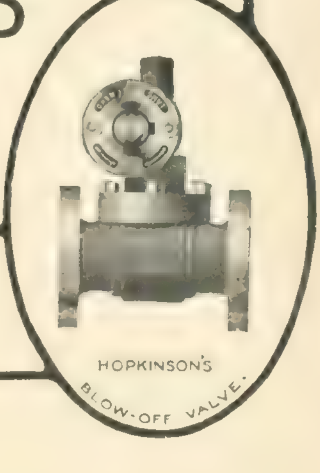

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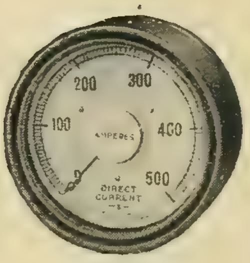

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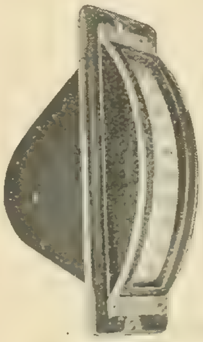

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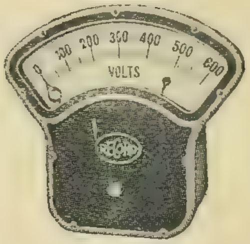

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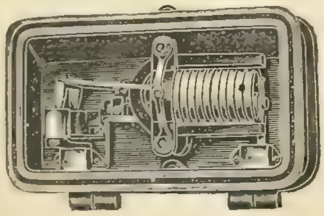

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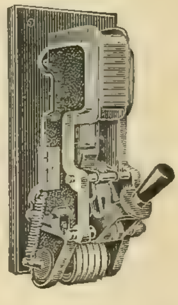

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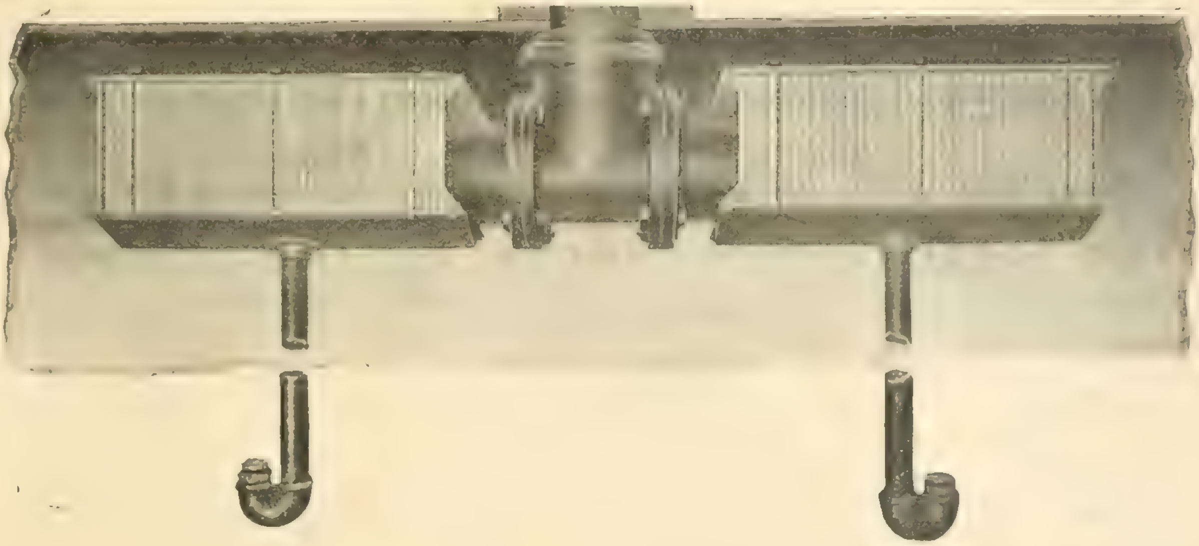

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